Crankcase and Cylinder Head

A. Cleaning and Pressure-Testing of Crankcase and if necessary, Surface-Grinding

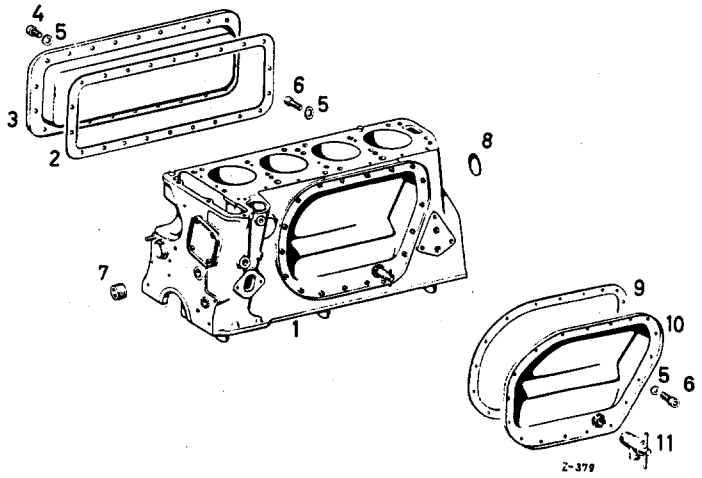


Fig. 01 — 5/1

1 Crankcase
2 Gasket
3 Cylinder cover
4 Hexagon socket screw M 6×18 DIN 912-8 G, also for carburetor linkage bearing support
5 Washer
6 Hexagon socket screw M 6×12 DIN 912 8 G
7 Screw plug
8 Plug
9 Gasket
10 Cylinder cover
11 Drain valve

Cleaning:

1. The water passages and connecting canals must be thoroughly cleansed of scale and other impurities.

   In the course of time, dirt and other deposits can collect between the wall of the case and the cylinder covers. Both cylinder covers should then be taken off if any doubt exists and the deposits between case and covers removed.

2. Carefully clean the sealing surfaces of the covers and of the crankcase. New gaskets, with sealing compound applied, should be put on and the cylinder covers screwed down. The cylinder covers must make a perfect seal with the crankcase and for this reason it is absolutely necessary to carry out a leakage test.

3. Clean the oil passages. Remove the screw plugs at the front and the rear of the crankcase. The oil passages should then be cleaned with brushes and wire cleaners and blown out with compressed air.

   The oil passages which lead to the bearing for the horizontal and vertical distributor drive shaft und those which lead tc the cylinder head must also be cleaned.

   After cleaning, new screw plugs must be used and these must first be coated with sealing compound (e. g., Starryt) on the rear three threads before they are screwed in. Care must be taken to ensure that no sealing compound enters the oil passage when this is done.

   The upper oil passage has no screw plug at the front. The opening is for the oil relief valve.

Surface-grinding:

4. Check whether the upper separating surface of the crankcase is perfectly even. Maximum permissible departure from plane is 0.03 mm in a longitudinal direction and 0 in a lateral direction. If there is any unevenness in excess of this, the separating surface must be surface-ground or milled.

The overall thickness of stock machined off must not exceed 0.3 mm.

Departure from parallelity between the upper separating surface and the middle of the crankshaft bearing must not exceed 0.1 mm over the whole length.

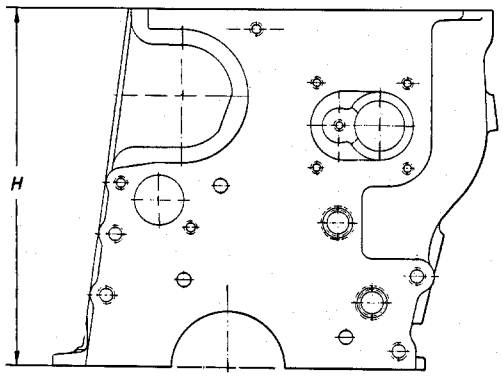


Fig. 01 — 5/2

The height H of the crankcase is normally 238.4 to 238.5 mm, measured from the separating surface for the oil pan (middle of crankshaft bearing) to the separating surface for the cylinder head (Fig. 01 — 5/2).

