

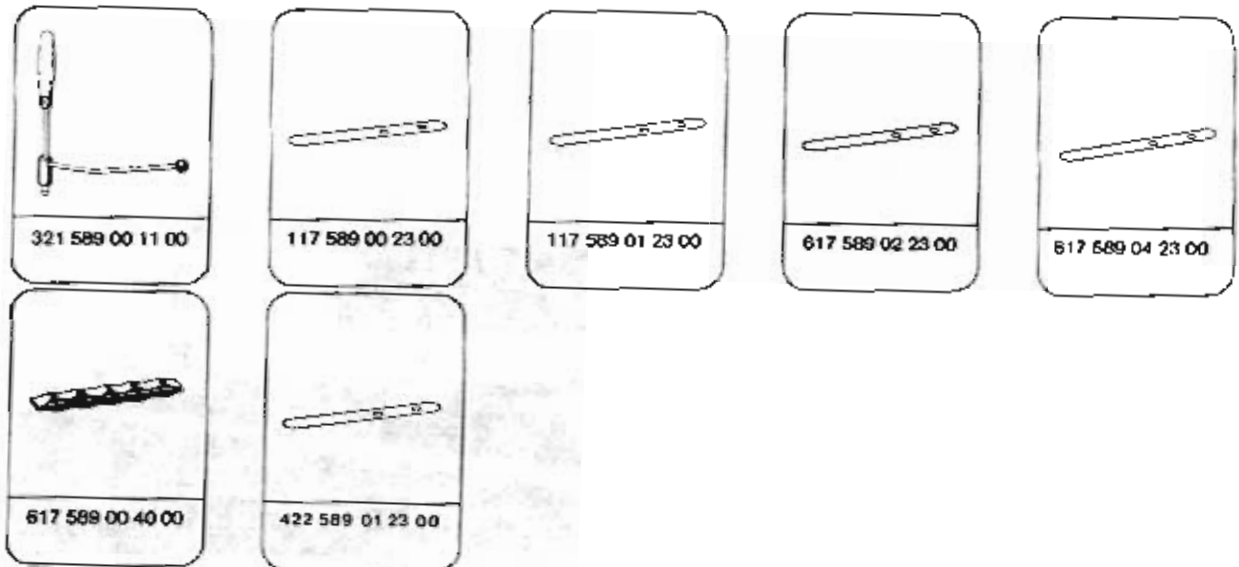
Data

Valve play (Coolant temperature max. 50° C)	352 A	352 A	362 LA
	110 kW (150 PS) 115 kW (156 PS) 124 kW (168 PS)	127 kW (172 PS) (BM 353.975)	
	Intake	0,20	0,25
Exhaust	0,30	0,40	0,60
Firing sequence			1-5-3-6-2-4
Overlap			6-2-4-1-5-3

Tightening Torques in Nm

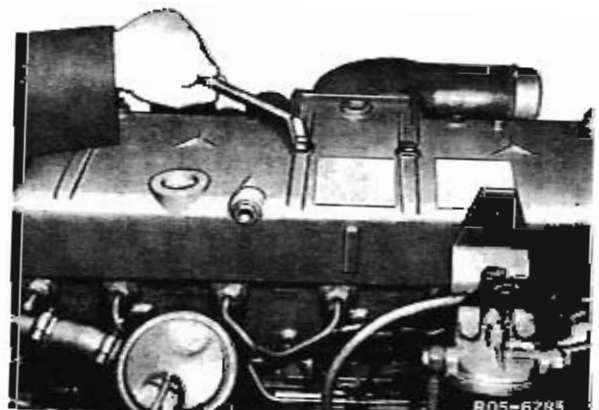
Cylinder head cover	25
---------------------	----

Special Tools



Adjusting Valve Play

- 1 Remove cylinder head cover.
- 2 Crank engine until the piston of the cylinder to be adjusted is at top dead centre. The valves must be closed, the rocker arms fully relieved and it must be possible to easily turn the tappet rods in the ball sockets. The valves must overlap on the up-stroke cylinder.



05.13 Adjusting Valve Play (Method 1)

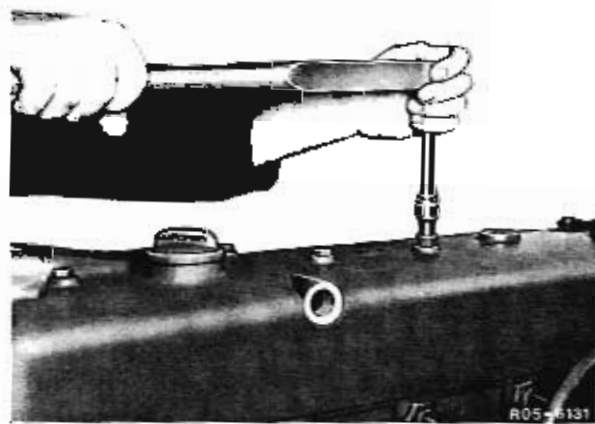
3 Insert special tool between intake valve and rocker arm or between exhaust valve and rocker arm. Valve play is correctly adjusted if the special tool can be pulled through with slight resistance.



Gauging strap 0.20 mm	117 589 00 23 00
Gauging strap 0.25 mm	117 589 01 23 00
Gauging strap 0.30 mm	617 589 02 23 00
Gauging strap 0.40 mm	617 589 04 23 00
Gauging strap 0.60 mm	422 589 01 23 00
Gauging strap holder	617 589 00 40 00
Valve adjusting wrench	321 589 00 11 00

4 If it is necessary to correct the valve play, fit special tool to adjusting screw, slacken lock nut and correct valve play. Re-tighten lock nut, holding adjusting screw in place.

5 Fit cylinder head cover with new gasket and torque fastening bolts to 25 Nm with torque wrench.



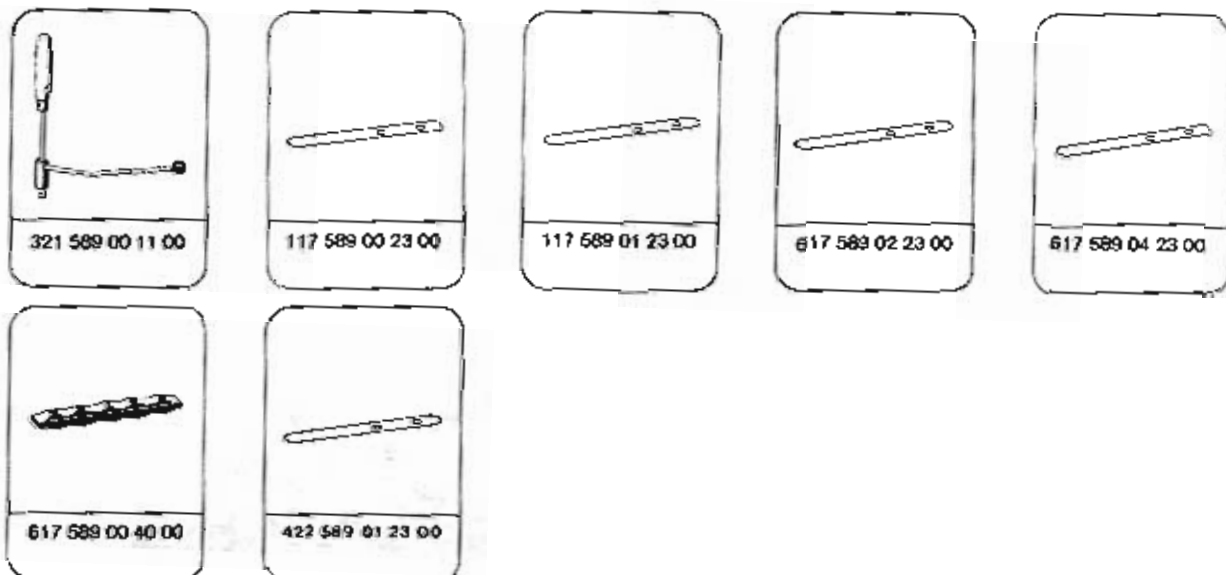
Data

Valve play (coolant temperature max. 50° C)	352 A	352 A	362 LA
	110 kW (150 PS) 115 kW (156 PS) 124 kW (168 PS)	127 kW (172 PS) (BM 353.975)	
	Intake	0,20	0,25
Exhaust	0,30	0,40	0,60
Firing sequence			1-5-3-6-2-4
Overlap			6-2-4-1-5-3

Tightening Torques in Nm

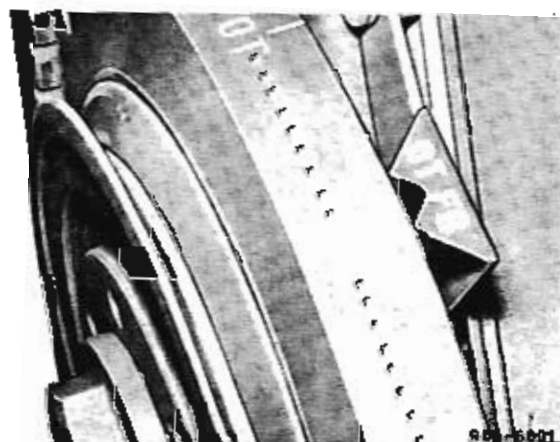
Cylinder head cover	26
---------------------	----

Special Tools



Adjusting Valve Play

- 1 Remove cylinder head cover.
- 2 Crank engine in direction of rotation until the FB (start of delivery) mark on the flywheel damper agrees with the adjusting pointer on the timing case.



05.13 Adjusting Valve Play (Method 2)

3 Check whether cylinder No. 1 is in ignition TDC or in overlap TDC (in ignition TDC both valves are closed, the rocker arms fully relieved and it must be possible to easily turn the tappet rods).

Note: The cylinder sequence is shown in the schematic drawing.

In ignition TDC the following valves can be adjusted:

Intake Valve	Exhaust Valve
1, 2, 4	1, 3, 5

In overlap TDC the following valves can be adjusted:

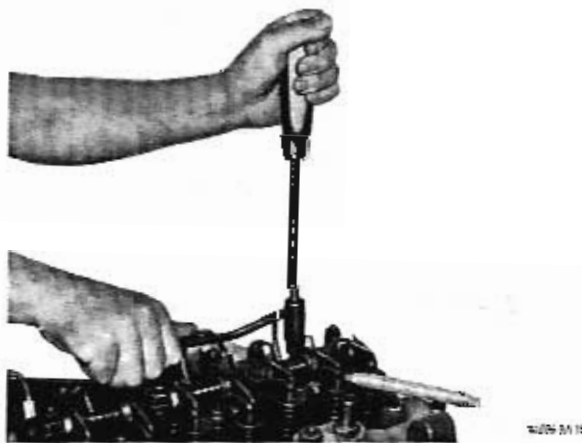
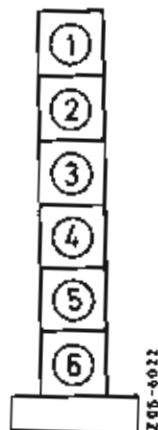
Intake Valve	Exhaust Valve
3, 5, 6	2, 4, 6

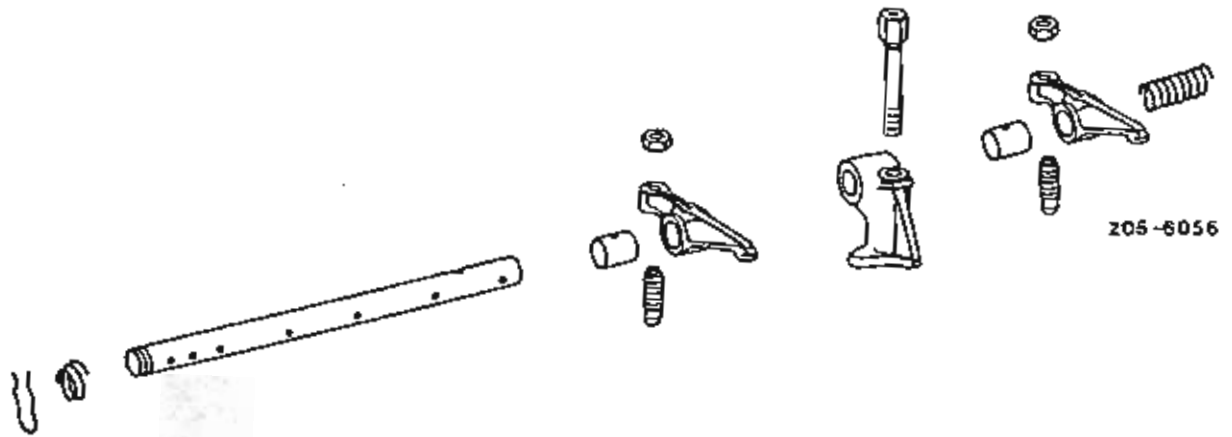
4 Insert special tool between intake valve and rocker arm or between exhaust valve and rocker arm. Valve play is correctly adjusted if the special tool can be pulled through with slight resistance.

5 If it is necessary to correct the valve play, fit special tool to adjusting screw, slacken lock nut and correct valve play. Re-tighten lock nut, holding adjusting screw in place.

6 Fit cylinder head cover with new gasket and torque fastening bolts to 25 Nm with torque wrench.

Gauging strap 0.20 mm	117 589 00 23 00
Gauging strap 0.25 mm	117 589 01 23 00
Gauging strap 0.30 mm	617 589 02 23 00
Gauging strap 0.40 mm	617 589 04 23 00
Gauging strap 0.60 mm	422 589 01 23 00
Gauging strap holder	617 589 00 40 00
Valve adjusting wrench	321 589 00 11 00

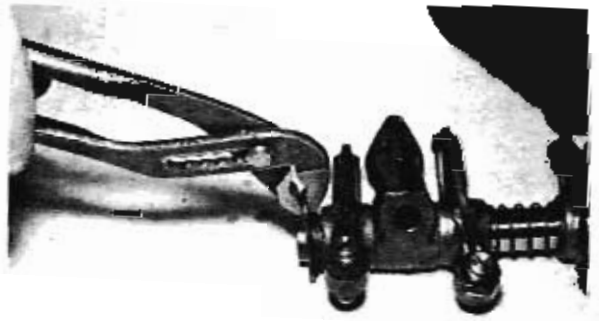




205-6056

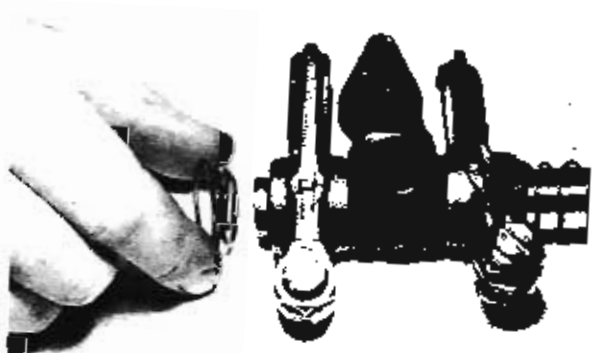
Disassembling

- 1 Pull spring clamp off rocker arm shaft with pliers.



R05-6154

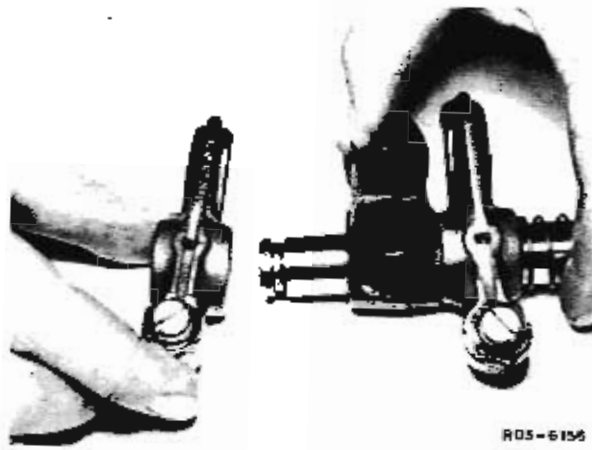
- 2 Remove spring from rocker arm shaft.



