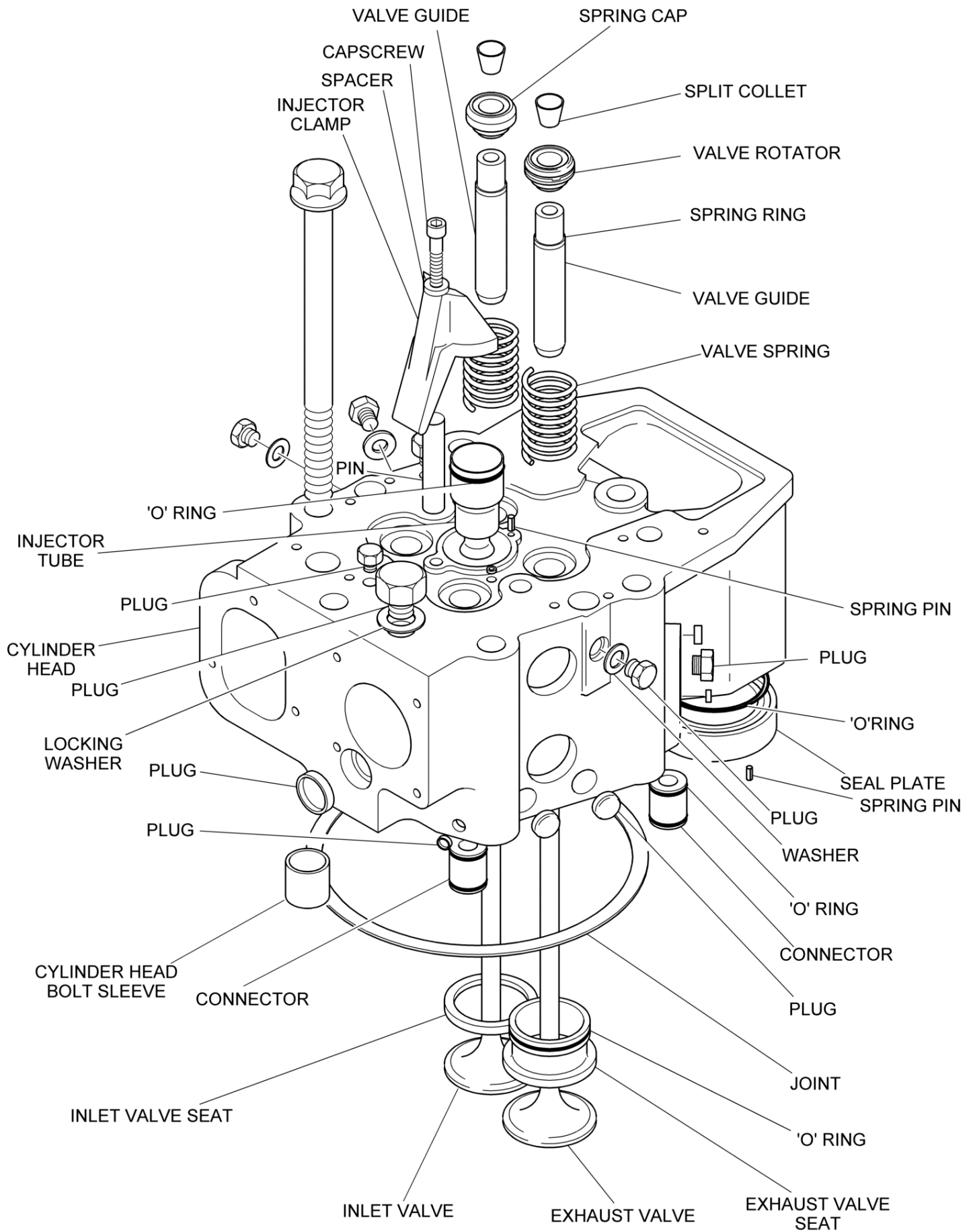


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Introduction

The individual cylinder heads (**Fig.1**), of alloy cast iron, are secured to the crankcase by six bolts and a joint ring is fitted between the cylinder head and the cylinder liner to form a gas tight seal.

Cylinder heads are water cooled, the water being fed from the crankcase to each cylinder head through connectors into the internal passages. Drillings in the cylinder head are used to feed filtered fuel to the injectors. Fig 1 cylinder heads in situ

Each cylinder head carries two inlet valves and two exhaust valves together with the necessary split collets and springs and a fuel injector housed in a tube.

The valve seats are hard-alloy inserts pressed into the cylinder head, the nitro-carburised exhaust valve seats are water cooled.

Inlet and exhaust valves are made of heat-resisting steel and work in detachable guides, each valve being loaded by an inner and an outer spring, with each pair of springs sandwiched between the cylinder head and an upper spring plate locked to the valve by a pair of split collets.

Maintenance

For maintenance hours see schedule

C-Interval

Renew rocker cover joints

F-Interval

Decarbonise and crack detect head. Regrind valves and inlet seats if necessary. Renew all seals and O rings.

G-Interval

Renew valves, seats and guides.

H-Interval

Replace bolts.

Removal

1. Drain down jacket cooling water system.
2. Evacuate fuel feed system, see section G04.
3. Remove rocker cover (**Fig.2**).
4. Disconnect jacket outlet rail from cylinder head (**Fig.3**).