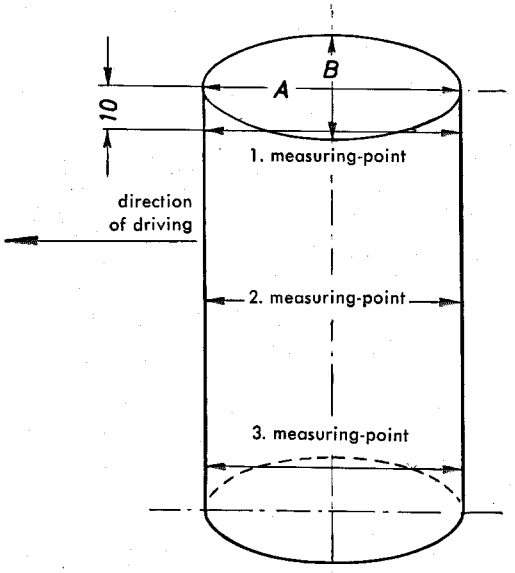
Pressure-testing:

5. The crankcase is tested for leakage by subjecting it to a pressure-test with hot water (approx. 70° C) at a pressure of 2 atmospheres.

   Before pressure-testing, the sealing compound must be allowed to dry for a sufficient period of time (at least 4—6 hours).

B. Boring and Honing of Cylinder Bores

Measure the cleaned cylinder bores at the top, in the middle and at the bottom, using an internal micrometer. The measurements must be taken in the direction of the axis of the piston pin (direction A) and then at right angles to this axis (direction B) (Fig. 01 — 5/3).



A = Longitudinal direction B = Lateral direction

Fig. 01 — 5/3

Out-of-round cylinder bores mean increased oil consumption and they must therefore be bored and honed. Honing alone is insufficient as the hone follows the out-of-round contour.

If the cylinder bores are conical, but the degree of conicity does not exceed 0.05 mm, honing is sufficient. But if the conicity exceeds this figure, the cylinders must be re-bored and then honed.

The point of maximum wear in the bore is taken as the basis on which the required overhaul is decided.

The allowance for honing should not be more than 0.03 mm. Machining dimensions must be kept strictly to the limits laid down in the table.

After honing, the cylinder walls must be entirely free of scorings and scratches.

The maximum permissible roughness of the honed cylinder may be as much as 0.005 mm, but the average depth of corrugation must not exceed 50% of the average permissible roughness, i. e., 0.0025 mm.

Machining Tolerances

Permissible degree of out-of-round	0.013 mm
Permissible conicity	0.013 mm
Departure from vertical to crankshaft axis, calculated over total height of cylinder	0.050 mm

At the works, the numbers 0 or 1 or 2 are punched on the upper separating surface of the crankcase, opposite each cylinder.

The number 0 indicates:
Cylinder diameter 85.00 mm

the number 1 indicates:
Cylinder diameter 85.01 mm

the number 2 indicates:
Cylinder diameter 85.02 mm.

The pistons are available in three gradings — within the overhaul stages — in steps of 0.01 mm. The pistons must be selected so as to give

0.04 mm Running Clearance.

If, when a repair is being carried out, only one size of piston is available, the cylinders should be honed out to fit the available pistons.

After boring and honing out the cylinder bores, it is advisable to check the crankcase for leakage (see Job No. 01 — 5, Section A).

Machining Dimensions of Cylinder Bores

in mm

Overhaul stage	Cylinder bore	Available piston sizes
Standard size	85.000 / 85.022	84.96 84.97 84.98
Intermediate stage	85.250 / 85.272	85.21 85.22 85.23
1st Overhaul stage	85.500 / 85.522	85.46 85.47 85.48
2nd Overhaul stage	86.000 / 86.022	85.96 85.97 85.98
3rd Overhaul stage	86.500 / 86.522	86.46 86.47 86.48

C. Machining and Pressure-Testing of Cylinder Head

If the separating surface or the upper side of the cylinder head is uneven or has become distorted or if there is slight surface damage such as scorings, scratches, etc., the damaged surface must be re-faced.

In the longitudinal direction, the separating surface must not be more than 0.10 mm out of level, and in the lateral direction, not more than 0.01 mm.

If the cylinder head surface is machined, the overall thickness of metal machined off must not exceed 0.5 mm. The standard height H of the cylinder head is 84.80—85.00 mm (Fig. 01 — 5/4).

After the separating surface has been machined, the capacity and the height of the compression chamber must be measured. Any discrepancies must be corrected by milling out the compression chamber to the correct capacity (Fig. 01 — 5/5).