R05-6155

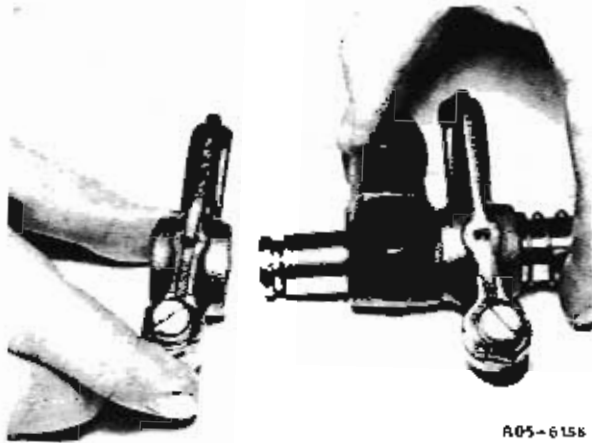
05.13 Disassembling and Assembling Rocker Arm Gear

3 Remove rocker arm.

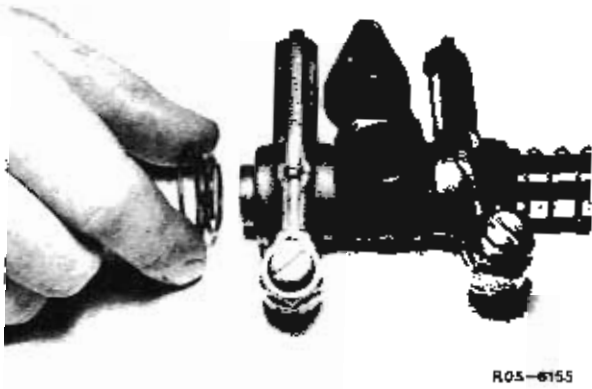


Assembling

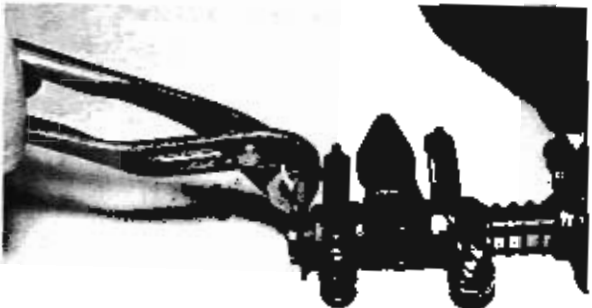
1 Slip rocker arm onto rocker arm shaft.



2 Fit spring onto rocker arm shaft.



3 Fit spring clamp on rocker arm shaft with pliers.



Cylinder head removed

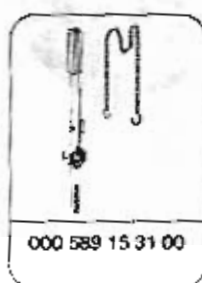
Valve Springs

ID	Wire dia.	Length un-tensioned	Initial tension		Final tension	
			Length ¹⁾	Load	Length ²⁾	Load
25 + 0,4	4,25	60,5	46,7	300 ± 15 N	35,18	590 + 40 - 20 N

1) Corresponds when installed to length of valve when closed

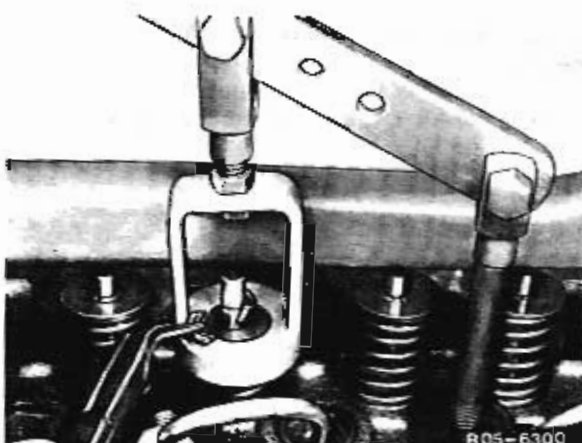
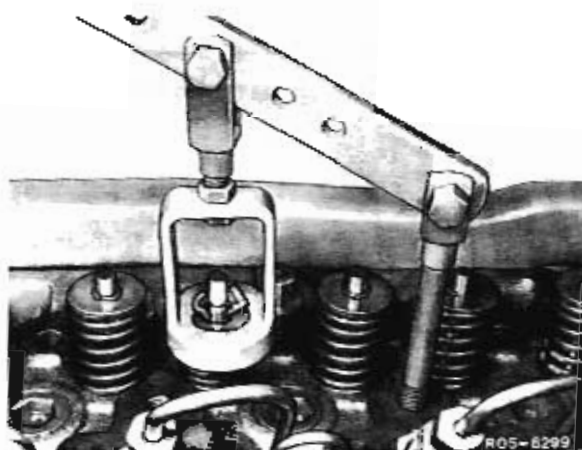
2) Corresponds when installed to length of valve when open

Special Tool



Removal

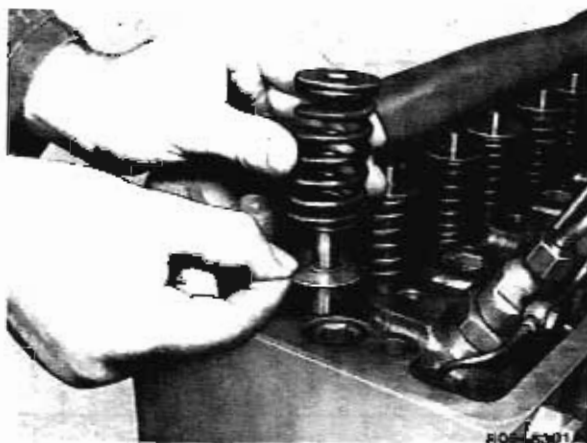
- 1 Place cylinder on an even base. Do not damage nozzle.
- 2 Screw valve lifter into the cylinder head.
- 3 Press valve plate down with a sudden movement to separate the valve cone halves.
- 4 Take off valve cone halves.
- 5 Remove valve lifter.



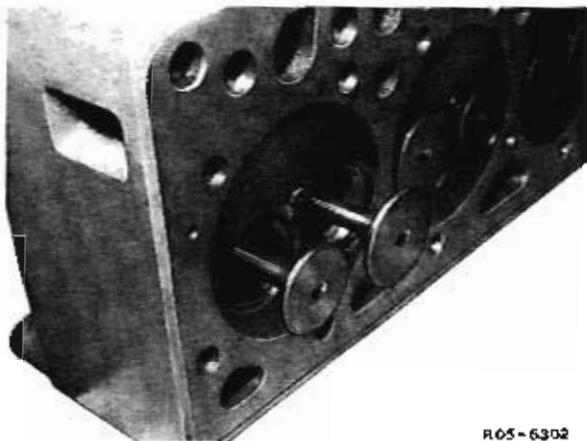
Valve lifter 000 589 15 31 00

05.13 Removing and Installing Valves

5 Remove valve spring plate, valve spring and washer for valve spring.

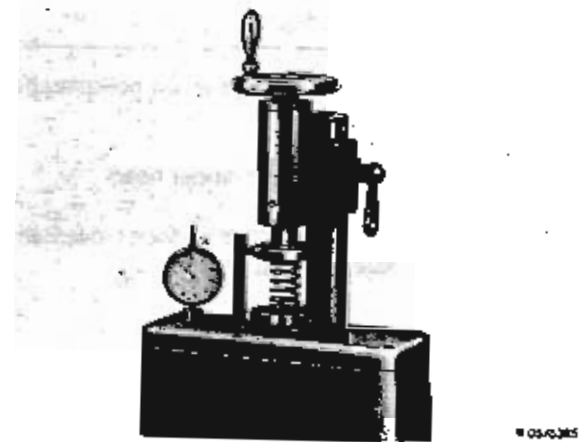


6 Turn cylinder head around and take out valves.



Installing

1 Check valve springs on the spring balance.



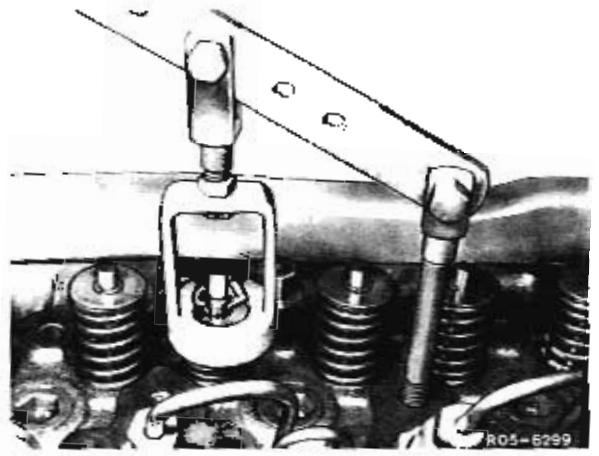
2 Oil valve stem, inserting into cylinder head from below.

3 Insert washer, valve spring and valve plate.

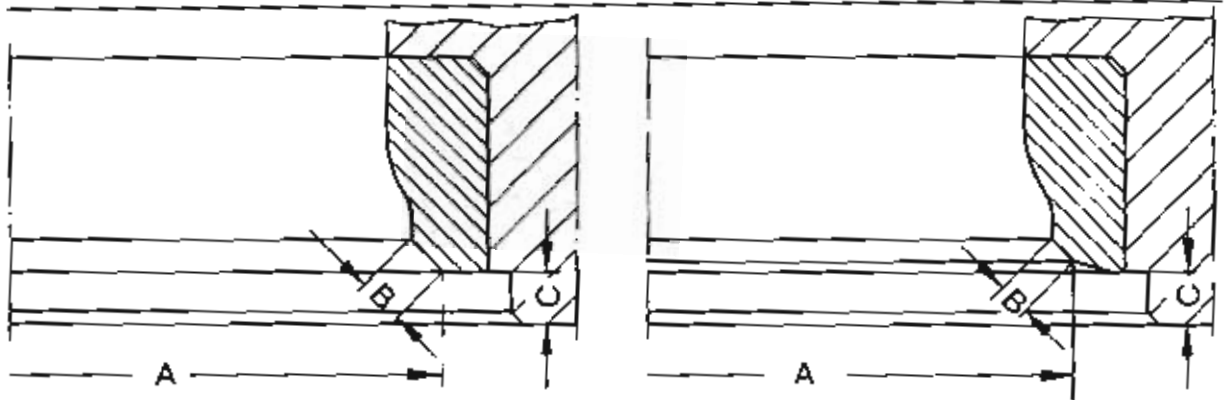


- 4 Install valve lifter and press down valve plate.
- 5 Insert valve cone halves and relieve pressure on valve plate.
- 6 Remove valve lifter.

Note: The gap between the valve cone halves should be equally large on both sides.



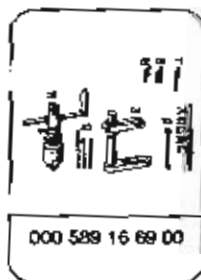
Machining Valve Seat 05.13



Z 05-6057

Data	362 LA	352 A
Valve seat angle	Intake	30°
	Exhaust	45°
Diameter "A" of valve seat with new seat rings (finish-machined)	Intake	41,3
	Exhaust	35,3
Width "B"	Intake	1,5 - 2,5
	Exhaust	2,0 - 2,5
Size "C" Check size (when new)	Intake	3,1 ^{+0,2} _{-0,1}
	Exhaust	2,6 ^{+0,2} _{-0,1}

Special Tools



Machining Valve Seats

Note: Valve guides are inserted.

- 1 Clamp cylinder head on valve clamp.
- 2 Measure valve seat diameter.

Note: If valve seats are slightly worn, they can be reworked without renewing the valve seat rings.

05.13 Machining Valve Seat

3 Introduce pilot into valve guide until the stop of the slotted rod rests on the valve guide, pressing slotted rod down with screwdriver if necessary. Tighten pilot.

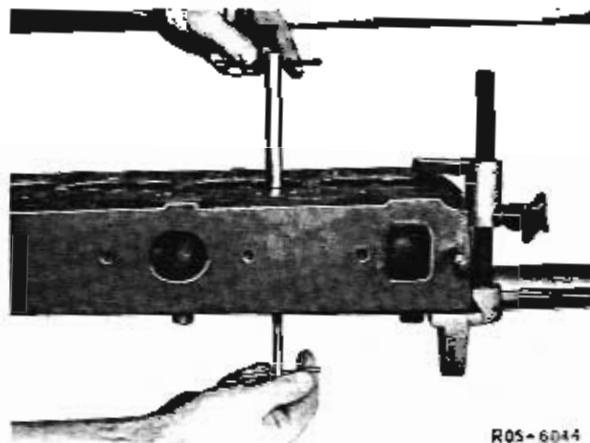
4 Bolt tight turning tool on support.

Note: Ensure that turning tool is fitted to the support with the correct degree setting. Take free support out of operation by slackening the coupling nut. Fit the crank handle to the appropriately marked arm.

5 Slacken coupling nut (2), push the turning tool over the pilot and move the rapid adjustment by turning the screw (1) so that the turning tool rests on the centre of the valve seat.

6 Press pilot rest (1) down onto the pilot and clamp tight using the screw (2), with the knurled washer (3) being screwed down and the locking screw (4) being screwed tight.

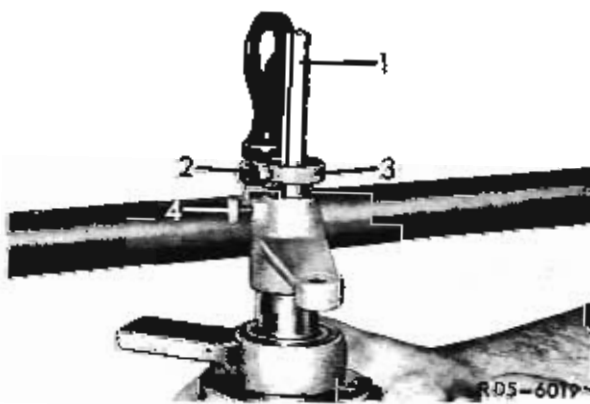
7 Move the steady rest into correct position with hand crank. Clamp pendulum guide horizontally approximately in the middle of the guide with the steady rest pliers. The turning tool must now turn as easily as before.



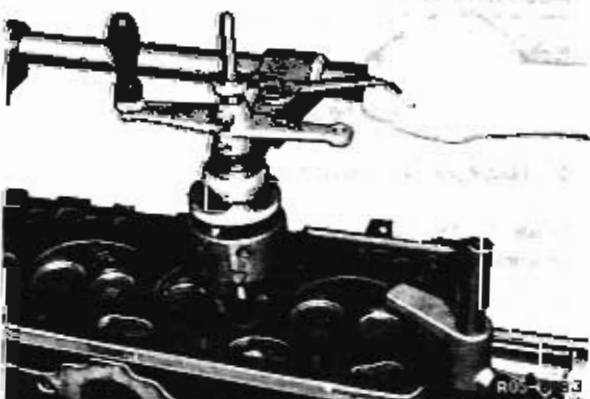
R05-6044



R05-6007

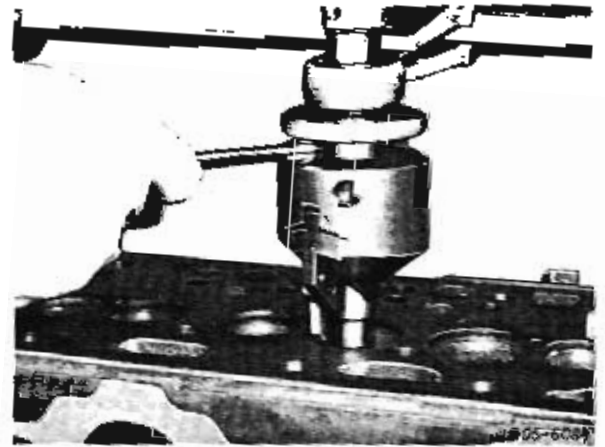


R05-6019



R05-6083

8 Move the turning tool next to the inner seat edge by turning the quick adjustment, then tighten the coupling nut. Do not make any machining infeed yet.



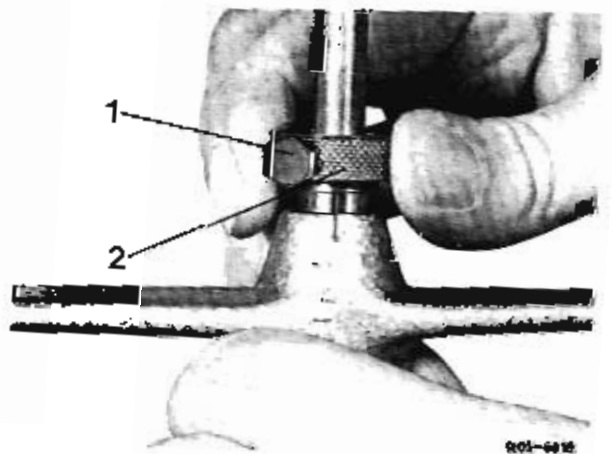
9 Hold the feed control tight and turn the crank handle. The chip removal is usually irregular in such cases. After rotating, slacken the coupling nut of the quick adjustment and move the tool in again.

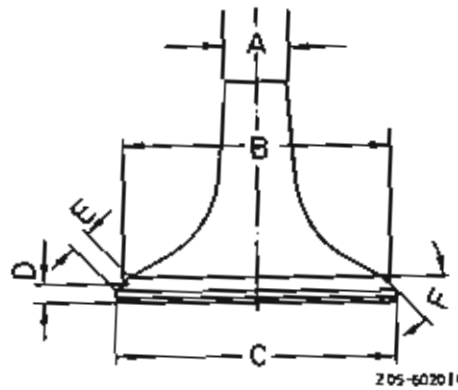


10 Slacken the locking screw (1) and turn the knurled disc (2) approx. 1/2 divisions (1 division = 0.1 mm) to the left. Re-tighten the locking screw (1) and coupling nut, rotate again.

11 Hold feed control tight and turn crank until the tip of the turning tool has moved to the outside.

12 An infeed must be as performed as often as is necessary to achieve a clear seat (the machining limit must not be exceeded). Then rotate once again without infeed. The values specified in the table must be reached for newly installed valve seat rings.