Fig 1 cylinder heads in situ

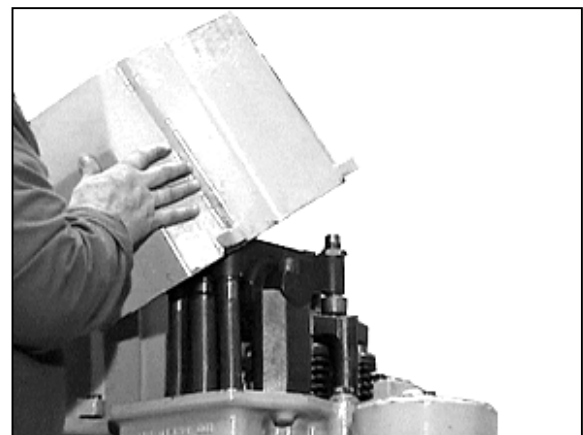


Fig.2 Remove the rocker cover

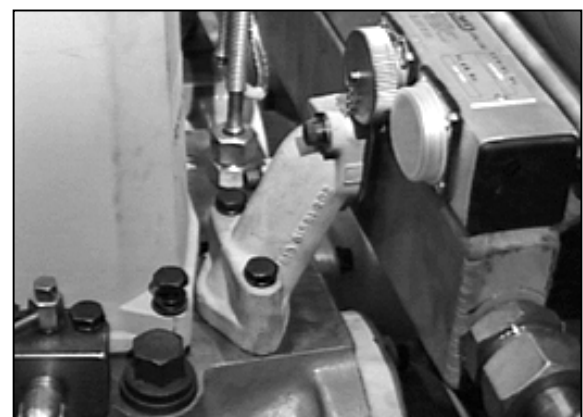


Fig.3 Disconnect the jacket outlet rail from the cylinder head

5. Disconnect fuel supply bridges (**Fig.4**).
6. Disconnect air inlet and exhaust flanges (**Fig.5**).
7. Slowly remove the two cap screws locating the rockers to release spring pressure.

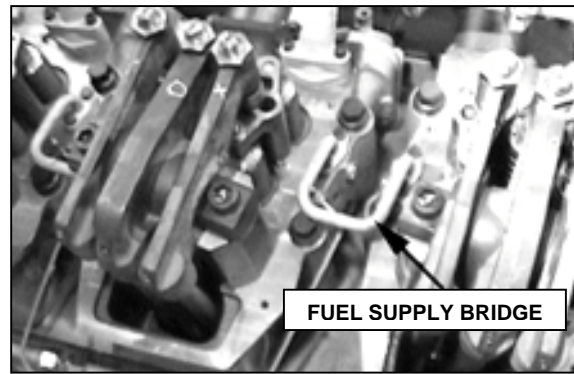


Fig.4 Disconnect the fuel supply bridges.

8. Remove rocker assembly, see section D02.
9. Remove bridge pieces.
10. Withdraw push rods.

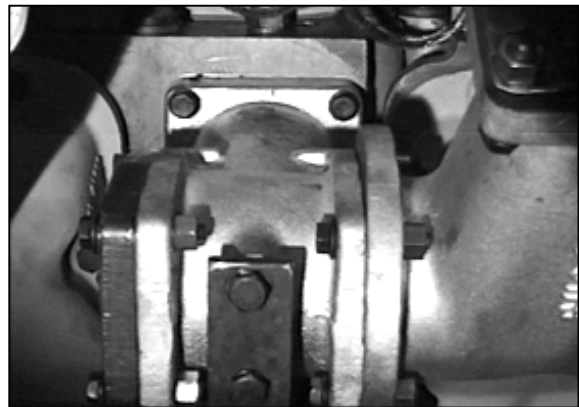


Fig.5 Disconnect the exhaust flanges

11. Remove unit injector, see section G04.
12. Release and remove cylinder head bolts.
13. Fit eye bolts in the tapped holes for the fuel supply bridge (**Fig.6**).
14. Lift cylinder head, ensuring that water transfer tubes do not fall away (**Fig.7**).



Fig.6 Fit eye bolts to the tapped holes.

CAUTION:-Take care not to damage sealing face on cylinder head or damage unit injector nozzle if still fitted.

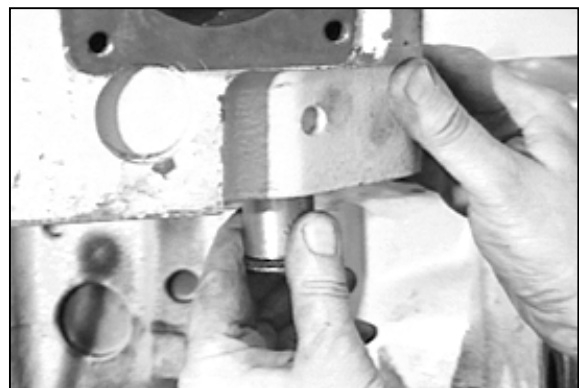


Fig.7 Ensure the water transfer tubes do not fall away.

Dismantling

Valves and springs

1. Fit the plate and stud of the compressor tool through the injector hole from the combustion face side.
2. Screw the pivot socket onto the stud (**Fig.8**).
3. Position the stirrup on top of the spring cap, press down (**Fig.9**) and remove the collet .
4. Extract the collets (**Fig.10**) then release the compressor tool slowly; remove the tool and withdraw the valve springs caps and springs.
5. Turn the head on its side and remove the valves (**Fig.11**).
6. Examine the valve guides, valves, valve seats and injector tubes. Replace any as necessary in accordance with instructions in OVERHAUL REPLACEMENT PROCEDURES on page 6.