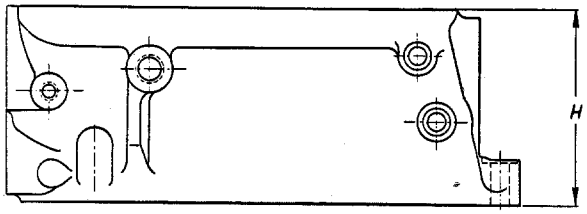


Fig. 01 — 5/4

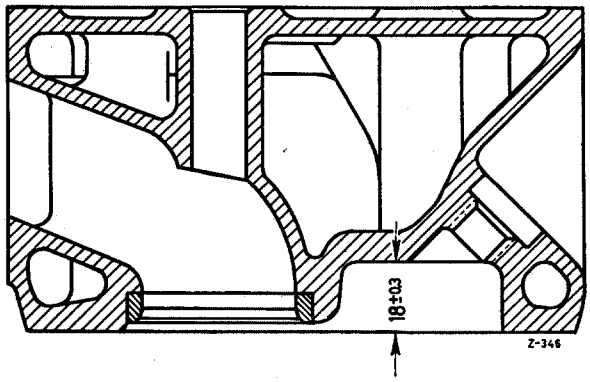


Fig. 01 — 5/5

Compression Ratio and Capacity of Compression Chamber

Cylinder head	Standard compression	Lower compression (Optional, SA 10 250)
Compression factor ε	maximum 7.8 : 1 standard 7.5 : 1 minimum 7.25 : 1	7.0 : 1 6.8 : 1 6.6 : 1
Total compression chamber capacity with cylinder head fitted	69.8 — 75.8 cm³	78.5 — 84.5 cm³
Compression chamber capacity in cylinder head with valves and spark plugs fitted	62.3 — 63.3 cm³	70.3 — 71.3 cm³

After machining the cylinder head separating surface, the head must be pressure-tested at a pressure of 2 atmospheres.

Cylinder Head with Lower Compression
(Optional, SA 10 250)

In countries where only fuels with a lower anti-knock value are available, a cylinder head with a lower compression (Part No. 121 010 33 20) is available as an optional item.

If such a cylinder head is to be installed, another type of cylinder head gasket (Part No. 121 016 10 20) must be installed at the same time.

When this is done, the ignition setting must be adjusted so that the engine operates without pinking when the vehicle is driven.

D. Checking and Replacing Valve Guides

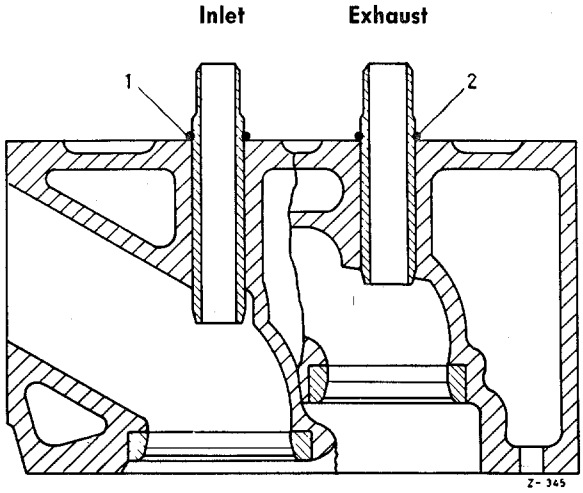


Fig. 01 — 5/6

1 Snap ring 14 DIN 9045 for inlet
2 Snap ring 14 DIN 9045 for exhaust

1. Clean the bores of the valve guides with Cylinder Brush 000 583 04 38 and gasoline or paraffin.

   Hard oil carbon deposits in the guides should be removed with a honing tool. Paraffin should be used for the lubrication.

   The honing tool consists of the following parts:

Hand Honing Tool with Nut and Setting Wrench	000 589 01 67
Adapter with Collet	000 589 03 31
Honing Shaft for Inlet	000 589 04 67
Honing Shaft for Exhaust	000 589 05 67

2. Use Testing Plug Gages 636 589 00 21 and 187 589 01 21 to measure the bores for the inlet and for the exhaust respectively.

   The gage should just drop to the bottom of the bore on the "go" side, and on the "not-go" side it should just bind on entering. If the "not-go" section of the Testing Plug Gage can be inserted, the guide must be replaced.

Note: Only testing plug gages in new condition must be used for measuring the bores. Attention is here drawn to the fact that **the gages must be examined from time to time to make sure that their accuracy has not been impaired by use.**

3. When replacing a valve guide, knock out the old valve guide with Drift 136 589 00 39.

4. Then check the base bore in the cylinder head, using an internal micrometer. High spots can be smoothed off with a reamer or broach. If necessary, the base bore can be remachined but this must be done at an exact right-angle to the cylinder head separating surface.

5. The new valve guides must be selected so as to give a force-fit oversize of 0.007 mm. If a valve guide of the required force-fit allowance dimension is not available, an oversize guide must be re-ground or turned down to the required dimension.

6. Rub a little talc into the bores in the cylinder head and then place the valve guide on the bore (the valve guide must just bind at the entrance to the bore) and press into position with Forcing Sleeve 187 589 10 39. The guide must either be **pre-cooled** before being installed or alternatively, the cylinder head must be heated to approx. 60° C.