Data

Engine	Valve seat angle "F"	Valve plate dia. "C"	Valve stem dia. "A"	Valve length	Dia-meter "B"	Height "D" when new	Height "D" Mach. limit	Valve seat width "E"	Hardness at end of valve stem
352 A	Intake 45°	$\frac{44,10}{43,90}$	$\frac{8,950}{8,935}$	$\frac{140,7}{140,3}$	42	$\frac{2,8}{2,5}$	2,1	$\frac{3,5}{2,8}$	HRC = 57 ± 3
	Exh. 45°	$\frac{36,10}{35,90}$	$\frac{9,940}{9,925}$	$\frac{140,7}{140,3}$	34	$\frac{2,8}{2,5}$	2,1	$\frac{4,2}{3,5}$	HRC = 57 ± 3
362 LA	Intake 30°	$\frac{42,10}{41,90}$	$\frac{8,950}{8,935}$	$\frac{140,7}{140,3}$	40	$\frac{2,8}{2,5}$	2,1	$\frac{4,3}{3,3}$	HRC = 57 ± 3
	Exh. 45°	$\frac{36,10}{35,90}$	$\frac{9,940}{9,925}$	$\frac{140,7}{140,3}$	34	$\frac{2,8}{2,5}$	2,1	$\frac{4,2}{3,5}$	HRC = 57 ± 3

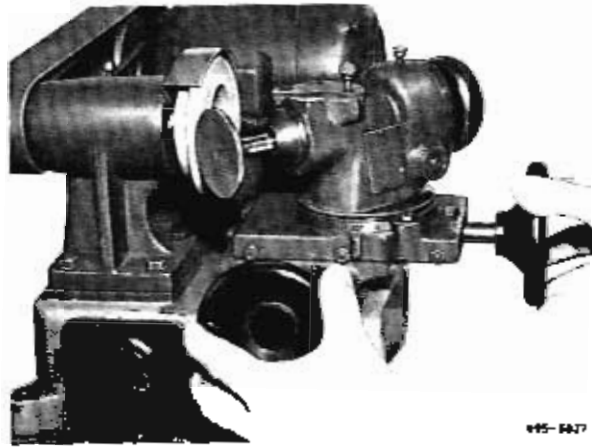
1) $\frac{8,940}{8,925}$ up to engine end no. 004 686

Perm. runout between valve seat and stem	0,03
Perm. runout between valve plate and stem	0,20
Perm. out-of-roundness of valve seat	0,01
Perm. runout at face	0,008

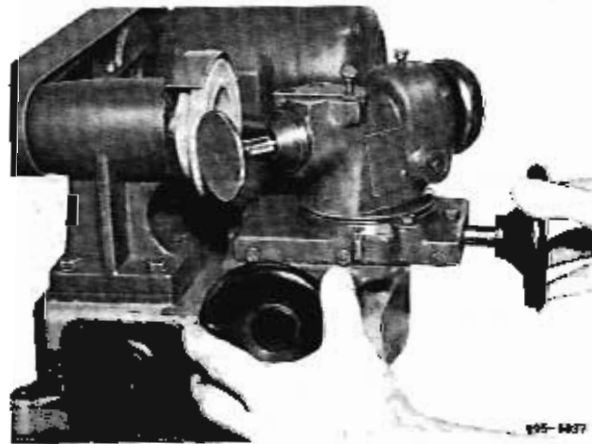
05.13 Grinding Valves

Grinding Valves

- 1 Clean removed valves, remove any oil carbon adhering to them.
- 2 Check that the valves can be re-used. There must not be any surface damage to the ends of the valve stems. The valve wedge grooves must not be worn and the chrome layer on the valve stems must be intact. Scorched valves should always be replaced.
- 3 Check valves for concentricity and dimensional tolerance. It is not permitted to straighten a valve.
- 4 Minor deviations in concentricity may be corrected by regrinding the valve seat on a valve grinding machine.
- 5 It is good practice to clamp the valve in place as close as possible behind the valve plate to avoid any interfering vibrations.



- 6 Adjust grinding angle on the scale.
- 7 Slowly move valve toward the rotating grinding stone with the feed until the stone comes into contact with the seat face of the valve.
- 8 Continue grinding with low feed until the valve seat is clean over its entire circumference.



Note: The size following this operation must not be less than size "B" specified in the table.

- 9 Face grinding of the end of the valve stem can be performed on the prism holder fitted to the valve grinding machine.



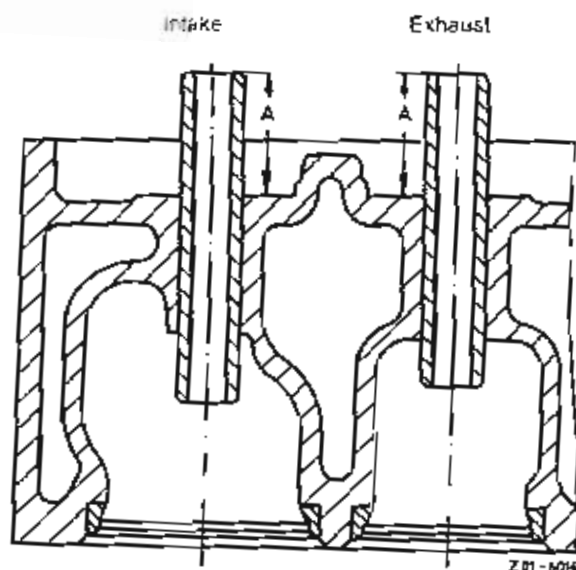
Data

Repair stage	Valve guide		Length of valve guide		Board in cylinder head	Over-lap in cylinder head	Play of valve stem in valve guide			
	OD	ID	Intake	Exhaust			Intake	Exhaust	Intake	Exhaust
Standard	15,046 15,028					15,018 15,000				
Rep. Stage I	15,146 15,128	9,022 9,000	10,022 10,000	78 73		15,118 15,100	0,010 to 0,046	0,050 to 0,087		
Rep. Stage II	15,246 15,228	Wear limit				15,218 15,200		Wear limit		
Rep. Stage III	15,546 15,528	9,050 ¹⁾	10,050 ¹⁾			15,518 15,500		0,115 ¹⁾ 0,125 ¹⁾		
Concentricity of valve seat relative to valve guide							0.04			
Distance from valve guide to contact face of valve spring size "A"							24.5 - 0.5			

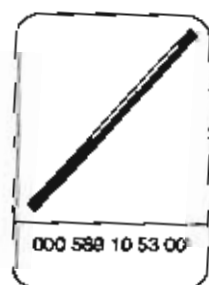
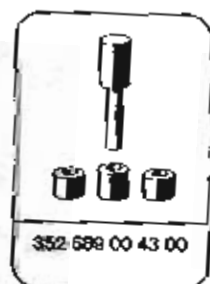
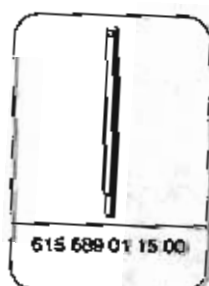
¹⁾ Measure at half guide height

²⁾ 352 A up to engine end no. 004 686 $\frac{9,022}{9,000}$

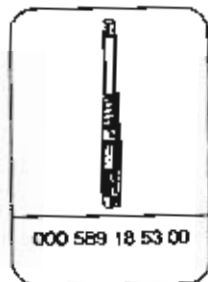
Valve guides



Special tools



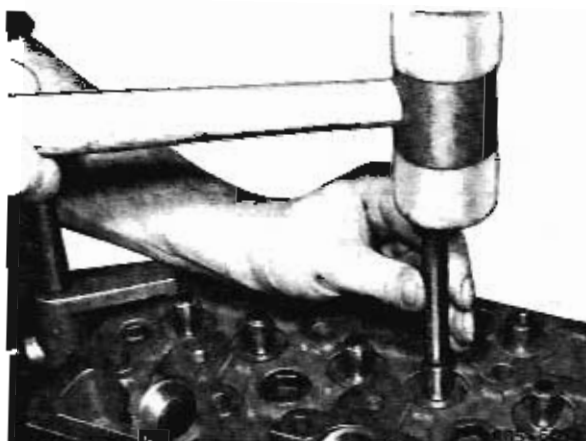
05.13 Removing and Installing Valve Guides



Removing

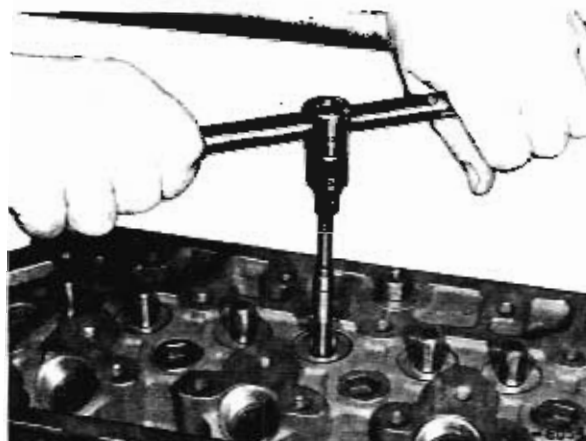
- 1 Clamp cylinder head in place.
- 2 Force valve guide out of the cylinder head with special tool.

Drill 110 589 02 15 00
Drill 619 589 01 15 00



- 3 Ream bore in cylinder head with adjustable reamer to the next larger repair stage.

Reamer 000 589 18 53 00



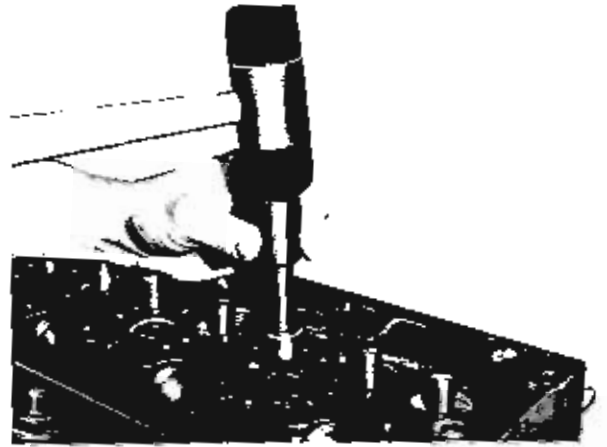
Installing

- 1 Heat cylinder head in water bath to approx. 80 °C. Coat new valve guide with graphited oil and fit into the bore of the cylinder head.
- 2 Slip spacer sleeve from special tool over valve guide.

Spacer sleeve from 352 589 00 43 00

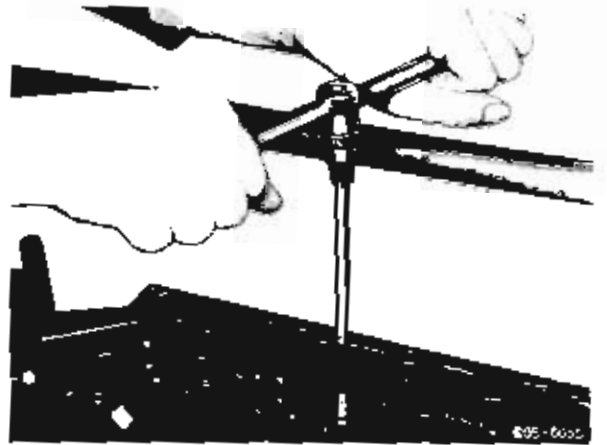


3 Force valve guide into the heated cylinder head with special tool.



Drill 352 569 00 43 00

4 Ream out inner diameter of valve guide with reamer according to the valve stem diameter.



Reamer 000 589 10 53 00

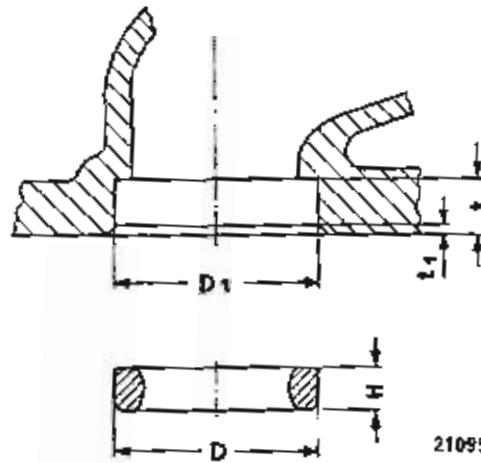
Reamer 000 589 11 53 00

05-6000



Replacing Valve Seat Rings 05.13

Cylinder head and valves removed



Data

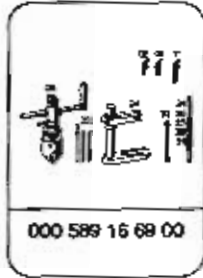
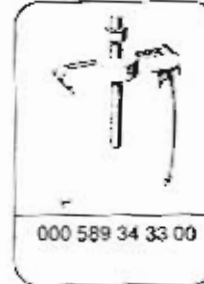
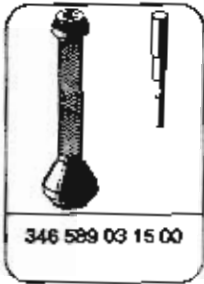
Engine		353 A			362 LA	
		Intake ¹⁾	Intake ²⁾	Exhaust	Intake	Exhaust
OD "D" of valve seat ring	Standard	$\frac{45,080}{45,070}$	$\frac{45,880}{45,870}$	$\frac{38,080}{38,070}$	$\frac{43,880}{43,870}$	$\frac{38,080}{38,070}$
	Rep. Stage I	$\frac{45,380}{45,370}$	$\frac{46,180}{46,170}$	$\frac{38,380}{38,370}$	$\frac{44,180}{44,170}$	$\frac{38,380}{38,370}$
	Rep. Stage II	$\frac{45,580}{45,570}$	$\frac{46,380}{46,370}$	$\frac{38,580}{38,570}$	$\frac{44,380}{44,370}$	$\frac{38,580}{38,570}$
Basic bore "D 1" in cylinder head for valve seat ring	Standard	$\frac{45,025}{45,000}$	$\frac{45,825}{45,000}$	$\frac{38,025}{38,000}$	$\frac{43,825}{43,800}$	$\frac{38,025}{38,000}$
	Rep. Stage I	$\frac{45,325}{45,300}$	$\frac{46,125}{46,000}$	$\frac{38,325}{38,300}$	$\frac{44,125}{44,100}$	$\frac{38,325}{38,300}$
	Rep. Stage II	$\frac{45,525}{45,500}$	$\frac{46,325}{46,000}$	$\frac{38,525}{38,500}$	$\frac{44,325}{44,300}$	$\frac{38,525}{38,500}$
Overlap of valve seat ring in cylinder head	0,045 - 0,080	0,045 - 0,080	0,045 - 0,080	0,045 - 0,080	0,045 - 0,080	
Depth "l" of bore in cylinder head	$\frac{11,2}{11,0}$	$\frac{11,2}{11,0}$	$\frac{11,2}{11,0}$	$\frac{11,2}{11,0}$	$\frac{11,2}{11,0}$	
Height "H" of valve seat ring	$\frac{8,3}{8,2}$	$\frac{8,3}{8,2}$	$\frac{8,5}{8,4}$	$\frac{8,0}{7,9}$	$\frac{8,5}{8,4}$	
Distance "l 1" between parting face of cylinder head and facing end of valve seat ring	$2,8^{+0,2}_{-0,1}$	$2,8^{+0,2}_{-0,1}$	$2,6^{+0,2}_{-0,1}$	$3,1^{+0,2}_{-0,1}$	$2,6^{+0,2}_{-0,1}$	

¹⁾ Up to engine end No. 549 881

²⁾ From engine end No. 549 882

05.13 Replacing Valve Seat Rings

Special Tools



Shop Equipment

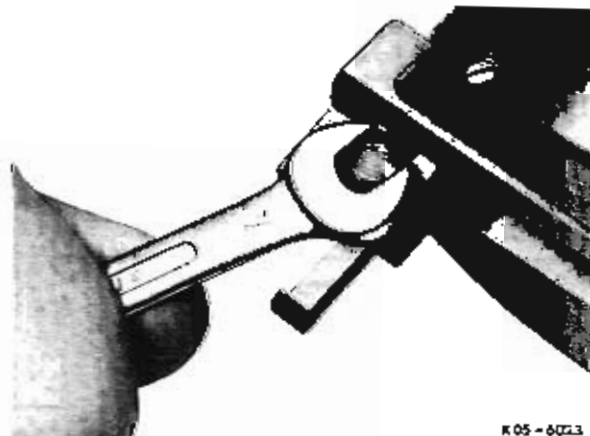
Valve clamp

Internal measuring instrument

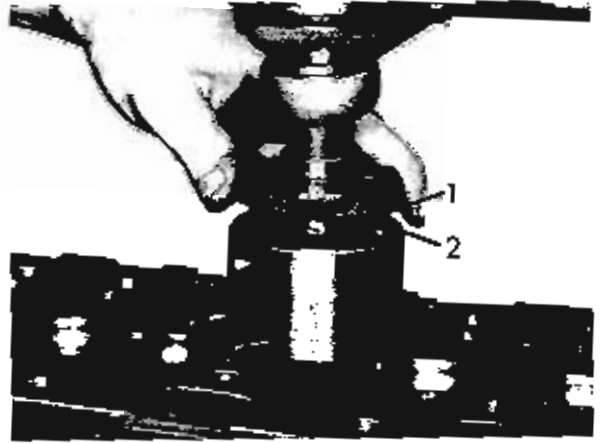
Removing

Note: Valve guides are installed.