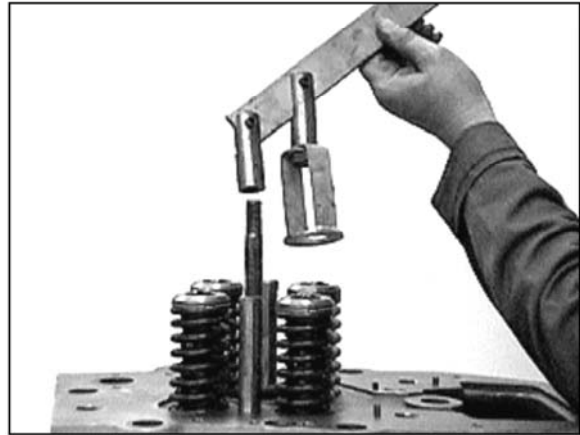


Fig.8 Fit the pivot socket to the stud.

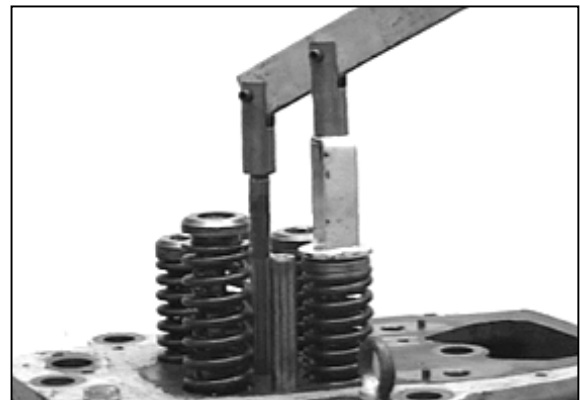


Fig.9 Press down on the spring cap.



Fig.10 Carefully extract the collets.



Fig.11 Remove the valves.

Overhaul replacement procedures**Valve guides**

1. Using a rod of suitable dimensions (**Fig.12**) press the valve guides out of the cylinder head from the combustion chamber face.
2. Inspect the new guide to ensure that it is clean and undamaged, particularly on the top and bottom edges, then coat it with a mixture of white lead and tallow and ensure that the split ring is located in its groove (**Fig.13**).
3. Press the guide into the cylinder head, from the top until the circlip meets its mating face.

CAUTION:-Use a brass or copper pad to protect the top face of the valve guide.

4. Regrind valves and cut valve seats using hunger valve seat cutting machine

CAUTION:- The exhaust valve seats are nitro-carburised and must NOT be refaced.

Injector tubes

These normally require no maintenance but if, because of water leakage, it becomes necessary to change a tube, proceed as follows.

1. Place the cylinder head, with the combustion face uppermost, on a bench.
2. Thread the injector tube 1/2 in B.S.P., taking care not to damage the cylinder head.

NOTE:- Although a "full" thread is not produced, it will be sufficient to enable the tube to be removed.

3. Screw a suitable plug into the tapped portion of the tube and using a suitable drift drive out and remove the tube (**Fig.15**). In cases where removal is difficult the chamfered face of the tube should be drilled away.

CAUTION:-Care must be taken not to damage the cylinder head.

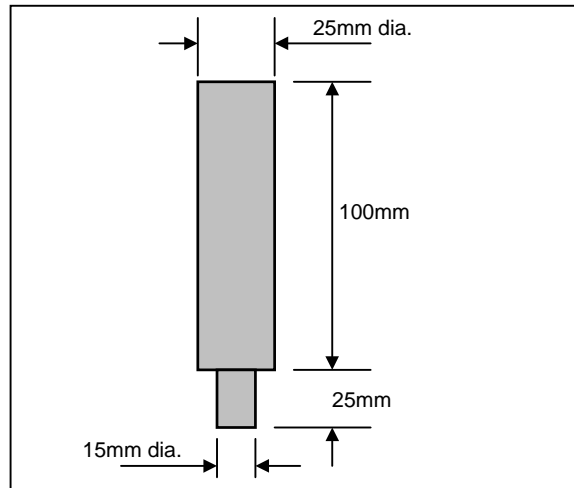


Fig.12 Suitable rod dimensions to press out the guides.



Fig.13 Fit the split ring to the valve groove.



Fig.14 Injector tube and 'O' ring.

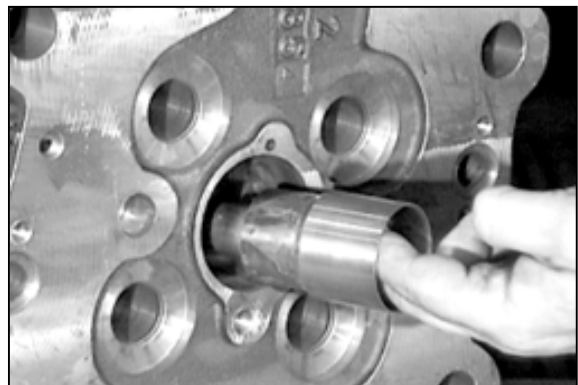


Fig.15 Drive out and remove the injector tube.

4. Clean out the tube housing in the cylinder head, ensure that the new tube is clean and free from burrs.
5. Fit a new 'O' ring into the cylinder head (**Fig.16**) and press or lightly tap the tube into position to be firmly seated on the lower face.

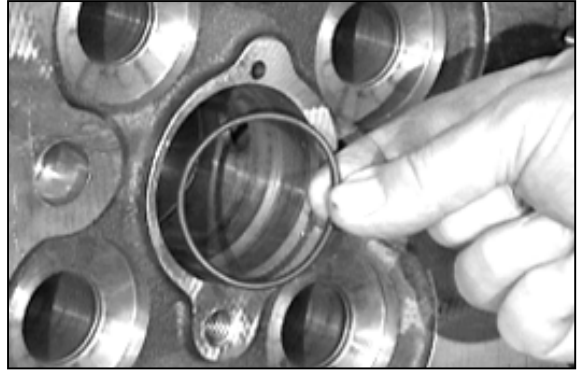


Fig.16 Fit a new 'O' ring into the cylinder head.