   The valve guide can be pre-cooled by means of liquid air or carbon dioxide snow.

Note: The valve guides are fitted with a radial groove in which there is a snap ring which serves to prevent axial displacement of the valve guide in the bore (see Fig. 01 — 5/6). The valve guides should therefore be pressed into the cylinder head only as far as the point where the snap ring lies against the cylinder head. If the valve guides are pressed in too far, the snap ring will jump out.

7. Check that the valve guides are firmly held in the cylinder head. Use a suitable plastic drift and by means of light hammer taps, attempt to drive the guide out again. If the guide remains firmly held, the correct force-fit has been obtained. But if the guide can be tapped back out of the bore, a guide

with a greater external diameter must be installed.

8. After pressing the valve guides into position, the bores should be checked with the testing plug gages. Any narrow parts should be carefully honed up to the correct dimension, using the honing tool for this purpose (see Paras. 1 and 2). It is, however, better to replace the valve guide once more.

Dimensions of Valve Guides and Bores in Cylinder Head

Measurements in mm

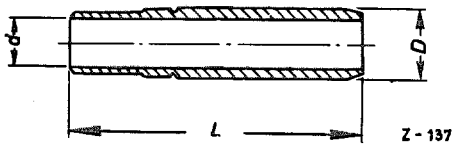


Fig. 01 — 5/7

Overhaul stage	Color code	Valve guide					Bore in cylinder head
		External diameter D	Internal diameter d		Length L		
			Inlet	Exhaust	Inlet	Exhaust	
Standard size	plain	14.013 / 14.007	9.000 / 9.015	10.000 / 10.015	67	58	14.000 / 14.006
	red	14.019 / 14.013					14.006 / 14.012
	white	14.025 / 14.019					14.012 / 14.018
	yellow	14.031 / 14.025					14.018 / 14.024
	blue	14.037 / 14.031					14.024 / 14.030
	brown	14.043 / 14.037					14.030 / 14.036
1st Overhaul stage	red	14.225 / 14.207					14.200 / 14.218
	white	14.425 / 14.407					14.400 / 14.418

E. Replacement of Valve Seat Rings

If a valve seat ring has to be replaced, the old valve seat ring must be carefully milled out. This can be done with Valve Seat Ring Turning Tool 000 589 01 69. Instructions for the use of this tool are given.

Dimensions of Bores in Cylinder Head and Valve Seat Rings

Inlet

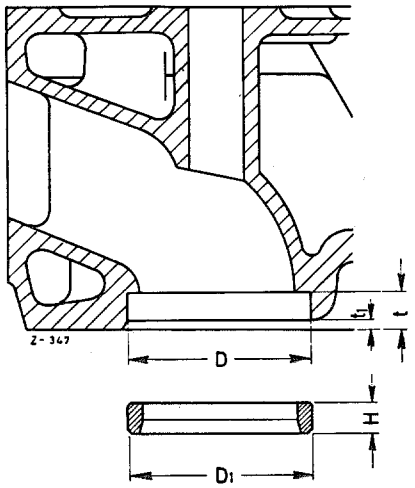


Fig. 01 — 5/8

Exhaust

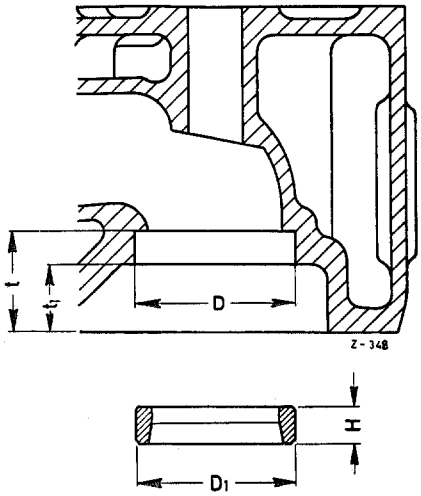


Fig. 01 — 5/9

Measurements in mm

	Overhaul stage	Milled-out well in cylinder head D	Diameter of valve seat ring D_1	Height of valve seat ring H	Depth in cylinder head t	Depth in cylinder head t_1
Inlet	Standard size	48.000 / 48.016	48.160 / 48.150	8.000 / 7.910	10.00 / 10.10	2
	1st Overhaul stage	48.500 / 48.516	(49.300)* / 48.660 / 48.650	8.000 / 7.910	10.00 / 10.10	2
Exhaust	Standard size	42.000 / 42.016	42.145 / 42.135	9.500 / 9.410	27.50 / 27.60	17.70 / 18.30
	1st Overhaul stage	42.500 / 42.516	(43.300)* / 42.645 / 42.635	9.500 / 9.410	27.50 / 27.60	17.70 / 18.30