- 1 Clamp cylinder head on the valve clamp.
- 2 Introduce the pilot into the valve guide until the stop of the slotted rod rests against the valve guide, pressing slotted rod down with screwdriver if necessary. Tighten with the drift inserted in the top and bottom of the pilot.
- 3 Clamp the turning tool for annular groove in the support.

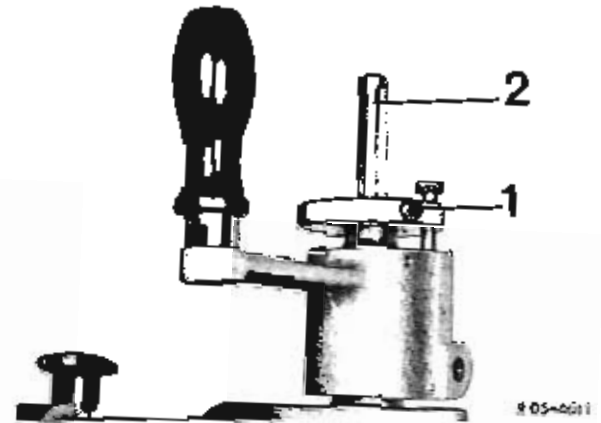


4 Slacken lock nut (2). Insert turning tool over the pilot moistened with oil, turn screw (1, quick adjustment) until turning tool rests against the pilot, then push turning tool down until it is in the centre of the valve seat ring.

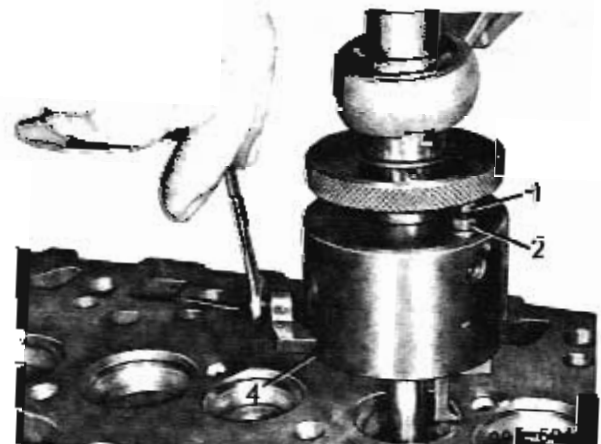


5 Hold turning tool tight in this position. Slacken locking screw (1) of the pilot rest, press pilot rest (2) down until it is touching the pilot. Retighten locking screw (1).

6 Move steady rest rod into suitable position relative to workpiece with hand crank. Clamp pendulum guide horizontally approximately in the middle of the guide with the steady rest pliers. The turning tool must turn as easily as before.



7 Turn back the screw of the quick adjustment (1) until the turning tool is moved up to the valve seat ring, but is not touching it yet. Tighten lock nut (2). Screw in horizontal stop screw (3) until it rests against the housing and then unscrew 2 to 3 mm. Tighten the clamping screw (4) located below.



8 Adjust the height of the turning tool so that approx. 1 mm material remains at the bottom of the valve seat ring following machining.

Note: If the knurled disc (2) is held tight and the crank of the turning tool is turned to the right, the turning tool moves down or, if turned to the left, the turning tool moves up.



05.13 Replacing Valve Seat Rings

9 Turn annular groove in the valve seat ring by turning the turning tool and at the same time holding the knurled disc (2) tight, which must be briefly released if the turning resistance increases slightly. Depth of annular groove approx. 2 to 3 mm.

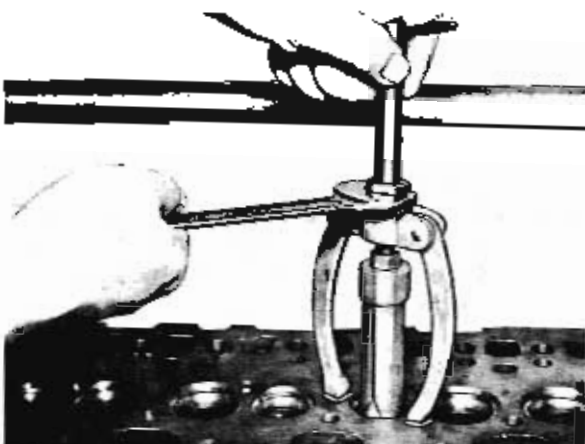
Note: Do not remove excessively large chips. The turning tool must be easy to turn, which is achieved by briefly releasing the knurled disc (2).



10 Remove turning tool.

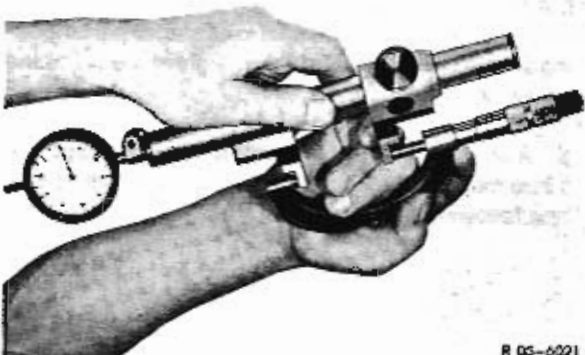
11 Fit internal extractor in the annular groove, tighten nut and pull out with countersupport.

Note: Copper plate should be laid below the supports of the countersupport to avoid damaging the cylinder head face.



Internal extractor 000 589 28 33 00
Internal extractor 000 589 29 33 00
Countersupport 000 589 34 33 00

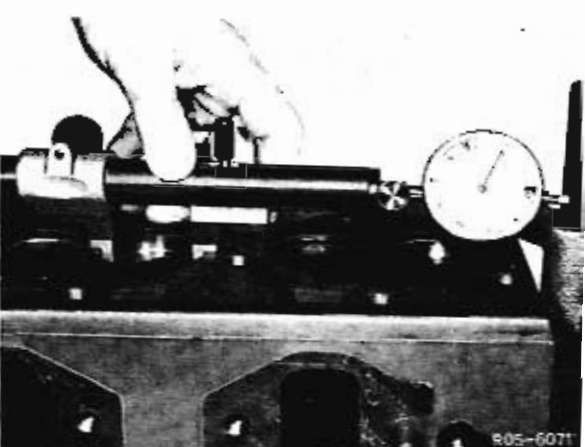
12 Adjust internal measuring instrument with micrometer.



R 05-6021

13 Measure the holes for the valve seat rings in the cylinder head with the internal measuring instrument.

Note: If the sizes differ from the values in the table, the bores must be enlarged to the next stage.



R 05-6071

Dial gauge 001 589 53 21 00

Reworking Basic Bore

- 1 Clamp the turning tool in the support.
- 2 Insert the pilot in the valve guide until the stop of the slotted rod rests on the valve guide, pressing the slotted rod down with a screwdriver if necessary. Tighten with the drift inserted at the top and bottom of the pilot.

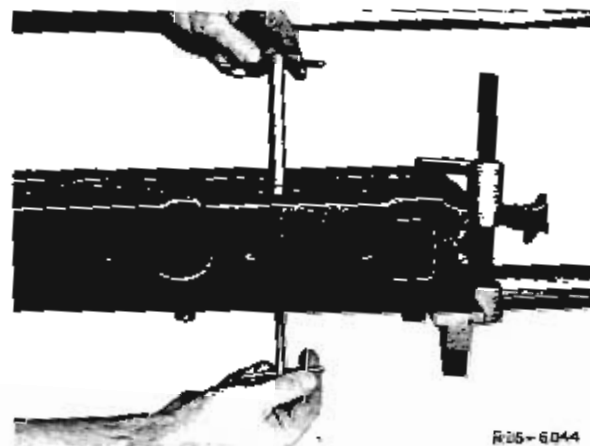
- 3 Slacken lock nut (1), fit turning tool over the pilot moistened with oil, turn quick adjusting screw (2) until the turning tool has moved out horizontally beyond the bore, then push turning tool down until it is resting on the cylinder head.

Caution! Fit tools carefully to prevent the hard metal blade of the turning tool being damaged.

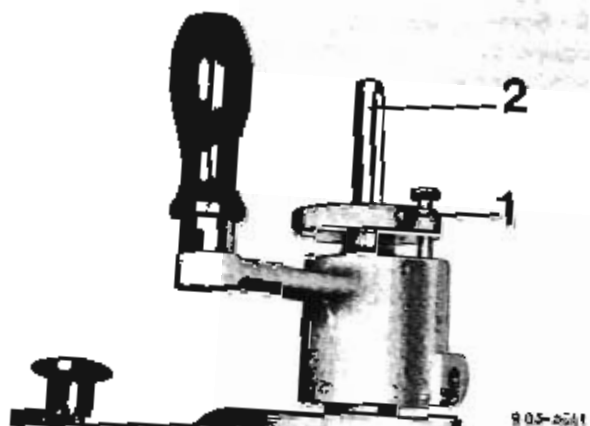
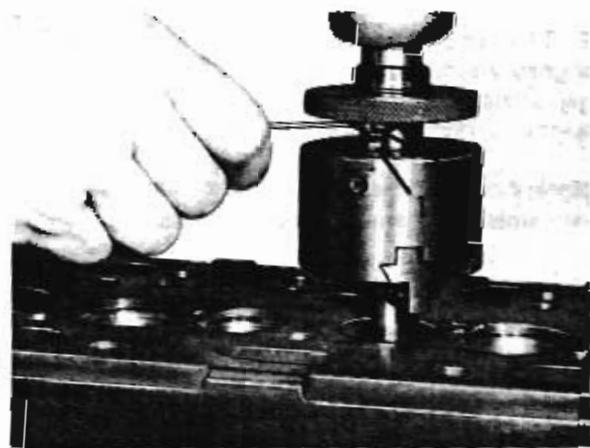
- 4 Slacken locking screw (1), press pilot rest (2) down until it touches the pilot, re-tighten locking screw (1).

- 5 Turn the knurled disc to adjust the height of the tool so that it is just clear.

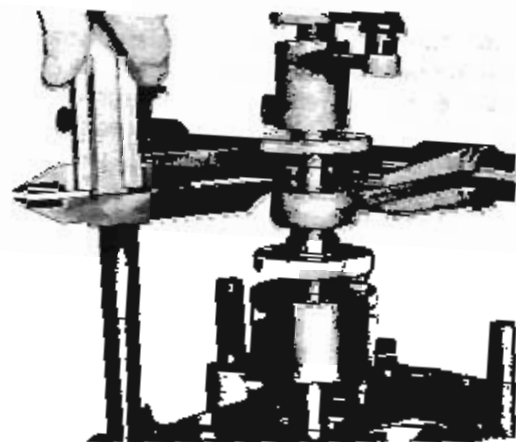
- 6 Clamp the pendulum guide horizontally with the steady rest pliers; the working depth (size "1" in table) must have been set between adjusting ring and pendulum guide.



R25-6044



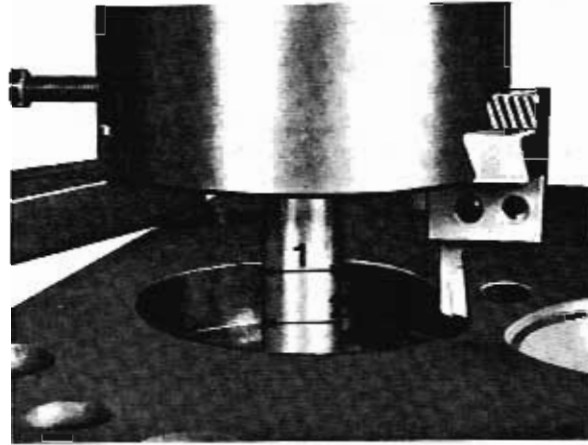
R05-6041



05.13 Replacing Valve Seat Rings

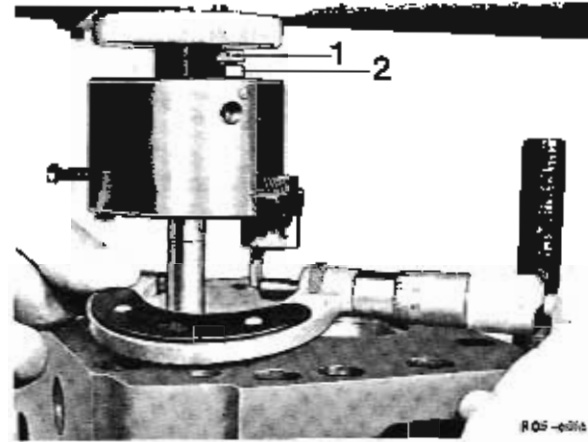
7 Calculation of adjustment size "2". Adjustment size "2" is basic bore "D 1" (Table Column "D 1") and pilot diameter "1" divided by 2.

$$"2" = \frac{D 1 + 1}{2}$$

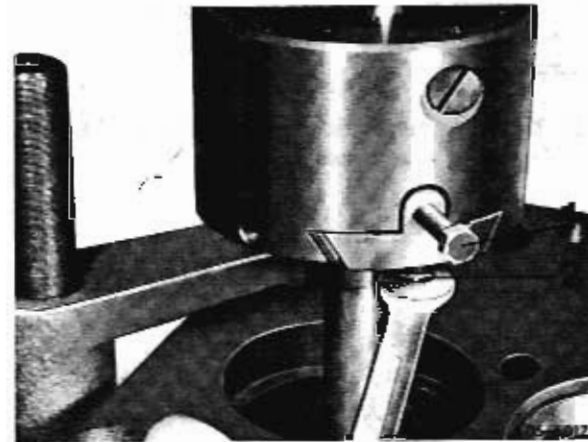


8 Slacken coupling nut, set micrometer to size "2", slightly raise turning tool, fit micrometer to pilot, precisely adjust turning tool to the size "2" with quick adjustment (1). Tighten coupling nut (2).

Note: It is good practice to adjust the turning tool 0.1 mm smaller in diameter for the first chip.

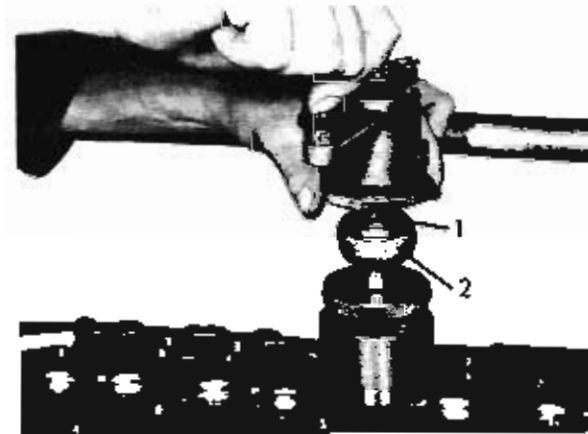


9 Screw in horizontal stop screw (1) until it rests against the housing, tighten the screw (2) below this, which prevents the stop screw from turning.



10 Turn the hole for the valve seat ring by turning the hand crank and at the same time holding the upper knurled disc for vertical infeed light until the adjusting ring (1) touches the steady rest bearing (2).

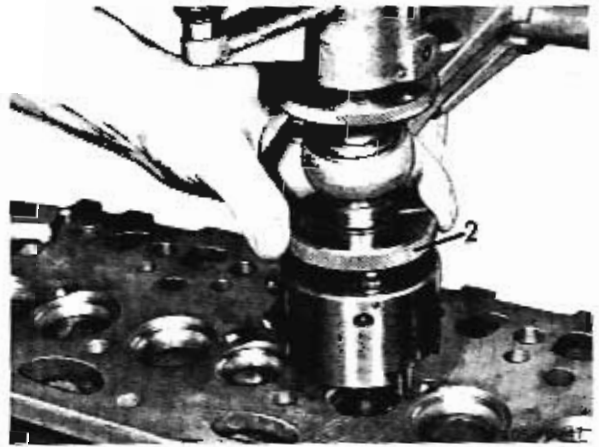
Note: Adjust turning tool as often as necessary until the adjustment size calculated in Job No. 7 is reached then again turn without any chip infeed to achieve a roughness of max. 0.006 mm.



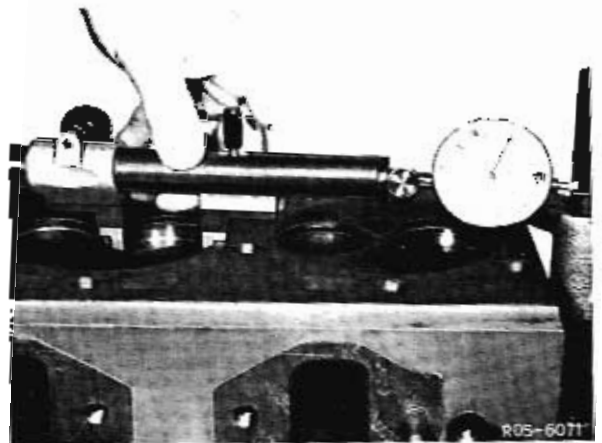
11 Stacken coupling nut, turn back tool with quick adjusting screw, then slightly raise turning tool.