6. Using the injector tube expander tool (**Fig.17**) roll out the bottom of the tube.
7. Assemble injector tube swaging tool (**Fig.18**) into cylinder head as shown. Ensure that the shoulder press is firmly seated inside the injector tube and that the retaining clamp is seated firmly on the cylinder head and shoulder press.



Fig.17 Injector tube expander tool and tube.

8. Tighten retaining clamp cap screw.
See DATA for tightening torque.

9. Tighten swaging nut.
See DATA for tightening torque.

10. Remove injector tube swaging tool and water test the cylinder head to a pressure of 7 bar.

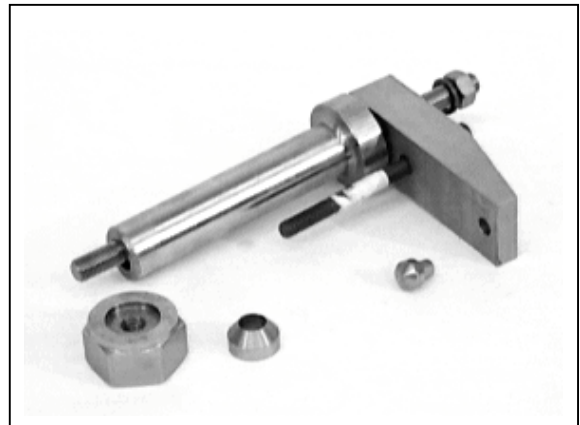


Fig.18 Swaging tool.

Valve seats

When a valve seat is worn to the limit i.e., to the corner of the original profile as shown in the VALVE SEAT REFACING instruction, it should be removed and replaced as follows.

1. Fit an extraction tool to the cylinder head (**Fig.19**) and withdraw the seat.



Fig.19 Fit the extraction tool to the cylinder head.

2. Press or draw the new insert into the cylinder head (**Fig.20**). If replacing an exhaust valve seat also replace the 'O' ring and coat the outer edge, at the seat end, with 'Hi-strength sealant'.
3. Reface the replaced valve seat.



Fig.20 Press the new insert into the cylinder head.

Cup plugs

These normally require no maintenance but if, because of water leakage, it becomes necessary to change one proceed as follows.

1. Remove the old cup plug.
2. Clean out the hole, removing all traces of old sealant.
3. Coat the outer edge of the cup plug with 'Hydraulic sealant'.
4. Press the cup into position (**Fig.21**).

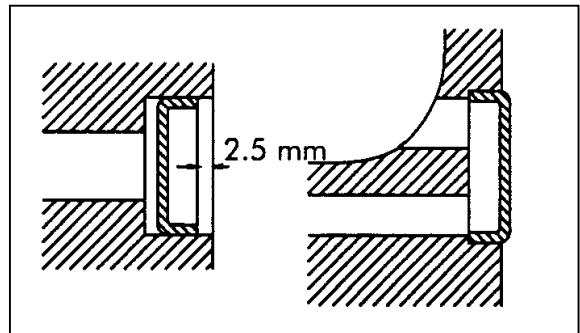


Fig.21 Press the cup into position.

PROCEDURE FOR MEASUREMENT OF VALVE STEM/VALVE GUIDE CLEARANCE

The valve stem/valve guide clearances are best measured by the amount of movement of the valve head when at its "full lift" position (**Fig i**).

The valve lift is 22 mm for both inlet and exhaust valves

To measure the valve stem/valve guide clearance proceed as follows:

1. Remove valve caps/rotators valve collets and springs from the valves
2. Remove valve from guide and ensure the stem and guide bore are not damaged or worn (check diameters as shown in Data). Make sure the valve head and stem are clean and dry.
3. Refit inlet or exhaust valve to its valve guide and pull the valve out of the guide a distance of 22mm.

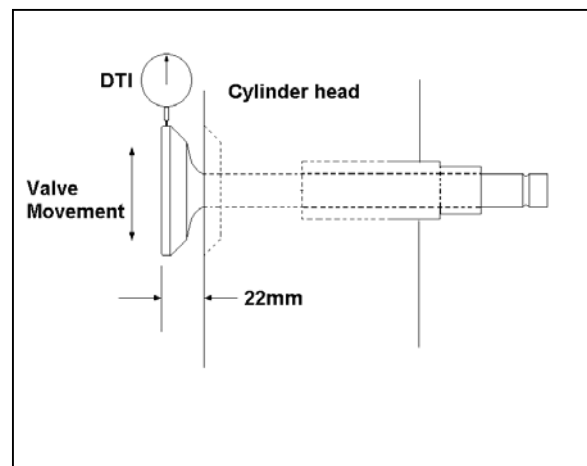


Fig.i measurement of valve in full lift position.

4. Assemble a dial indicator (DTI) on the rim of the valve head by means of a magnetic base attached to the cylinder head flame face
5. Zero the DTI
6. Move the valve and record the total amount of movement on the DTI.
7. Repeat the test in two mutually perpendicular directions
8. The allowable movement measured at the valve head are as follows:

Exhaust valve:

Movement	as new	0.23mm/0.38mm
	Max allowable	0.6mm

Inlet valve:

Movement	as new	0.10mm/0.22mm
	Max allowable	0.36mm

Assembly

1. Coat the valve stems with graphited oil, then fit the valves to the head.
2. Fit the valve spring and the spring caps.
3. Compress the springs with the compressor (**Fig.22**) and fit the taper collets to the valve stem.
4. Ease off the spring compression tool evenly and gradually, checking that the collets are correctly seated.
5. Fit the connector tubes with new 'O' rings and fit the tubes to the cylinder head (**Fig.23**).
6. Replace the 'O' rings in the seal plate and fit to the cylinder head, retain in position with the spring tension pins.