* Rough-turning dimension

Force-fit oversize of the valve seat rings in cylinder head

Inlet = 0.134—0.160 mm
Exhaust = 0.119—0.145 mm

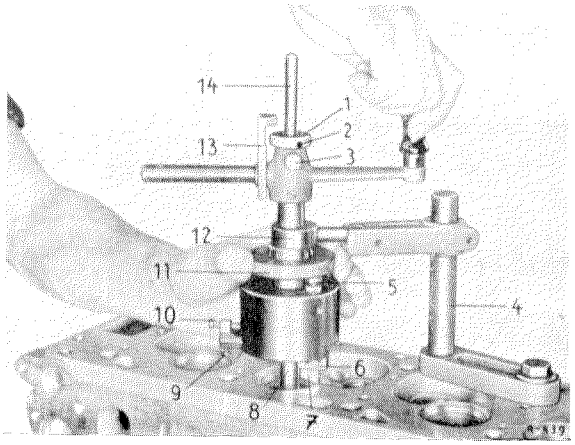


Fig. 01 — 5/10

1 Knurled nut for cut control
2 Locking screw
3 Locking screw
4 Holding stand
5 Rapid adjustment
6 Carriage
7 Cutter
8 Pilot with collet
9 Clamping screw
10 Stop screw
11 Feed control
12 Holding stand bearing
13 Stop
14 Contact mandrel

The turning tool is centered with the aid of a combined pilot (8) and bearing on which it is supported and it is held in position by means of a holding stand (4).

If the feed control (11) is held steady and the handle is turned, the carriage (6) moves from the inside to the outside with the cutter (7), describing a spiral path.

Movement in the radial direction is limited by the stop screw (10) which is locked by means of the clamping screw (9).

When the rapid adjustment (5) is turned, the carriage (6) returns to its original position.

After the cutter has been moved back, care must be taken to ensure that the lower nut of the rapid adjustment is tightened up again since otherwise the automatic feed control will be inoperative.

The cut control (determining the cutting depth) is operated by turning the knurled nut (1).

One graduation on the scale = 0.1 mm.

1. Clean and test the valve guide and if necessary, replace it (see Job No. 01 — 5, Section D).

2. Place the pilot with the collet (8) in the bore of the valve guide and fix it in position.

3. Screw the cutter (7) onto the carriage (6) with the aid of the carriage screw.

4. Set the cutter to the working diameter. The working diameter should be 0.6—0.8 mm smaller than the external diameter of the valve seat ring so that after the stock has been milled away, 0.3—0.4 mm remains.
   The working diameter is set by moving the carriage with the aid of the rapid adjustment (5). Release the lower nut and turn the upper nut until the required diameter is obtained. Then tighten up the lower nut again.
   After the working diameter has been set, the stop screw (10) is screwed in until it rests against the stop and is then locked by means of the clamping screw (9).
   Then once more release the lower nut of the rapid adjustment (5) and move the cutter inward by turning the upper nut.
   Once more fix the rapid adjustment in position by tightening up the lower nut.

5. Now push the turning tool over the pilot and adjust it for height. To do this, release the locking screw (2), press the contact mandrel downward and move the tool axially so that the cutter is approximately 0.5 mm below the upper edge of the valve seat ring. Then tighten up the locking screw; when this is done, the knurled nut (1) must be screwed downward and the locking screw (3) must be tightened.
   The stop nose (13) serves as a limiting stop to determine the milling depth.

6. Set up the holding stand (4) so that its bearing end is centrally located. Between the holding stand bearing (12) and the handle there must be a distance of at least 10 mm.

7. Now hold the feed control (11) steady and turn the handle. As soon as the stop screw (10) reaches its stop, release the feed control and give the handle one or two further turns.

8. Release the lower nut of the rapid adjustment (5) and, by turning the upper nut, once more move the cutter inward. Lock the rapid adjustment once more by tightening the lower nut.

9. Release the locking screw (3) and back out the knurled nut (1) about 5 graduations; this causes the cutter to be moved about 0.5 mm downward and thus a new cut can be made. This procedure should be repeated until the knurled nut (1) lies against the stop nose (13).

10. After finishing the milling process, take off the turning tool and the pilot and remove the remains of the valve seat ring.

11. Clean the valve seat ring recess and measure the diameter with Internal Micrometer 000 589 10 21 (Fig. 01 — 5/11).

    If the diameter lies within the specified tolerances — the permissible maximum increase in diameter is 0.02 mm — a valve seat ring of the same size may be installed again.