12 Face-turn the front end at the bottom by turning the hand crank and at the same time holding the bottom knurled disc for the horizontal feed tight until the stop screw is resting against the housing.

2 Knurled disc



13 Remove turning tool, measure bore with internal measuring instrument (ensure overlap exists between valve seat ring and bore).



Installing

1 Insert valve seat rings in coolbox and pour in liquid oxygen. Super-cool valve seat rings approx. 20 - 30 minutes.

Note: Liquid oxygen can be obtained from any oxygen manufacturer.

2 Heat cylinder head to approx. 80°C in water bath.

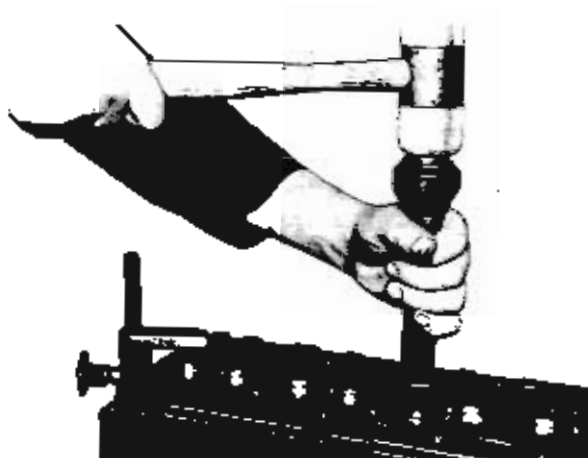
3 Take valve seat rings out of the coolbox and place on the bore of the heated cylinder head.



05.13 Replacing Valve Seat Rings

4 Knock valve seat rings in with special tool.

Note: The valve seat ring must be inserted immediately. Do not allow your fingers to come into contact with the liquid or with the super-cooled valve seat ring.



Forcing drift 346 589 03 15 00

Data

Repair Stages of Camshaft and Bearings

Stages	Camshaft bearing	Camshaft bearing journal dia.	Lift journal for air compressor	Final bore dia. of press-fitted bearing
Standard	1	<u>55,960</u> 55,941		<u>56,030</u> 56,000
	2	<u>55,710</u> 55,691		<u>55,770</u> 55,740
	3	<u>55,460</u> 55,441	<u>32,000</u> 31,984	<u>55,520</u> 55,490
	4	<u>55,210</u> 55,191		<u>55,270</u> 55,240
Standard I	1	<u>55,860</u> 55,841		<u>55,930</u> 55,900
	2	<u>55,610</u> 55,591		<u>55,670</u> 55,640
	3	<u>55,360</u> 55,341	<u>31,900</u> 31,884	<u>55,420</u> 55,390
	4	<u>55,110</u> 55,091		<u>55,170</u> 55,140
Rep. Stage I	1	<u>55,760</u> 55,691		<u>55,780</u> 55,750
	2	<u>55,460</u> 55,441		<u>55,520</u> 55,490
	3	<u>55,210</u> 55,191	<u>31,750</u> 31,734	<u>55,270</u> 55,240
	4	<u>54,960</u> 54,941		<u>55,020</u> 54,990
Rep. Stage II	1	<u>55,460</u> 55,441		<u>55,530</u> 55,500
	2	<u>55,210</u> 55,191		<u>55,270</u> 55,240
	3	<u>54,960</u> 54,941	<u>31,500</u> 31,484	<u>55,020</u> 54,990
	4	<u>54,710</u> 54,691		<u>54,770</u> 54,740

Tightening Torques in Nm

Thrust washer at cylinder crankcase	35
Timing device at camshaft	300
Camshaft gear at injection pump input gear	35

05.13 Removing and Installing Camshaft

Data

Camshaft play	radial	0,030 - 0,079	
	axial	0,18 - 0,52	
Backlash between	Crankshaft gear and camshaft gear	0,12 - 0,17	
	Injection pump gear and idler gear or camshaft gear	0,12 - 0,17	
Hardness of lifting journals and lifting journal radii		57 - 63 HRC	
Max. deviation in concentricity when shaft running on outer bearing points	Timing gear seat	0,02	
	Cam base circle	0,025	
	Bearing points	0,025	
Cam projection above base circle diameter	352 A	Intake	7,20
		Exhaust	7,20
	362 LA	Intake	6,35
		Exhaust	6,60

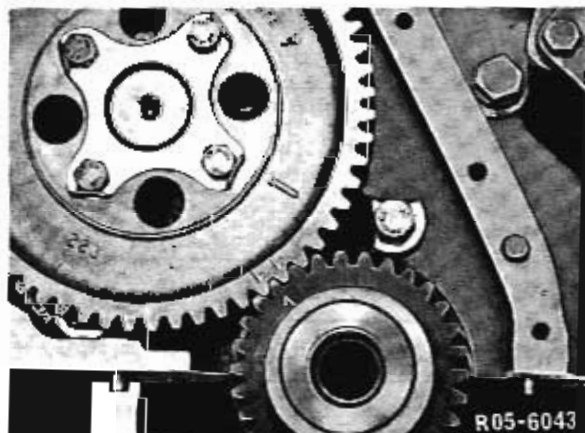
Preliminary Work

Remove tappet rods and valve tappets. Remove oil pump. Take off air compressor. Unscrew timing case cover.

Removing

352 A up to engine end no. 470 359

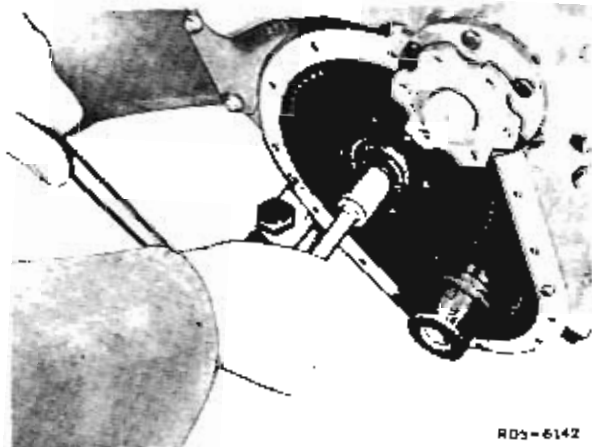
- 1 Crank engine in direction of rotation until the marks on the camshaft and crankshaft agree.
- 2 Unscrew thrust washer for holding camshaft.
- 3 Take camshaft with camshaft gear out of cylinder crankcase.



352 A from engine end no. 470 360

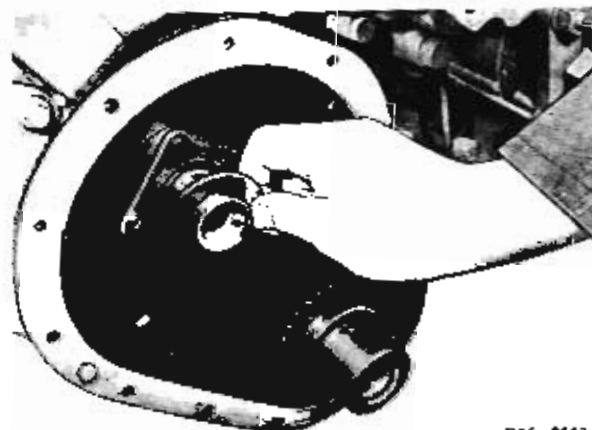
362 LA from start of production

1 Slacken bolt for fastening timing device and take off timing device.



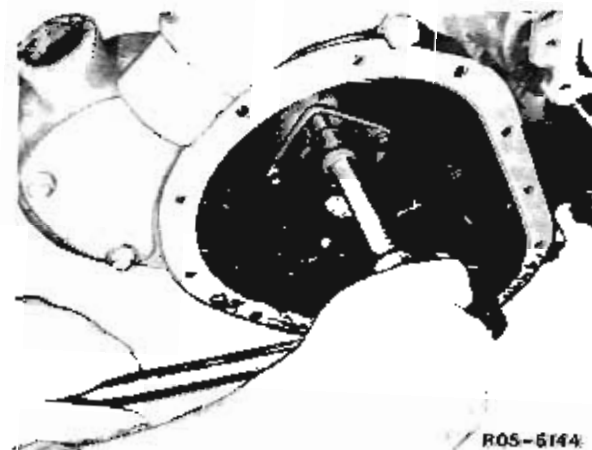
R05-6142

2 Remove spacer shim from camshaft.



R05-6143

3 Unscrew thrust washer and take camshaft out of the cylinder crankcase.



R05-6144

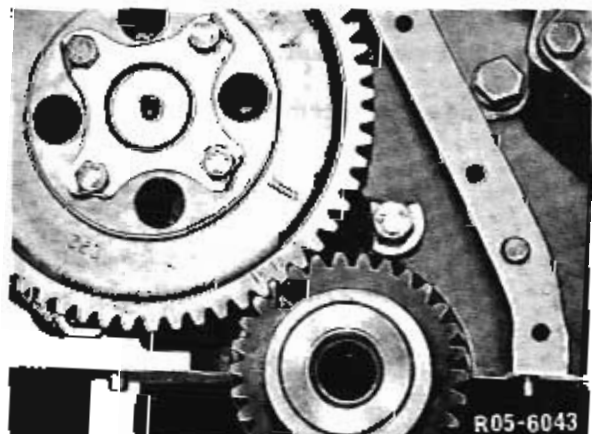
Installing

352 A up to engine end no. 470 359

1 Carefully insert the camshaft in the cylinder crankcase so that the bearings are not damaged.

Note: Ensure that the tooth marked with "1" of the crankshaft gear rests between the teeth of the camshaft gear which are also marked with "1-1".

2 Bolt thrust washer tight without tab washer.



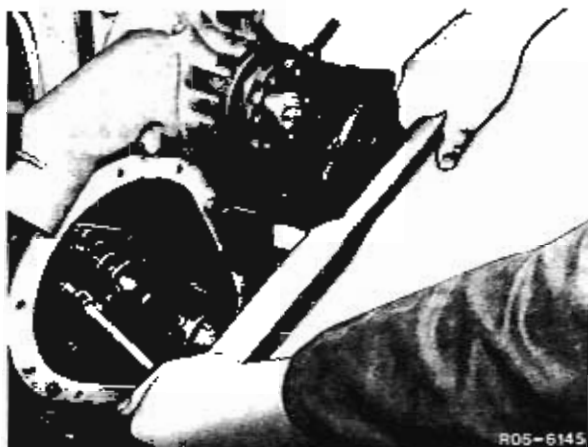
R05-6043

05.13 Removing and Installing Camshaft

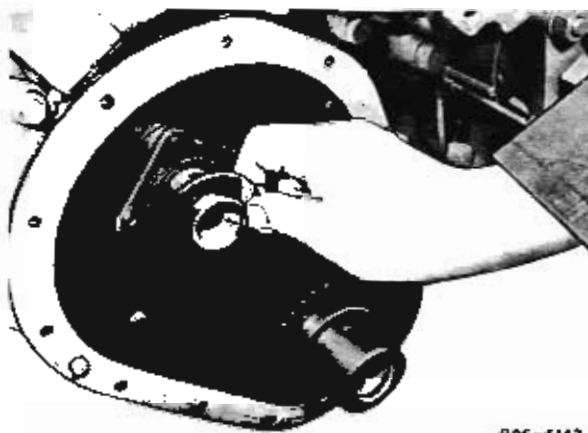
352 A from engine end No. 470 360

362 LA from start of production

- 1 Carefully insert camshaft into the cylinder crankcase so that the bearings are not damaged.
- 2 Torque thrust washer to 35 Nm with torque wrench.

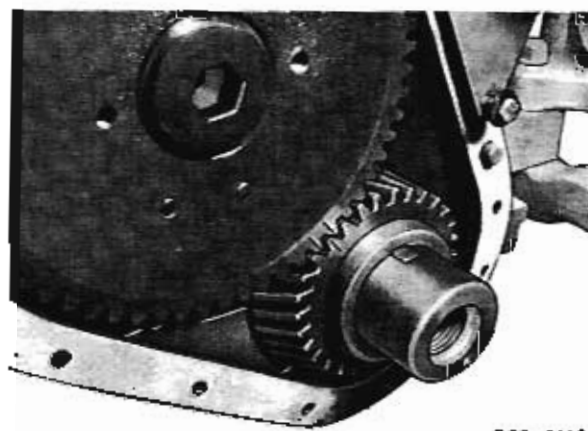


- 3 Fit spacer shim onto camshaft.



- 4 Mount timing device with fitting key onto camshaft and fit fastening bolt.

Note: Ensure that the tooth of the crankshaft gear marked with "1" rests between the teeth of the timing device which are also marked with "1-1".



- 5 Torque the fastening bolt for the timing device to 300 Nm with torque wrench.

- 6 Check the end play of the camshaft.



Engine Output	Injection Pump Bosch Designation (MB Part No.)	Regulator Bosch Designation	Test Values MB Sheet
110 kW/150 PS	PES 6 A 80 C 410 RS 2085 (006 074 67 01)	RQV 300 ... 1425 AB 551 DL	MB 5,7 b
110 kW/150 PS	PES 6 A 80 C 410 RS 2085 (006 074 45 01)	RQV 300 ... 1425 AB 625 DL	MB 5,7 h
115 kW/156 PS	PES 6 A 80 C 410 RS 2085 V (009 074 58 01)	RQV 300 ... 1425 AB 625 DL	MB 5,7 h
110 kW/150 PS	PES 6 A 80 C 410 RS 2085 (007 074 47 01)	RQV 300 ... 1425 AB 620 DL	MB 5,7 h
124 kW/168 PS	PES 6 A 90 C (D) 410 RS 2293 Z (001 074 03 02)	RQV 300 ... 1425 AB 740 L	MB 5,7 n
124 kW/168 PS	PES 6 A 90 C (D) 410 RS 2293 Z (001 074 04 02)	RQV 300 ... 1425 AB 781 L	MB 5,7 n
124 kW/168 PS	PES 6 A 90 C (D) 410 RS 2293 Z (001 074 07 02)	RQV 300 ... 1425 AB 780 L	MB 5,7 n
124 kW/168 PS	PES 6 A 90 D 410 RS 2293 (005 074 31 02)	RQV 300 ... 1425 AB 946 L	MB 5,7 s
124 kW/168 PS	PES 6 A 90 D 410 RS 2293 (005 074 33 02)	RQV 300 ... 1425 AB 948 L	MB 5,7 s
124 kW/168 PS	PES 6 A 90 D 410 RS 2293 (005 074 34 02)	RQV 300 ... 1425 AB 949 L	MB 5,7 s
124 kW/168 PS	PES 6 A 90 D 410 RS 2293 (005 074 32 02)	RQV 300 ... 1425 AB 947 L	MB 5,7 s
124 kW/168 PS	PES 6 A 90 D 410 RS 2293 Z (004 074 44 02)	RQV 300 ... 1425 AB 925 L	MB 5,7 n 1
124 kW/168 PS	PES 6 A 90 D 410 RS 2293 (009 074 72 02)	RQV 300 ... 1400 AB 1142 L	MB 5,7 x
124 kW/168 PS	PES 6 A 90 D 410 RS 2293 (009 074 70 02)	RQV 300 ... 1400 AB 1140 L	MB 5,7 x
124 kW/168 PS	PES 6 A 90 D 410 RS 2293 (009 074 71 02)	RQV 300 ... 1400 AB 1141 L	MB 5,7 x
124 kW/168 PS	PES 6 A 90 D 410 RS 2293 (009 074 69 02)	RQV 300 ... 1400 AB 1138 L	MB 5,7 x 1
127 kW/172 PS	PES 6 A 90 D 410 RS 2293 (005 074 99 02)	RQV 300 ... 1425 AB 982 DL	MB 5,7 t
127 kW/172 PS	PES 6 A 90 D 410 RS 2520 (006 074 27 02)	RQV 300 ... 1425 AB 982 DL	MB 5,7 n 5
127 kW/172 PS	PES 6 A 90 D 410 RS 2596 (007 074 91 02)	RQV 300 ... 1400 AB 1066-1 DL	MB 5,7 v 2
141 kW/192 PS	PES 6 MW 100/720 RS 1101 (010 074 29 02)	RQV 300 ... 1300 MW 44	MB 8,7 p

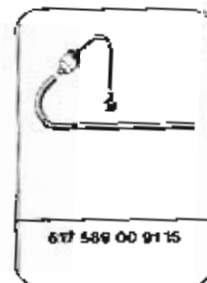
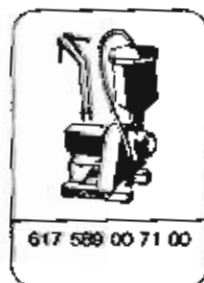
Data