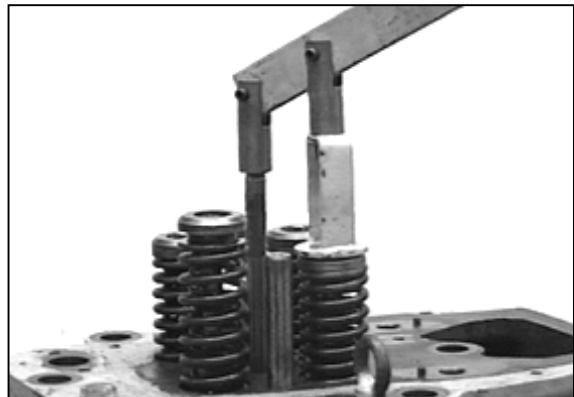


Fig.22 Compress the spring with the compressor and fit the collets.

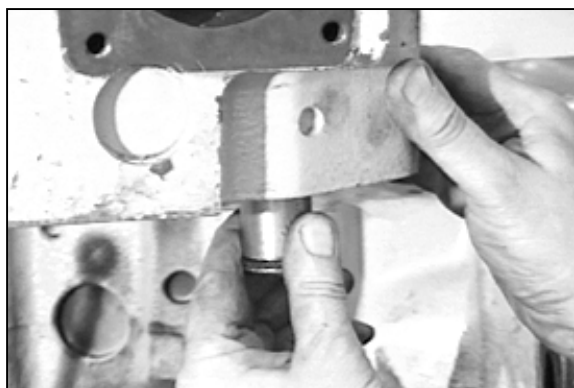


Fig.23 Fit new 'O' rings to the connector tubes and fit to the cylinder head.

Refitting

1. Ensure that the liner and cylinder head joint faces are clean and free from bruises and other damage.
2. Fit a new cylinder head joint to the step in the liner flange (**Fig.24**).
3. Lower the cylinder head in to position on the engine; ensuring that the connector tubes, seal plate and joint are in their correct positions.
4. Lightly lubricate the threads and underside of the cylinder head bolts with engine oil.
5. Tighten all bolts diagonally (Fig.25) to a torque between 90 and 100Nm.
6. Mark the bolt head and make a corresponding mark on the cylinder head.
7. Further rotate the bolts by an angle of $180^{\circ} \pm 1^{\circ}$.

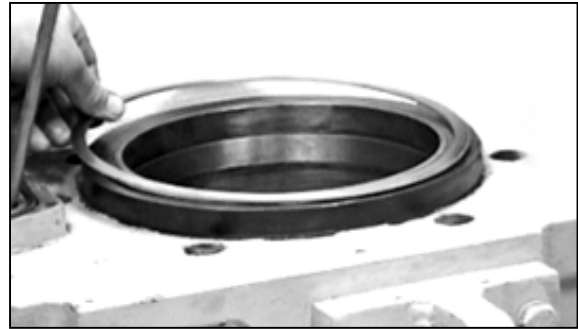


Fig.24 Fit a new cylinder head joint.

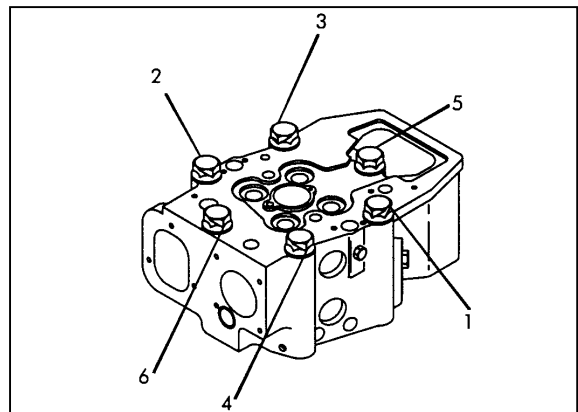


Fig.25 Tighten the bolts in the sequence above

NOTE:- Should the final two bolts be found to have become finger tight after tightening four bolts up to final stretch. Do not re-apply the 100Nm torque but only rotate by 180° as in point 7.

8. Refit associated equipment.

Special tools

Cylinder head lifting bracket	80.561.02386.100
Eyebolt (for lifting head)	86.561.02349.701
Valve spring compressor	80.561.02320.C01
Injector tube expander	80.561.02429.701
Injector tube fitting tool	80.561.02429.C01
Valve seat extractor (exhaust)	86.561.02336.C01
Valve seat extractor (inlet)	80.561.02459.C01
Valve seat installer	86.561.02335.301

DataValve guides - inlet

Bore diameter	16.000/16.018mm
Outer diameter	28.028/28.038mm

Valve guides - exhaust

Bore diameter	16.000/16.018mm
Outer diameter	28.028/28.038mm

Inlet valve

Head diameter	78.3/78.6mm
Seat angle	29.5°/30.0°
Stem diameter	15.930/15.955mm
Clearance of valve in guide	0.045/0.088mm

Exhaust valve

Head diameter	72.0/72.3mm
Seat angle	44.4°/45.0°
Stem diameter	15.882/15.907mm
Clearance of valve in guide	0.093/0.136mm