    An oversize fit of 0.12 mm in the case of the inlet valve and 0.10 mm in the case of the exhaust valve must be obtained in any case. If this fit is not obtained, the bore must be bored out to the next overhaul stage and a valve seat ring with a greater external diameter must be installed.

12. Heat the cylinder head to 60° C. and fit the valve seat ring, **preferably pre-cooled,** in the recess. Use a forcing drift with thrust collar to drive the ring home with light hammer taps. Tap the valve seat ring until it contacts the base of the bore all the way round.

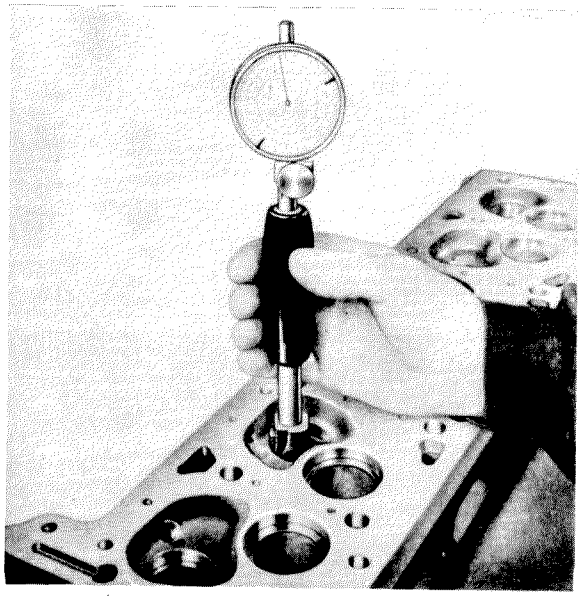


Fig. 01 — 5/11

Note: Liquid air or carbon dioxide snow may be used for pre-cooling the valve seat ring.

13. After a new valve seat ring has been pressed in, the ring should be carefully peened at three points.

F. Machining Valve Seats in Cylinder Head

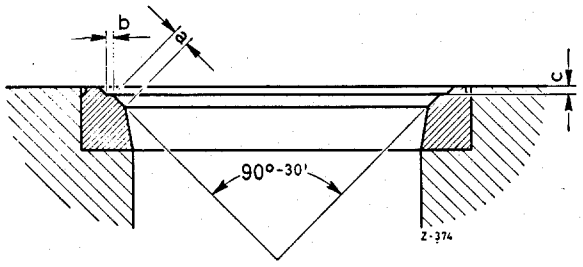


Fig. 01 — 5/12

Valve seat backed off with portable milling cutter

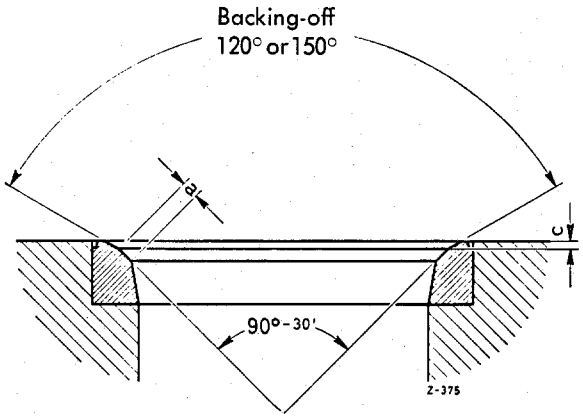


Fig. 01 — 5/13

Valve seat backed off with 120° or 150° backing-off cutter

a = Valve seat width
b = Backing-off with a portable milling cutter
c = Permissible milling depth for the backing-off

Machining of the valve seat can be carried out with the following tools:

a) with a valve seat turning tool,
b) with a backing-off cutter or
c) with a valve seat grinder.

In order to ensure that the valve seats perfectly, the valve seat should be backed-off so that the width of the seat "a" is from 1.25 to 1.75 mm. The backed-off section "b" must either be at least 0.1 mm in width or must be made at an angle of 120° or 150°.

The upper and lower edges of the valve seat on the valve must under no circumstances bear on the valve seat ring as the edges would bite into the seating, the valve would cease to form a perfect seal and would tend to burn out.

After the valve seats have been re-machined several times, they must be examined to ensure that they have not reached a level more than 1 mm lower than a new valve seat in the case of the inlet valve and 1.3 mm in the case of the exhaust valve.

The following table indicates the extent to which a valve seat can be re-machined. These measurements must be strictly adhered to and if this is not possible, a new valve seat ring must be installed (see Job No. 01 — 5, Section E).

Furthermore, care must be taken to ensure that the amount by which the cylinder head has already been re-machined (see Job No.