		110/115 kW	23° BTDC
Start of delivery	352 A	124 kW	21° BTDC
		127 kW	19° BTDC
	362 LA	141 kW	17° BTDC

Tightening Torques in Nm

Overpressure valve on injection pump	25
Union nut of injection line	25

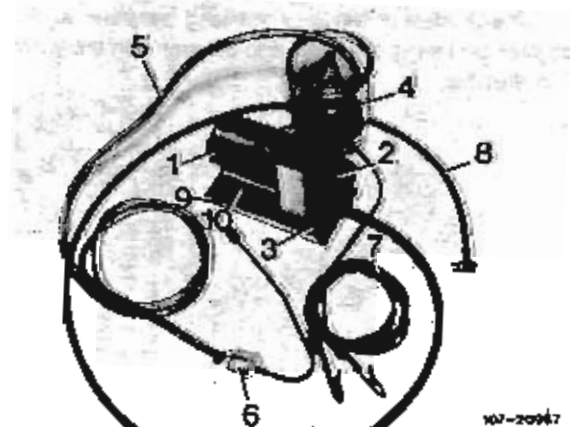
Special Tools



Testing Start of Delivery

Pump Assembly

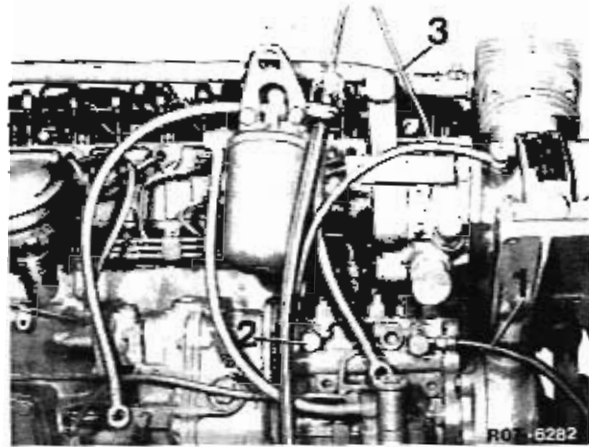
- 1 Electric motor (12 V DC/15 A)
- 2 Gear pump
- 3 Pressure limiting valve
- 4 Fuel tank
- 5 Return line
- 6 Sight glass with test line
- 7 Connection cable
- 8 Connection line (feed)
- 9 Base plate
- 10 Relay box with switch



107-20947

07.13 Testing Start of Delivery

- 1 Detach the fuel feed line at the injection pump and connect the feed line from the pump unit (1).
- 2 Detach the fuel return line and overflow valve at the pump and seal the bore with a blind plug (2).
- 3 Remove the injection line to No. 1 engine cylinder. Connect test line with sight glass to the connection of the injection pump for the No. 1 engine cylinder (3).

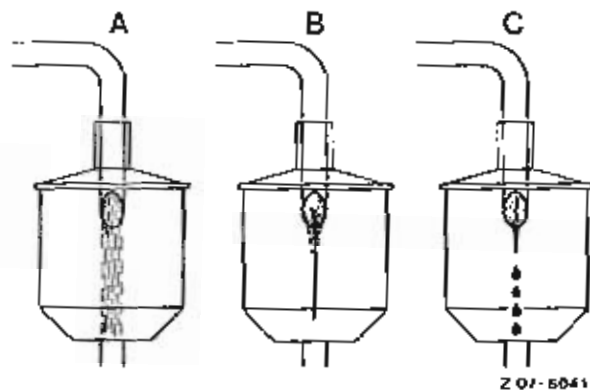


- 4 Connect the pump unit to a 12 volt battery.
- 5 Position crankshaft in direction of rotation approx. $\frac{1}{2}$ turns ahead of ignition TDC of No. 1 cylinder.
- 6 Push injection pump lever to full load, lock and switch on pump unit.

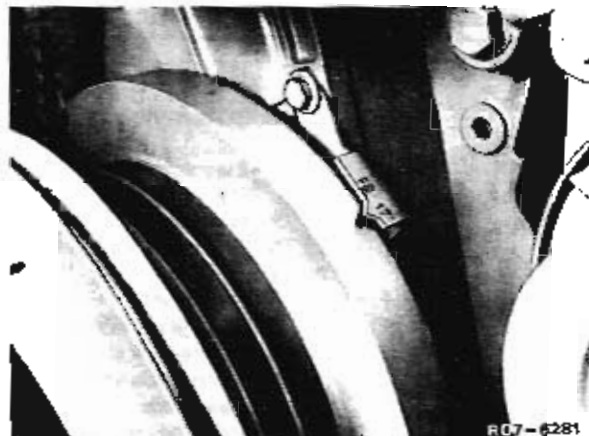
Note: The injection pump lever must not be operated when the pump is running. Switch on the pump unit only to perform measurement otherwise fuel may enter the injection chamber if the nozzle is leaking.

- 7 Slowly crank engine in direction of rotation and observe fuel flow in the sight glass until the fuel jet changes from a constricted jet to drips. The exact setting of the start of delivery is at this transition point.

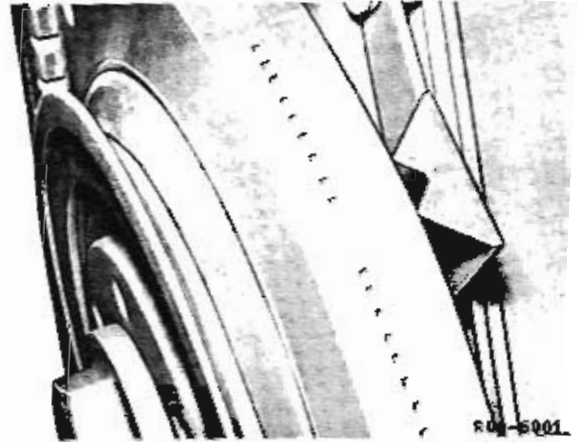
- A = "Full" fuel jet
- B = Constricted fuel jet
"shortly before start of delivery"
- C = String of drips start of delivery



- 8 Check start of delivery marking between setting pointer on timing housing and FB mark on the vibration damper.



9 If it is necessary to correct the FB setting, the crankshaft must be set in the direction of rotation exactly to the FB mark on vibration damper and setting pointer on timing case.

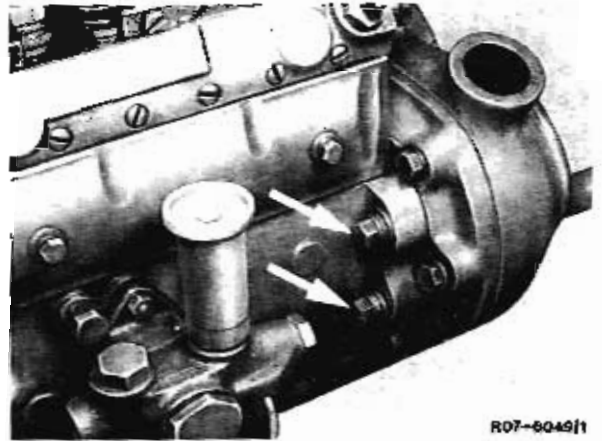


10 Slacken the fastening bolts for the injection pump.

11 Push the injection pump lever to full load, lock and switch on the pump unit. Do not operate the injection pump lever when the pump unit is running.

12 Swivel the injection pump in the oblong holes until the exact start of delivery is reached.

Note: First swivel the injection pump toward the engine.

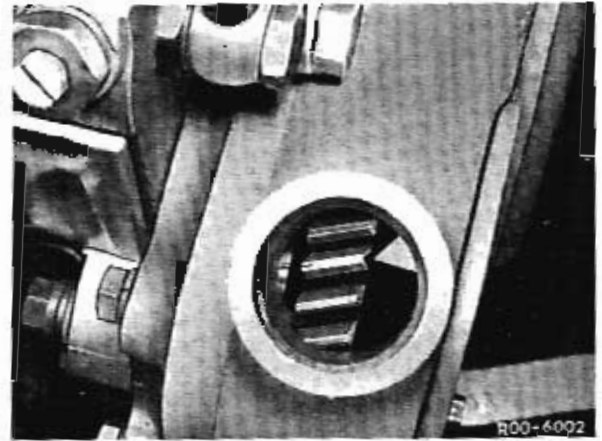


13 Tighten the fastening bolts of the injection pump.

14 Repeat the test of the start of delivery points 5 - 8 as a check.

Note: When inserting an injection pump, the mark on the injection pump gear must agree with the pointer in the timing case.

On engine OM 362 LA, the air compressor with bracket requires to be removed for this purpose.



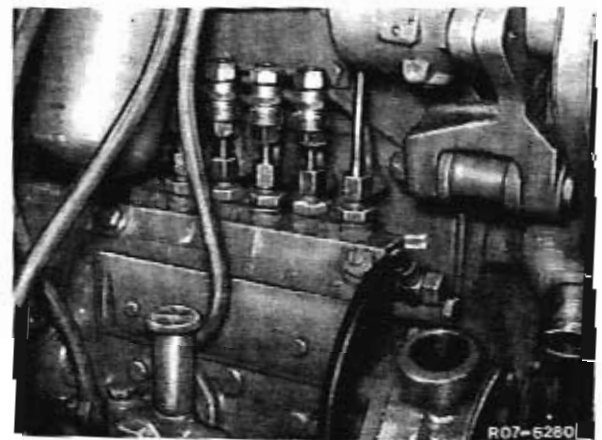
15 With a newly installed injection pump, the start of delivery should be checked with the pressure limiting valves mounted (without injection line).

16 Remove overpressure valves and fit injection lines.

17 Remove pump unit.

18 Install fuel feed line.

19 Install fuel return line with overpressure valve.



Removing and Installing Injection Pump 07.13

Data

		110/115 kW	23° BTDC
Starter of delivery	352 A	124 kW	21° BTDC
		127 kW	19° BTDC
	362 LA	141 kW	17° BTDC

Tightening Torques in Nm

Union nut at injection pump		25
Injection pump gear at injection pump	(M 14 x 1.5)	80
Injection pump gear at injection pump	(M 18 x 1.5)	105

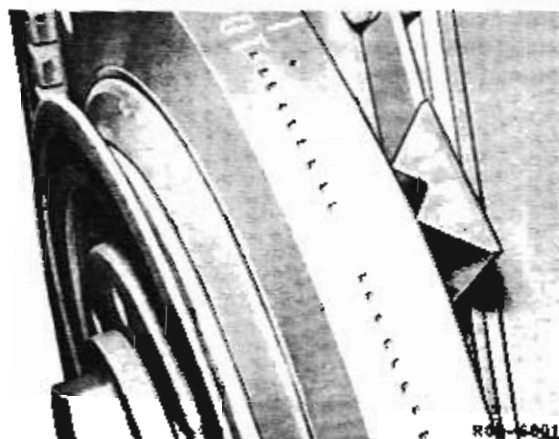
Special Tools



Removing

- 1 Remove oil filler neck from timing case (352 A).
- 2 Remove air compressor and bracket (362 LA).
- 3 Set engine in the compression stroke of No. 1 cylinder in direction of rotation to start of delivery (FB) according to the mark on the vibration damper and the setting pointer on the timing case.

Note: The gear backlash must be eliminated when turning back.

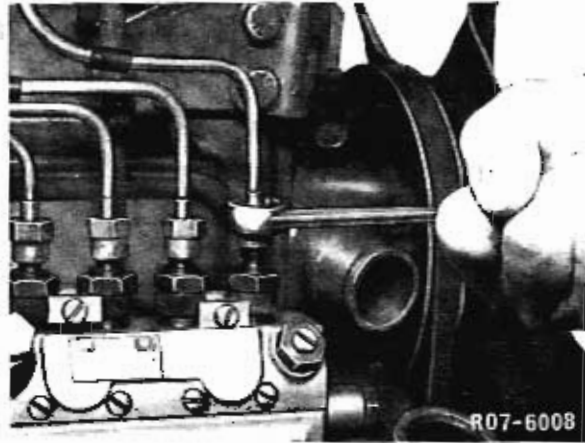


07.13 Removing and Installing Injection Pump

4 Unscrew the union nuts of the injection lines from the injection pump with a special tool.

5 Unscrew the fuel line from delivery pump and injection pump.

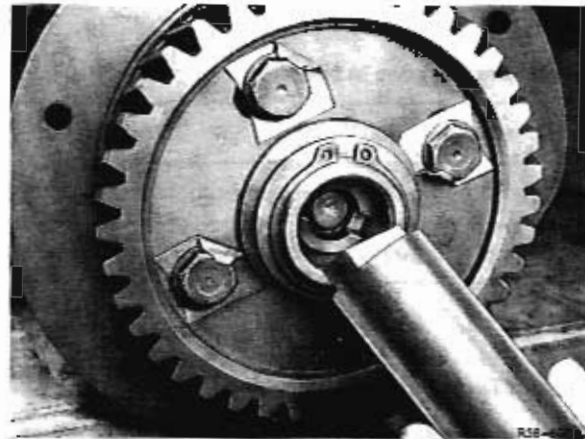
6 Unscrew oil feed line.



Box wrench 000 589 07 03 00

7 Unscrew injection pump with support from timing case and remove.

8 Unscrew slotted nut with special tool.

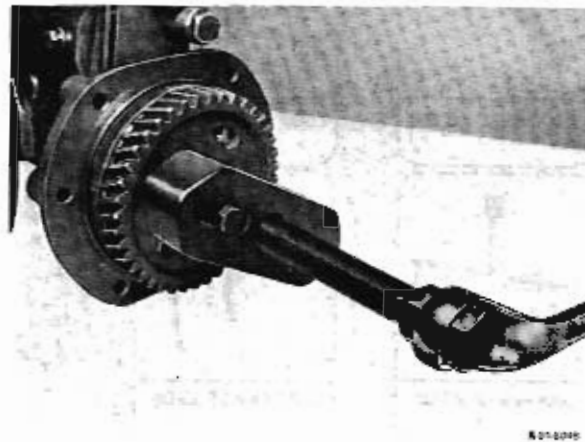


Screwdriver socket 322 589 00 09 00

9 Slacken tab washers for injection pump gear and unscrew bolts.

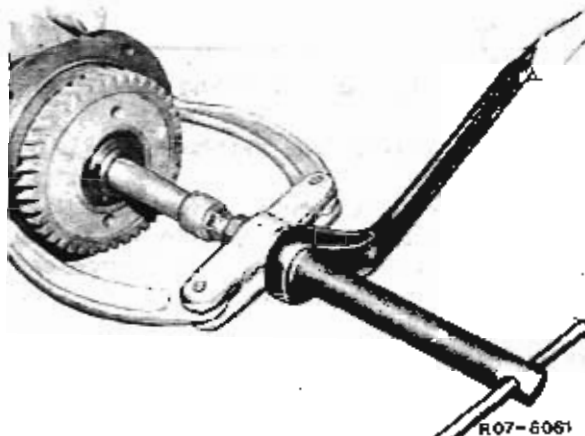
10 Slacken bolts of injection pump at cover.

11 Pull timing device off injection pump with special tool.



Puller 355 589 00 33 00

Note: From engine end No. 420 485 up to 470 359 the timing device is pulled off the injection pump with an internal extractor.



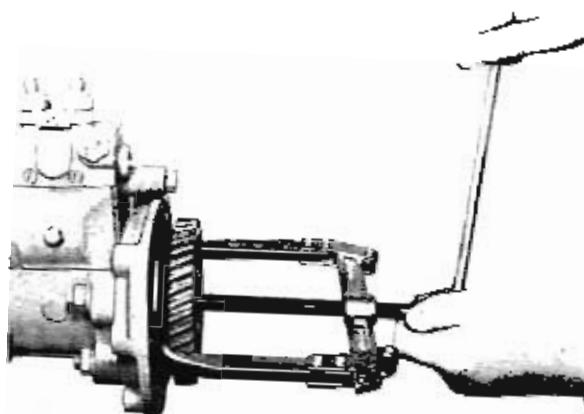
Internal extractor 000 589 27 33 00
Counter support 000 589 34 33 00

Removing and Installing Injection Pump 07.13

Note: OM 352 A from engine end No. 470 360
OM 362 LA from start of production

Pull input gear off injection pump with special tool.