Inlet valve seat

Outside diameter	80.085/80.11mm
Seat angle	30.0°/30.5°

Exhaust valve seat

Outside diameter	80.106/80.127mm
Seat angle	45.0°/45.5°

Valve spring

Free length	117.5mm
Minimum allowable	110mm

External diameter (maximum)	52.5mm
Internal diameter (minimum)	38mm +/-0.5mm

Cylinder head

Valve guide bore	28.000/28.021mm
Valve seat bore	74.0/73.7mm
Cylinder head bolt torque (See Points 4-7 page 10)	100Nm + 180° turn

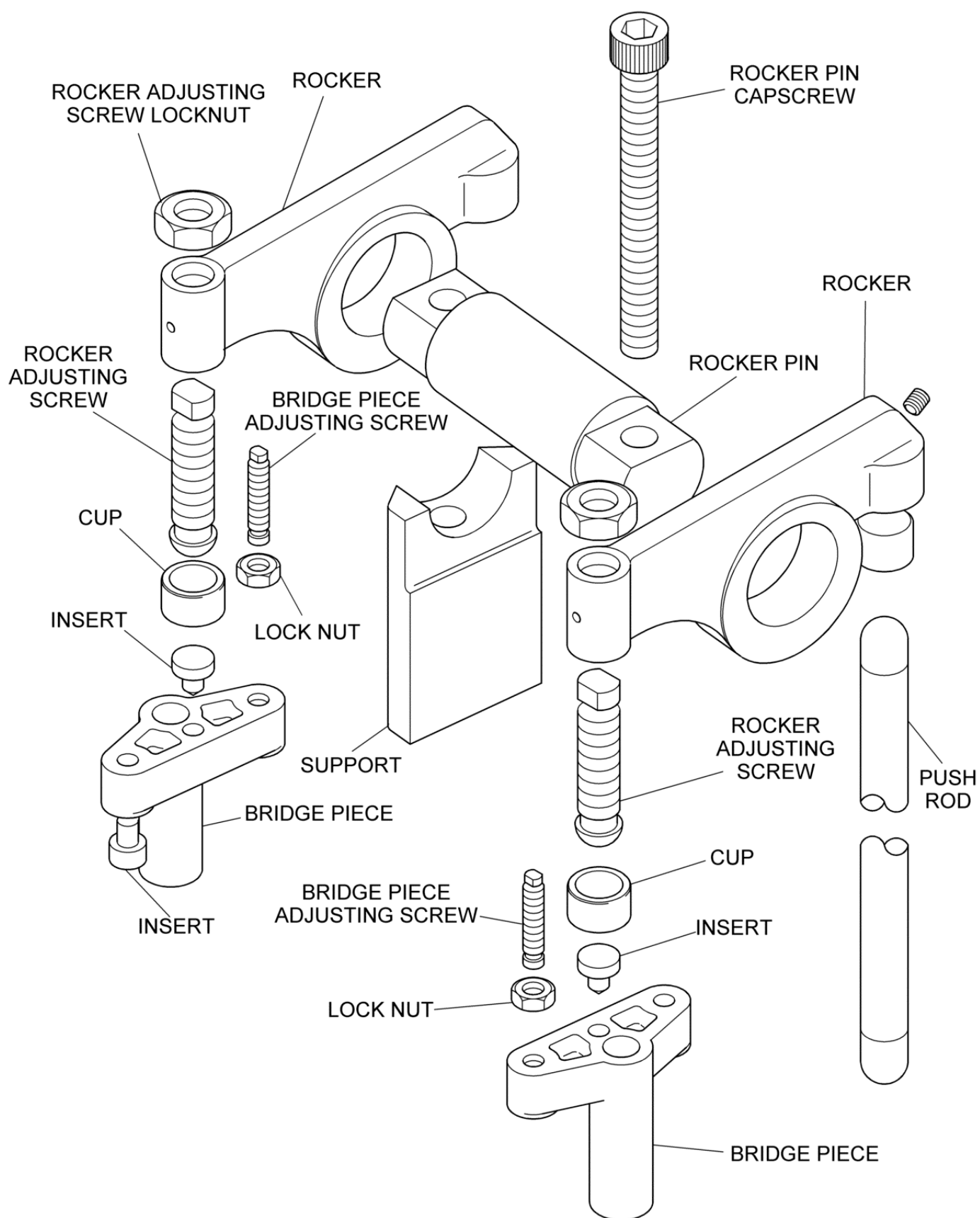
Injector tube clamp

Retaining clamp cap screw torque	150Nm
Chamfer clamp nut torque	First 66Nm Second 130Nm Last 110Nm

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Introduction

Each pair of valves is operated by a guided bridge piece which has a screw adjustment. This allows for compensation to be made for unequal valve stem length caused by varying rates of wear of the valve face and seat.

The valves are operated through rocker levers, push rods and cam followers by the inlet and exhaust cams. The rocker levers have pressed-in bushes and pivot on a hardened steel shaft common to the inlet valves, exhaust valves and injector rocker levers.

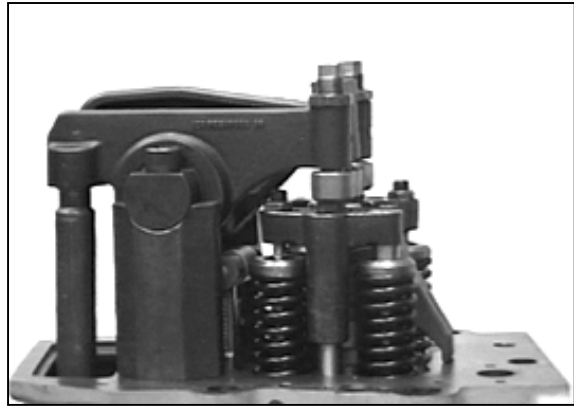


Fig.1 Cylinder head valve gear.