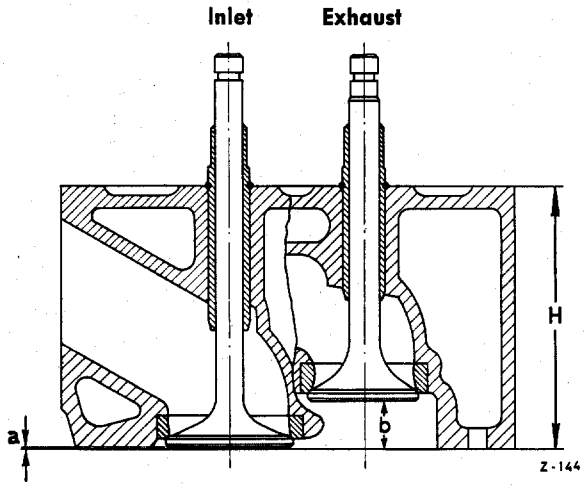


Fig. 01 — 5/14

	New valve seats		Re-machined valve seats	
	a	b	a	b
New valves	0.8	16	1.8	17.3
Re-ground valves	1.5	16.7	2.5	18

01 — 5, Section C) is subtracted from the specified dimensions before any further work is done.

Before the valve seats are re-machined, the valve guides must first be examined and if necessary, replaced (see Job No. 01 — 5, Section D) and at the same time the valve seats must be examined in order to ascertain whether they have not already been re-machined too much and whether the valve seat rings must be replaced.

The best way of checking this is to use a new valve.

A dial gage is used to test the concentricity and out-of-round of the valve seats. The maximum permissible run-out is 0.05 mm (Fig. 01 — 5/15).

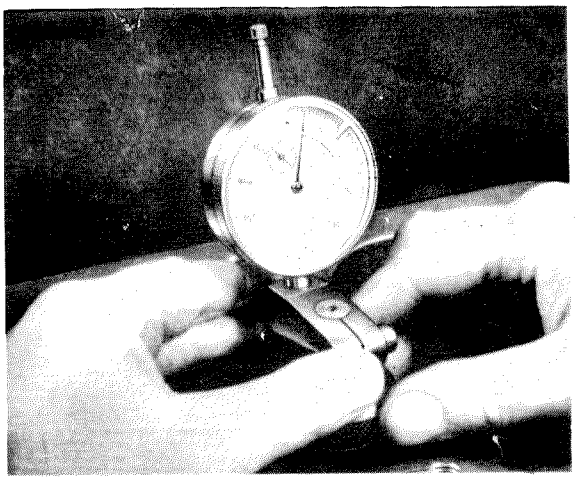


Fig. 01 — 5/15

The special tools required for this job are:

Dial Gage Holder	187 589 04 21
Testing Sleeve for Inlet Valve	187 589 02 21
with Testing Plug	187 589 05 21
Testing Sleeve for Exhaust Valve	187 589 03 21
with Testing Plug	187 589 06 21

The mating between valve and valve seat should be tested with blue dye. This test is made by turning the valve alternately one fifth to one sixth of a turn to the left and the same to the right.

In all cases, after the valve seats have been re-machined, a leakage test of the valves must be carried out, using gasoline.

The following paragraphs describe the methods of using the various tools:

a) **Machining the valve seat with Valve Seat Turning Tool 000 589 00 69.**

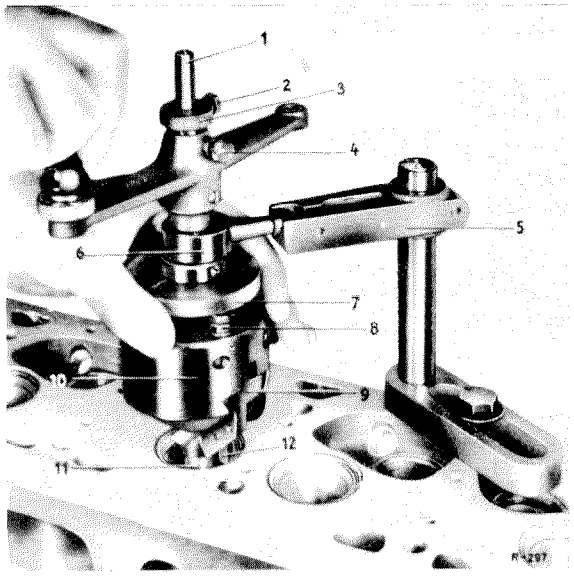


Fig. 01 — 5/16

1 Contact mandrel
2 Locking screw
3 Knurled nut for cut control
4 Locking screw
5 Holding stand
6 Holding stand bearing
7 Feed control
8 Rapid adjustment
9 Carriage
10 Head with built-in gearing
11 Pilot with collet
12 Cutter

The turning tool is centered with the aid of a combined pilot (11) and bearing on which it is supported and it is held in position by means of a holding stand (5).