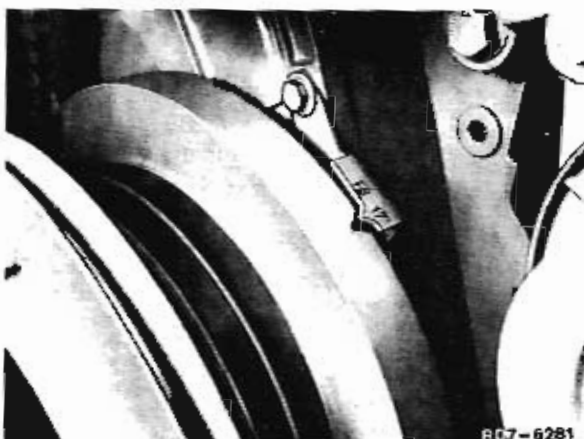
Part no. 000 589 89 33 00



R07-6089

Installing

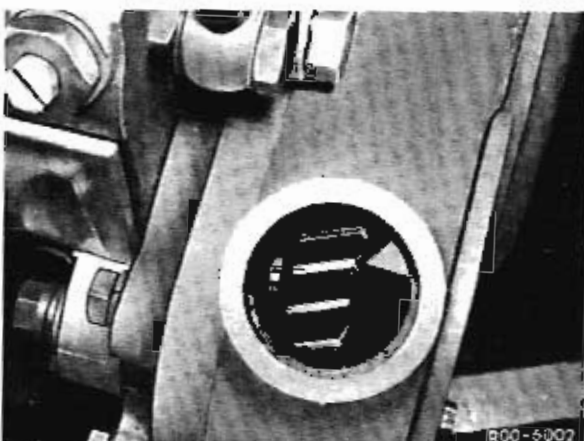
1 Install timing device and support or input gear on injection pump.



R07-6281

2 Position engine in compression stroke of No. 1 cylinder to start of delivery.

3 Insert injection pump with new gasket in timing case so that the tooth of the injection pump gear marked with a notch is aligned with the arrow mark in the timing case.



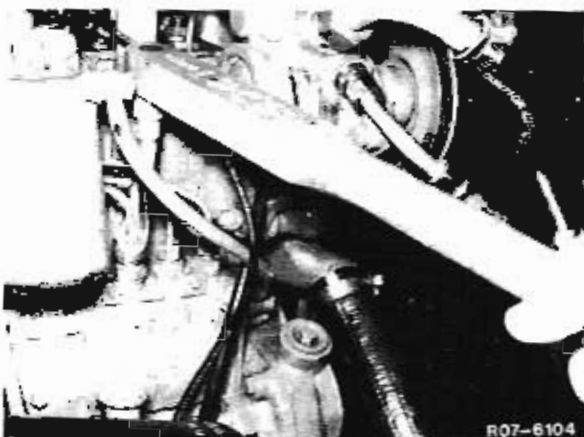
R00-6002

4 Tighten injection pump.

5 Adjust start of delivery.

6 Connect flow line to delivery pump and injection pump.

7 Tighten union nut of injection lines with special tool and torque wrench to pipe connections of injection pump.



R07-6104

Box wrench socket 000 589 68 03 00

Removing and Installing Nozzle Holder 07.13 and Protective Sleeve

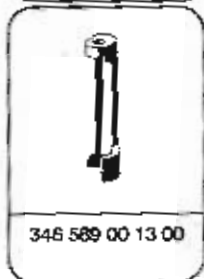
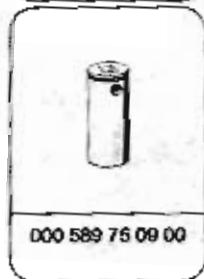
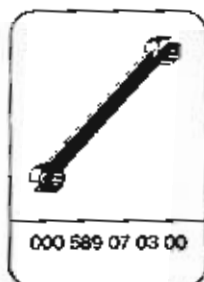
Data

Nozzle holder 352 A/362 LA	S nozzle	KDAL 74 S 3/19
352 A	P nozzle	KDEL 80 P 1/13

Tightening Torques in Nm

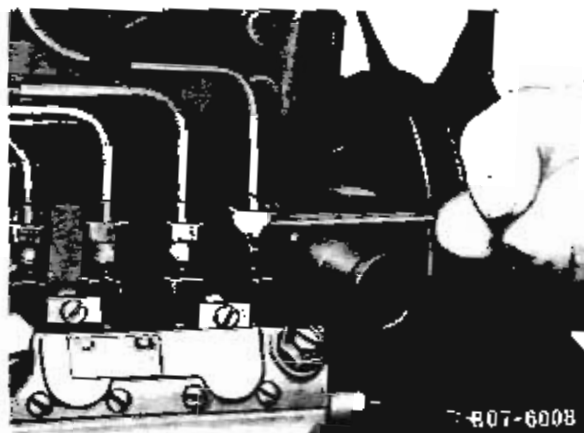
Cylinder head cover	25
Union nut injection line	25
Thrust bolt nozzle holder (S nozzle)	70
Protective sleeve in cylinder head (S nozzle)	60
Thrust bolt nozzle holder (P nozzle)	70
Protective sleeve in cylinder head (P nozzle)	40

Special Tools



Removing

- 1 Remove cylinder head cover.
- 2 Unscrew union nut of injection line at injection pump with special tool.

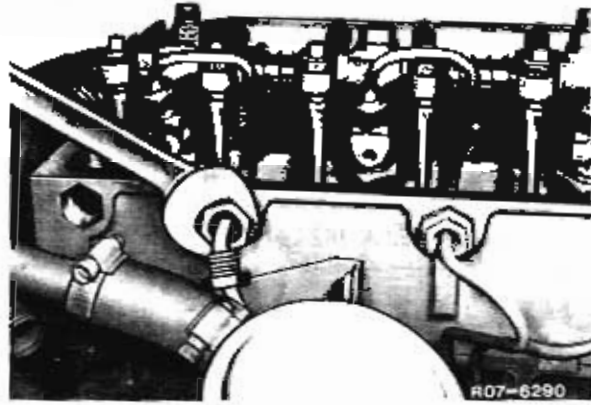


Box wrench 000 589 07 03 00

07-6008

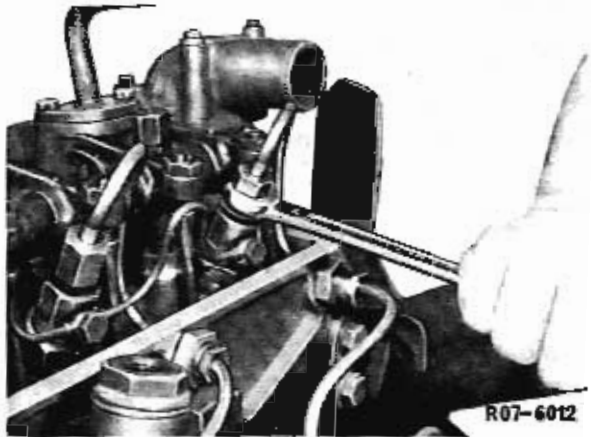
07.13 Removing and Installing Nozzle Holder and Protective Sleeve

3 Unscrew leak oil line and slacken plugs.



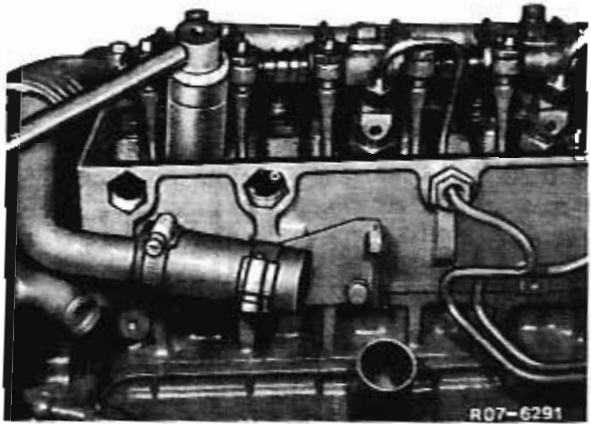
4 Unscrew union nut of injection line at nozzle holder with special tool and take off injection line.

Note: Avoid at all costs bending the injection line.



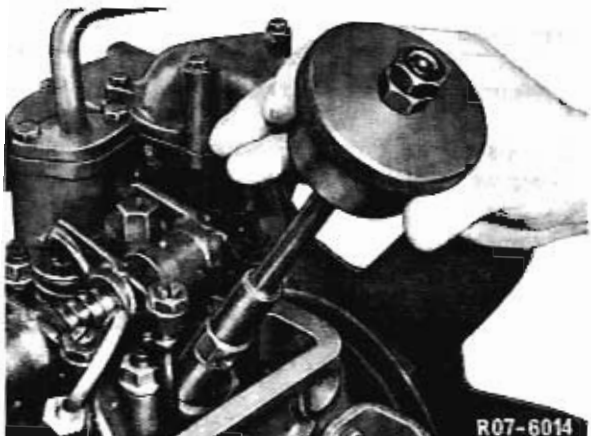
Box wrench 000 589 07 03 00

5 Unscrew thrust bolt for nozzle holder with special tool.



(P nozzle) pin wrench socket 403 589 04 07 00
(S nozzle) socket wrench socket 000 589 75 09 00

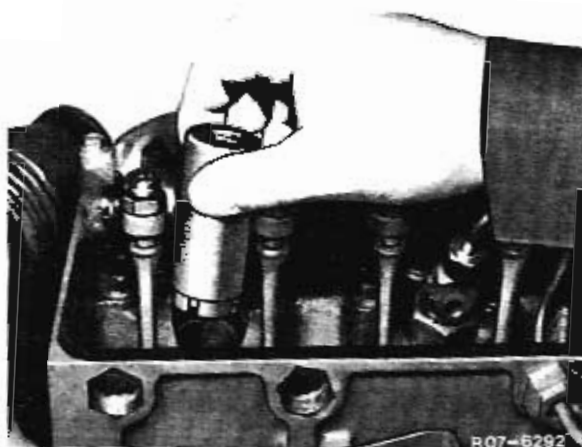
6 Knock nozzle holder out of cylinder head using special tool.



Impact extractor 355 589 01 63 00

Removing and Installing Nozzle Holder and Protective Sleeve 07.13

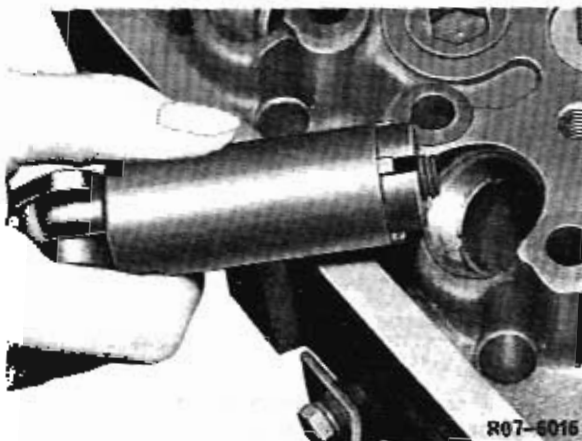
- 7 Insert special wrench in cylinder head.



Jaw wrench 346 589 00 07 00

R07-6292

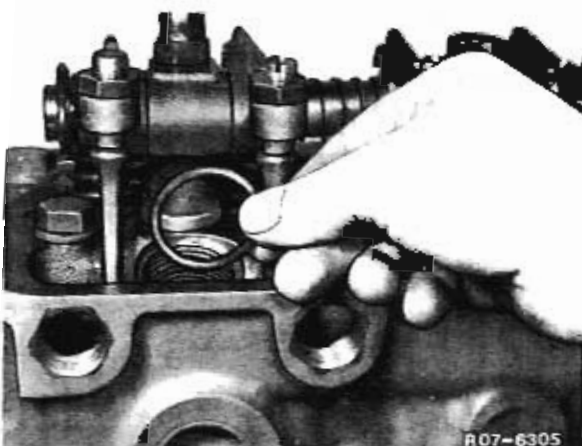
- 8 Unscrew protective sleeve from cylinder head.



R07-6016

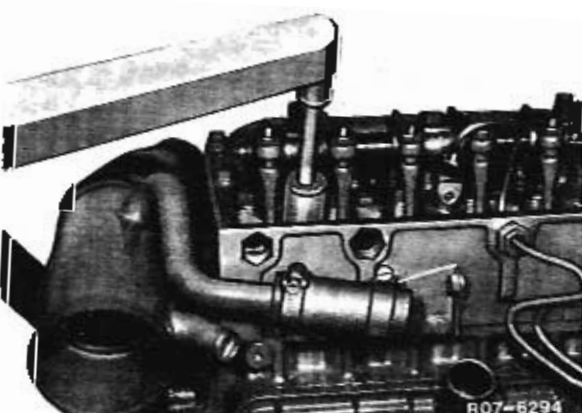
Installing

- 1 Clean sealing face in cylinder head. Insert new seal for protective sleeve in cylinder head with acid-free grease.
- 2 Insert protective sleeve in the cylinder head.



R07-6305

- 3 Screw protective sleeve into the cylinder head with special tool and tighten to specified torque.



Claw wrench 346 589 00 07 00

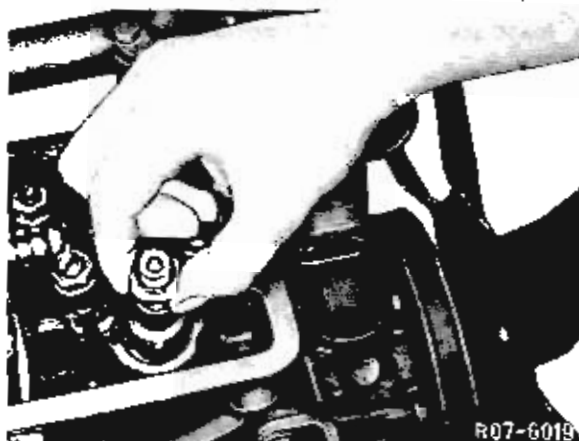
R07-6294

07.13 Removing and Installing Nozzle Holder and Protective Sleeve

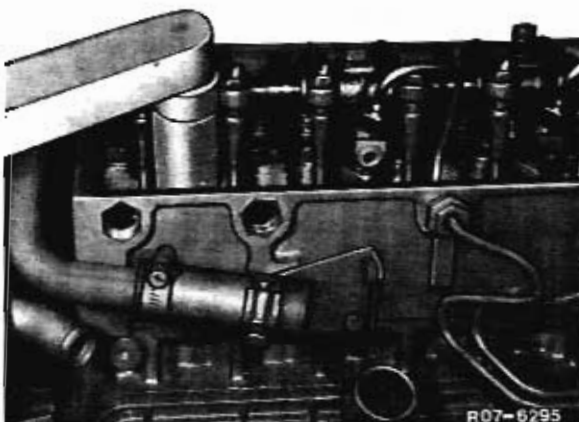
4 Fit new gasket for nozzle holder into the protective sleeve.

5 Introduce nozzle holder with nozzle into the cylinder head, ensuring that the nozzle holder and slot lock in the cylinder head.

Note: Do not strike nozzle!



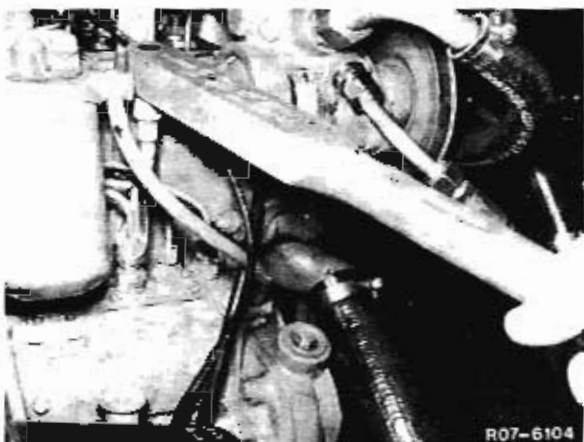
6 Screw in thrust bolt for nozzle holder using special tool and tighten to the specified torque.



(P nozzle) pin wrench socket 403 589 04 07 00
(S nozzle) socket wrench socket 000 589 75 09 00

7 Install leak oil line with new sealing clamps.

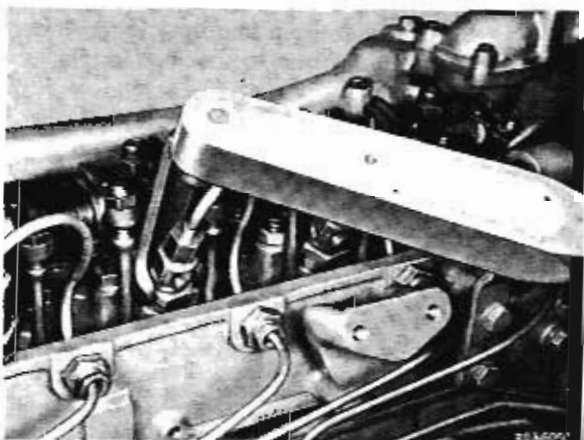
8 Install injection line and bolt tight to injection pump and nozzle holder.



Box wrench socket 000 589 68 03 00

9 Fit cylinder head cover to cylinder head with new gasket and tighten with torque wrench to 25 Nm.

Note: When injection lines are installed, re-tighten thrust bolt for nozzle holder with special tool.



(P nozzle) pin wrench socket 403 589 03 07 00
(S nozzle) box wrench socket 346 589 00 13 00

Data

	352 A	352 A	362 LA
Injection nozzles	S nozzle DLLA 150 S 2120	P nozzle DLLA 142 P 14	S nozzle DLLA 142 S 792
Ejection pressure new nozzles used nozzles	200 + 10 bar min 180 bar	240 + 10 bar min 220 bar	200 + 10 bar min 180 bar
Chatter code group	2	2	2

Note: The difference in pressure between the nozzles within one engine must not exceed 10 bar (kp/cm²).