Maintenance

For maintenance hours see schedule

B-Interval

1. Check the clearance between the rocker lever and the bridge piece for each pair of valves (**Fig.3**) and adjust as necessary.
2. With the engine running check the cylinder head joints, and fuel connections for leaks.
3. Ensure that there is an adequate oil supply to the valve gear.

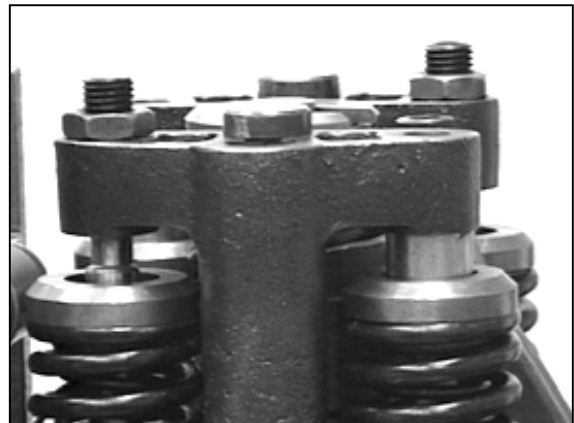


Fig.2 Bridge pieces.

F-Interval

Thoroughly clean all valve gear components, inspecting them for wear or damage and renew any which are found to be worn or defective.

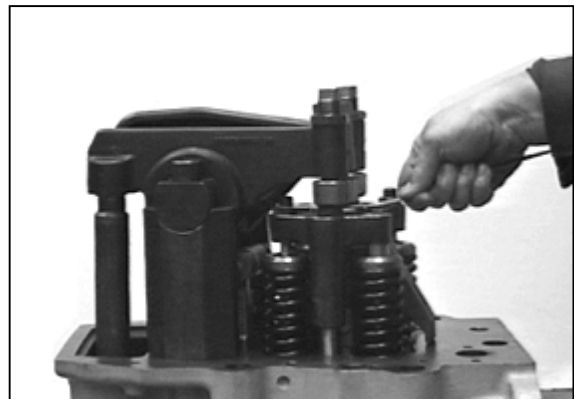


Fig.3 Check the clearances.

Dismantling

1. Bar the engine round to T.D.C. on the firing stroke of the cylinder concerned.
2. When removing the rocker supports care should be taken not to lose the locating pins (**Fig.4**).
3. Remove the push rods; noting from which position they have been removed; and remove the bridge pieces.
4. Check all components for wear or damage renewing items as necessary.

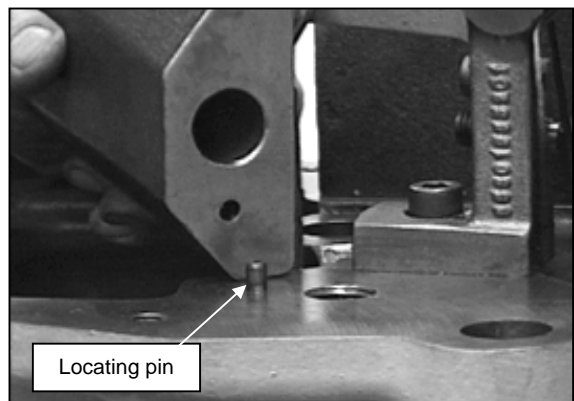


Fig.4 Do not loosen the locating pin.

Assembly

Ensure that all parts are clean and lightly oiled and replace in reverse order of dismantling.

Torque the two cap screws, retaining the rocker pin, to 450Nm.

Adjustment

The clearances between the rocker lever and the bridge piece, for each pair of valves, should be checked with the engine cold and the valves fully closed.

The correct clearances are quoted in DATA.

Check the clearances on each cylinder when its respective piston is at T.D.C. on the firing stroke. By checking all cylinders in the firing order sequence all can be dealt with in two revolutions of the crankshaft.

1. Bar the engine round to T.D.C. on the firing stroke of the cylinder concerned.
2. Set the adjuster on the bridge piece so that both valves will open simultaneously (**Fig.5**), torque the bridge piece locknut to 80Nm.
3. Release the locknut on the rocker lever adjusting screw and check the clearance, with feeler gauges (**Fig.6**), between the adjuster and the insert in the bridge piece.
4. Torque the locknut to 150Nm and re-check the clearance.



Fig.5 Set the adjuster on the bridge pieces so both will open simultaneously.

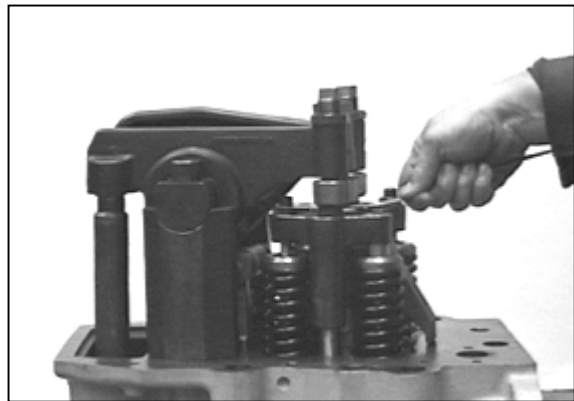


Fig.6 Check the clearances with feeler gauges.

Data

Inlet valve clearance - cold	0.38mm
Exhaust valve clearance - cold	0.63mm
Rocker pin diameter - new	62.915/62.939mm.
Rocker bore diameter - new	62.975/62.994mm.
Rocker pin capscrew torque	450Nm
Rocker adjusting screw locknut torque	150Nm
Bridge piece adjusting screw locknut torque	80Nm

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Introduction

Inlet and exhaust valves with worn or pitted seats and with deep indentation in the hardened end of the stem may be refaced as detailed in the following paragraphs.