If the feed control (7) is held steady and the handle is turned, the carriage (9) moves from the inside to the outside with the cutter (12), describing a spiral path.

When the rapid adjustment (8) is turned, the carriage (9) returns to its original position.

After the cutter has been moved back, care must be taken to ensure that the lower nut of the rapid adjustment is tightened up again since otherwise the automatic feed control will be inoperative.

The cut control (determining the cutting depth) is operated by turning the knurled nut (3).

One graduation on the scale = 0.1 mm.

1. Place the pilot with the collet (11) in the bore of the valve guide and fix it in position.

2. Screw the cutter (12) onto the carriage (9) by means of the carriage screw.

3. Release the lower nut of the rapid adjustment (8), slide the turning tool over the guide bolt and, by turning the upper nut, move the rapid adjustment so that the cutter is located at the middle of the valve seat. Do not allow the tool to drop.

4. Now press the contact mandrel (1) for the pilot (11) downward and lock it by means of the screw (2). When this is done, the knurled nut (3) must be screwed downward and the locking screw (4) tightened.

5. Set up the holding stand (5) so that its bearing end is centrally located. When this is done, the ball at the bearing of the holding stand must be free all the way round and the distance between the holding stand bearing (6) and the handle must be approximately 5 mm.

6. By turning the upper nut on the rapid adjustment, move the cutter to a position near the inner edge of the seat and then tighten the lower nut. **Do not advance the cut control mechanism yet.** Hold the feed control (7) steady and turn the handle. When this is done, the cut is usually irregular.

   After completing the cut, release the lock nut of the rapid adjustment and once more move the cutter inward.

7. Release the locking screw (4) and turn the knurled nut (3) approx. ½ to 2 graduations (1 graduation = 0.1 mm) to the left. Lock the locking screw (4) and immobilize the rapid adjustment once more and make a further cut.

8. The cut control must be advanced and a cut made often enough for the seat to be clean-cut, after which a further turn should be given without advancing the cut control (a "clearing cut").

9. The backing-off of the valve seat can also be done with this turning tool since the tool has a second carriage which sets its cutter to an angle of 120°.

   When backing off at 120° or 150°, the peened surfaces of the valve seat ring must under no circumstances be turned off.

   It is therefore recommended that the backing-off be made at an angle of 90° in accordance with Fig. 01 — 5/12.

b) **Machining the valve seat with a backing-off cutter.**

Special tools:

Cutting Arbor for	
Inlet	636 589 06 31
Exhaust	187 589 02 31
Handle for	
Cutting Arbor	187 589 06 31
Valve Seat Milling Cutter for	
Inlet	187 589 01 51
Exhaust	187 589 04 51
Portable Milling Cutter for	
Inlet	121 589 00 51
Exhaust	121 589 01 51

1. If the valve seat is insufficiently backed-off or is not backed-off at all, this must now be done. The backing-off "b" must be at least

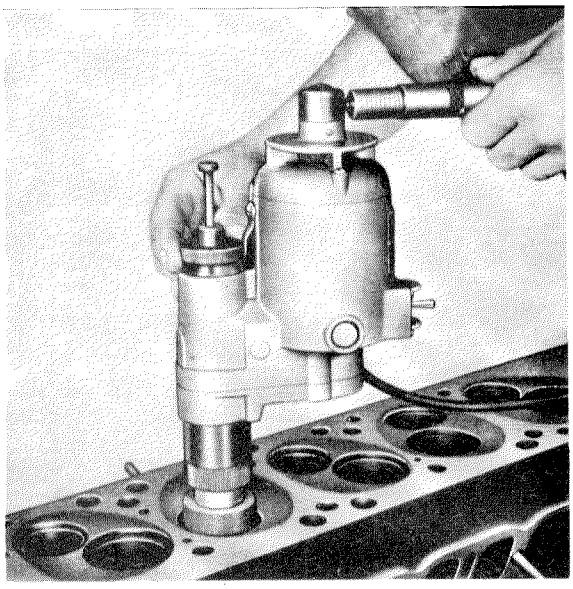


Fig. 01 — 5/17

0.1 mm in width or should be made at an angle of 120° or 150° (see Figs. 01 — 5/12 and 01 — 5/13).

2. After the seat has been backed-off, it should be rough-milled and finish-milled or alternatively, surface-ground. Surface-grinding should only be done with a very slight central pressure on the milling spindle.

c) **Machining of the valve seat with an eccentric valve seat grinder** (Fig. 01 — 5/17).

1. Set the grinding head on the angle grinder to an angle of exactly 90° — 30'.

2. Rough-grind the valve-seat and then finish-grind.