Refacing machine

For details of the refacing machine recommended contact MAN B&W Diesel service UK Headquarters. Contact details can be found at www.manbw.com

Operation

Initial setting of refacing machine

Before commencing work, fit the valve in the workhead and check, by means of a dial gauge, that the valve stem is concentric to within 0.013mm. Ensure that the workhead is set to the correct valve angle, as in VALVE GEAR Data, and that the grinding wheel is dressed.

Refacing the valve

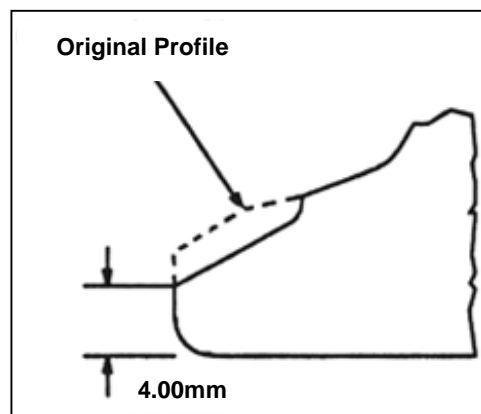
Set the valve in the workhead as detailed in the previous paragraph and proceed as follows:-

1. Back off the grinding head and traverse the workhead until the valve is in front of the grinding wheel.
2. Switch on both motors and open the coolant tap. Move the workhead to and fro across the front of the grinding wheel and gradually bring in the grinding head, applying the cut a little at a time until the full ground face is obtained. Allow the grinding wheel to "spark out" i.e., to grind itself entirely free, before inspecting the face (frequent inspections should be made to ensure that only the minimum amount of metal is removed whilst a full face is ground).

The diagram on the right shows the maximum wear limit which must be taken into account when grinding a new face on a valve.

Checking the face

1. Remove the valve from the machine then clean the face and stem.
2. Smear a very light coat of marking blue on the correct valve seating gauge on the valve, press it into contact with the valve face then lift the gauge and examine the face. The marking should be continuous and cover the full width of the valve face.



Refacing the end of the valve stem

1. Set the workhead parallel to the grinding wheel spindle, fit the valve into the workhead with the stem end close to the wheel and check that the valve stem is concentric to within 0.013mm.

2. Move the grinding head until the side of the wheel is level with the valve stem end.
3. Start both motors and ease the workhead close to the grinding wheel until the wheel begins to cut, then ease the grinding head gently back and forth until the wheel “sparks out”.
4. Continue the grinding as in (3) until a good clean surface is obtained but with minimum removal of metal.
5. Remove the valve and check the hardness of the stem end. If the hardness is below 50 Rockwell C, the valve may be reclaimed by removing 1.588mm. from the end which is then built up by depositing Stellite Grade 12 on it, and finally refacing the stem end to give an overall valve length of 342.8/343.2mm.

Dressing the grinding wheel

The grinding wheel should be dressed when it has become ridged, loaded with metal particles, or unable to provide a satisfactory surface finish, i.e., without traces of ridging or grinding marks.

The valve refacing machine is supplied complete with a diamond-tipped universal dressing tool which should be used in accordance with the manufacturer's instructions. The frequency of wheel dressing will depend on the grade of grinding wheel in use, the amount of roughing-out before wheel-dressing so that the wheel is then in its best condition for making a good-quality finish cut.

Re-assembly of valves

After refacing, the valves can be assembled into the cylinder heads without recourse to lapping or grinding-in by hand. The small differential between the seat and face angles ensures rapid “bedding-in” of the seats by impact.



Fig 1. Valve grinding machinery

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Introduction

Valve seat inserts which have become pitted, worn or distorted, should be recut by machine. For details of the refacing machine recommended contact MAN B&W Diesel service UK Headquarters.

Contact details can be found at www.manbw.com

Operation

Fit the correct angle cutter to the indexable head (45degrees for exhaust 30 degree for inlet valves).

Ensure that the single point cutting tool is in good condition.

Using the Go gauge confirm that the valve guides are in good condition (Valve guides that are excessively worn must be replaced as they will prevent a satisfactory finish to the valve sealing face being obtained).

Using the special reamer supplied by Hunger cut a chamfer on both the top and bottom of the valve guide (this ensures that the pilot sits in the guide correctly).

Fit the pilot into the guide ensuring that the three point stabiliser/steady is fitted correctly and that the three Allen head screws are tightened.

Lightly lubricate the pilot and position the indexable cutting head on the guide.

NOTE:- The carbide cutting tip must not be "dropped" or otherwise allowed to make contact with the valve seat.

Check that the auto index bar is in the disengaged position and then start the cutting head in 30-RPM mode.

Using the micro adjuster on the top of the tool, index the cutting head until the tool tip removes a fine shaving of metal from the valve seat. Once this has been achieved stop the cutting head, lift it clear of the valve seat and index the tool towards the pilot, once the tool tip is clear of the valve seat the indexing arm can be engaged and the cutting head lowered onto the pilot and a powered cut made across the valve seat face. This process to be repeated until metal is removed from the full width of the seat face (Marking the seat face with a black marker pen at 4 positions at 90 degrees to each other will prove helpful in deciding if a 360 degree continuous cut is being achieved).

As soon as a full width cut is achieved a fine finishing cut can be applied at the higher speed of 42 RPM.

It is imperative that the cylinder head is thoroughly cleaned following the machining of valve seats to ensure that no metallic swarf or dust remains in the head.



Fig 1. Valve seat refacing tool