Special Tools



Testing Injection Nozzle

- 1 Carefully remove any carbon residues on the nozzle.
- 2 Screw nozzle with nozzle holder onto nozzle tester.
- 3 Test injection nozzle for leaks.

Only clean test oil or filtered diesel oil may be used for the test. When testing a nozzle, on no account allow the jet from an injecting nozzle to strike your hand. The jet will penetrate deep into your flesh and destroy the tissue. The fuel which penetrates into the blood may cause blood poisoning.

Slowly press pump lever down until the pointer on the 20 bar pressure gauge is below the set opening pressure. The nozzle is tight if no drip drops from the mouth of the nozzle within 10 seconds. If the nozzle is leaking, dismantle the nozzle and clean it. If any leak which is present cannot be eliminated by carefully cleaning the seat faces on the nozzle body and the nozzle needle, replace the nozzle.



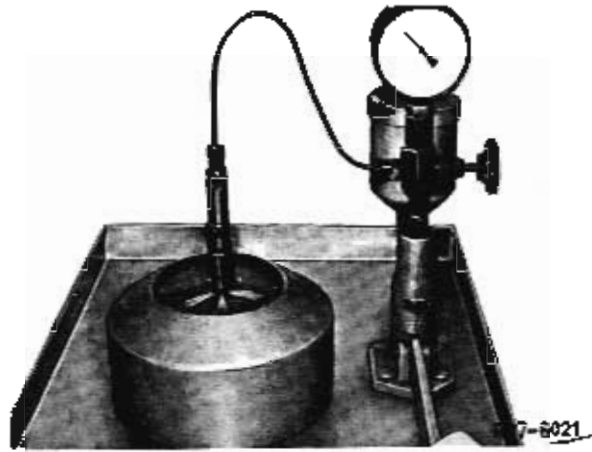
07.13 Testing Injection Nozzle

4 Testing opening or ejection pressure of injection nozzle.

Slowly press hand pump lever of nozzle tester down with the pressure gauge connected (1 stroke per second) and read off the opening pressure when the nozzle opens or at the start of ejection.

Note: If the pressure gauge is set, increase the pressure only slowly and, in particular, release the pressure only slowly otherwise the pressure gauge may be damaged.

Nozzle tester 000 569 14 27 00



If the ejection pressure is too high or too low, the injection nozzle must be dismantled, cleaned and correctly set.

If the pressure is too high, the shims should be replaced by weaker ones, if the pressure is too low, by stronger ones.

Chatter Behaviour/Jet Pattern

The pressure gauge must always be switched off to test the chatter behaviour and jet pattern.

Chatter Code Group 2

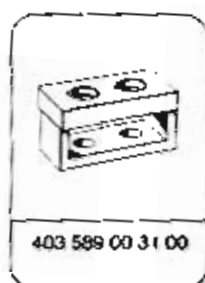
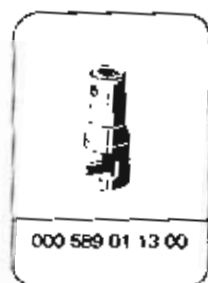
- a) **Chatter behaviour:** chatters properly with rapid and slow lever speed. There may be smaller, chatterless areas inbetween.
- b) **Jet pattern:** at low test speed dispersed jets with coarse atomization. In the chatterless range non-atomized straight jet. As lever speed increases, the jets become full and finely atomized.

Disassembling and Assembling Nozzle Holder and Injection Nozzle 07.13

Tightening Torques in Nm

Nozzle in nozzle holder (S nozzle)	80
Nozzle in nozzle holder (P nozzle)	40 - 50

Special Tools



Disassembling and Assembling (S Nozzle)

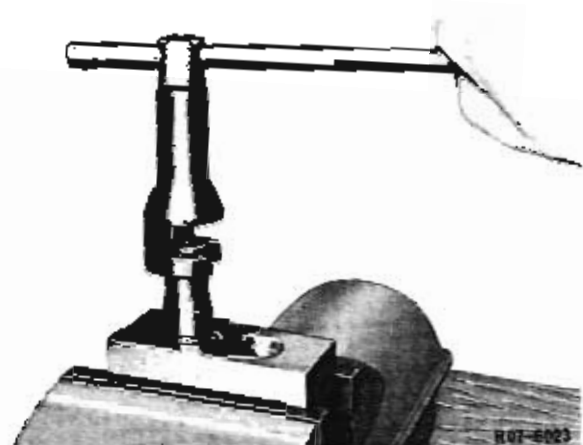
- 1 Insert the nozzle holder into the special tool.



Mount 403 589 00 31 00

- 2 Unscrew thrust nut from the nozzle body with the special tool, disassemble nozzle.

- 3 The disassembled nozzle should be cleaned on the outside and inside, in particular the needle seat and the annular groove, using a wooden stick in diesel fuel.



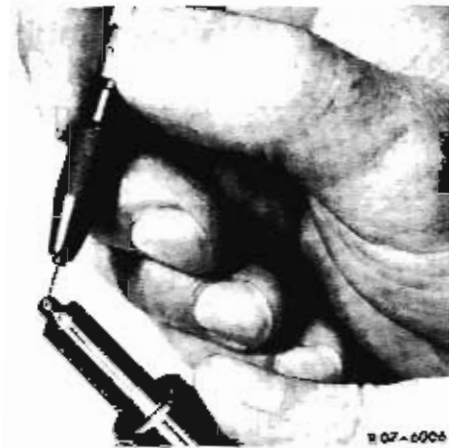
Open-end wrench socket 000 589 01 13 00

07.13 Disassembling and Assembling Nozzle Holder and Injection Nozzle

4 Carefully clean the injection holes of the nozzle body.

5 Dip nozzle needle and nozzle body in clean diesel fuel and test sliding property by means of a drop test.

Drop test: When the nozzle needle pulled 1/3 out of the nozzle body is released, it must slide down onto the seat as a result of its deadweight. If this is not the case, the nozzle and the nozzle body must be renewed.



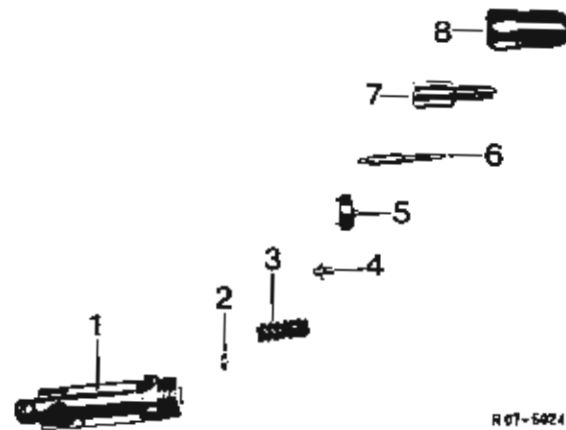
R 07-6006

6 Assemble nozzle, paying attention to the locating pins on the intermediate disc.

Note: If an excessive or inadequate ejection pressure was determined when testing the nozzle, an appropriate spacer disc (item 2) should be installed. Use only discs with a through-hole.

If the pressure is excessive, the spacer disc should be replaced by a weaker one, if the pressure is inadequate by a thicker disc.

- | | |
|----------------------|---------------------------------------|
| 1 Nozzle holder | 5 Intermediate disc with locating pin |
| 2 Spacer disc | 6 Nozzle |
| 3 Compression spring | 7 Nozzle body |
| 4 Thrust pin | 8 Thrust nut |



R 07-5024

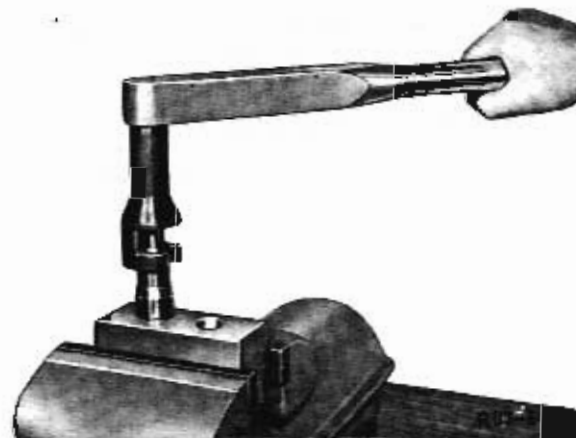
7 Insert nozzle holder in special tool.



Mount 403 589 00 31 00

R07-6022

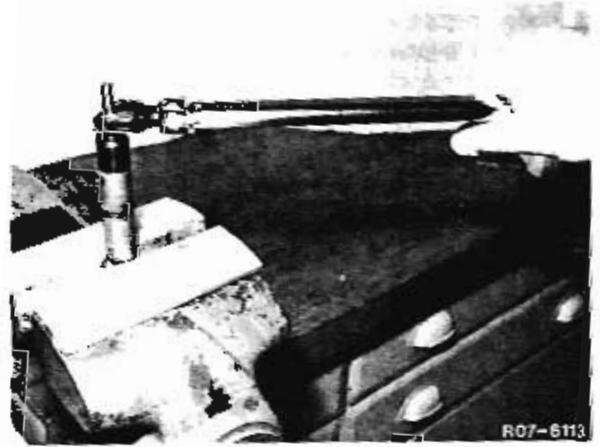
8 Tighten thrust nut to 80 Nm with special tool.



Open-end wrench socket 000 589 01 13 00

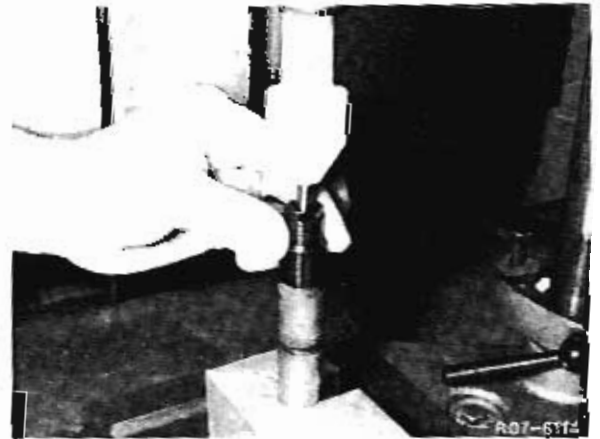
Disassembling and Assembling (P Nozzle)

1 Clamp nozzle holder in a vice by the wrench faces (use protective jaws) and slacken nozzle tensioning nut approx. 1/4 turns.



2 Release compression spring of injection nozzle with a press or upright drilling machine and unscrew nozzle tensioning nut.

Note: Relieving the compression spring prevents chips being shaved off the fine thread and penetrating into the nozzle of the sealing faces.



3 Clean the disassembled nozzle with a wooden stick in diesel fuel.

4 Carefully clean the injection holes of the nozzle body.

5 Dip nozzle needle and nozzle body in clean diesel fuel and test sliding property by means of a drop test.

Drop test: When the nozzle needle pulled 1/3 out of the nozzle body is released, it must slide down onto the seat as a result of its deadweight. If this is not the case, the nozzle and the nozzle body must be renewed.

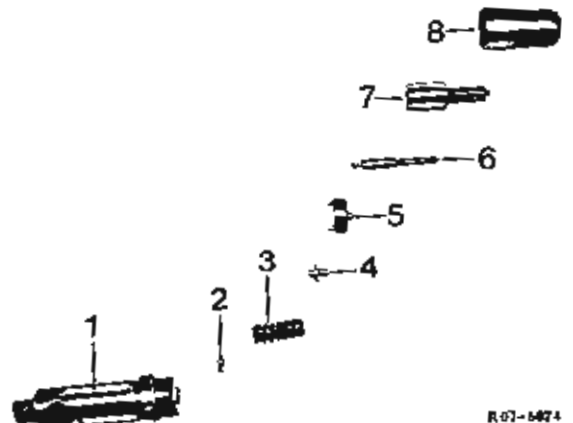


6 Assemble nozzle, paying attention to the locating pins on the intermediate disc.

Note: If an excessive or inadequate ejection pressure was determined when testing the nozzle, an appropriate spacer disc (item 2) should be installed. Use only discs with a through-hole.

If the pressure is excessive, the spacer disc should be replaced by a weaker one, if the pressure is inadequate by a thicker disc.

- | | |
|----------------------|---------------------------------------|
| 1 Nozzle holder | 5 Intermediate disc with locating pin |
| 2 Spacer disc | 6 Nozzle |
| 3 Compression spring | 7 Nozzle body |
| 4 Thrust pin | 8 Thrust nut |

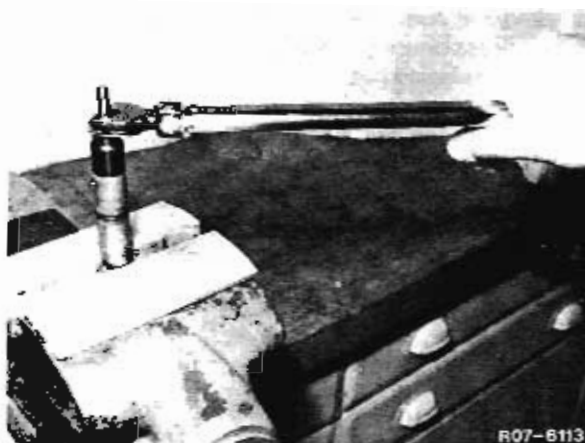


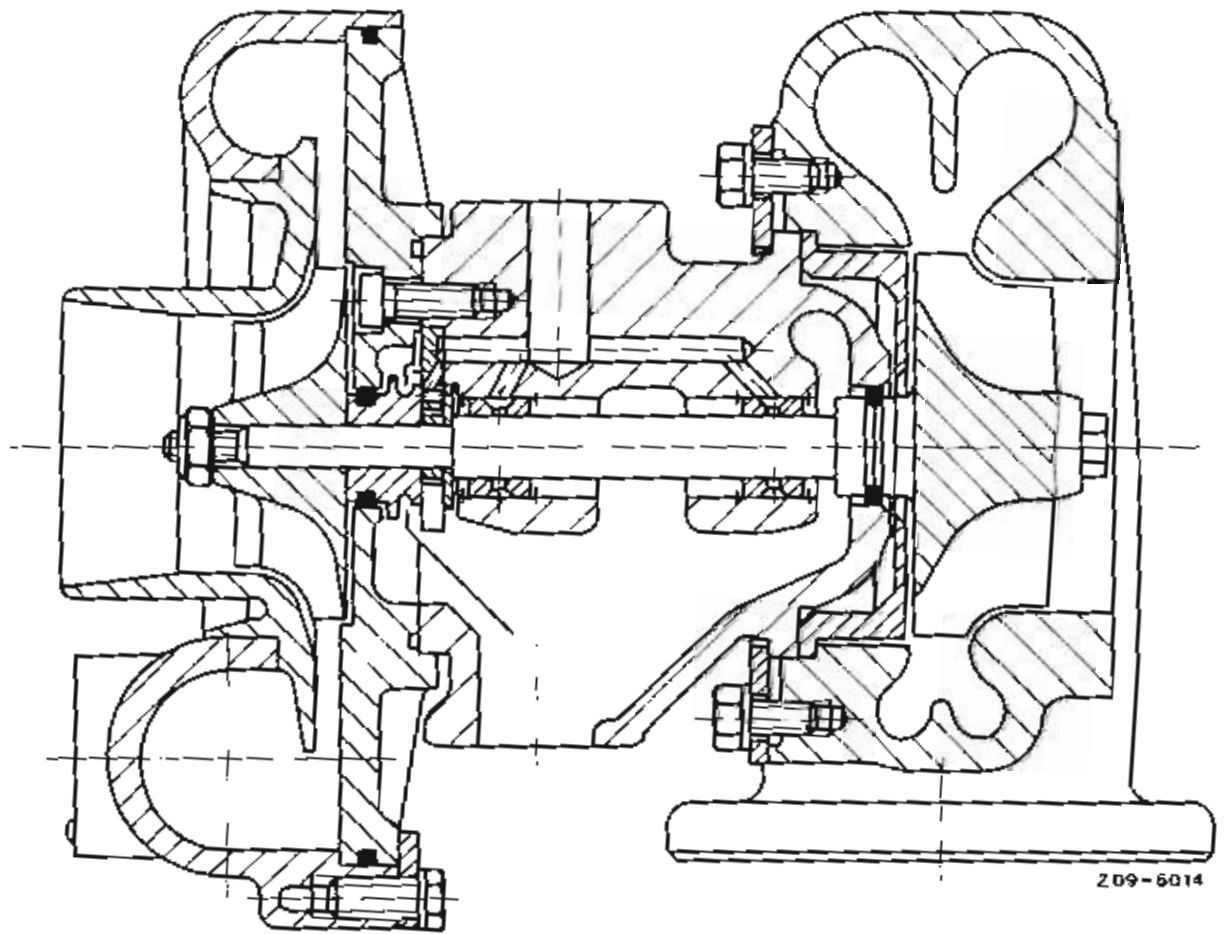
07.13 Disassembling and Assembling Nozzle Holder and Injection Nozzle

7 Insert nozzle in nozzle holder, pretension nozzle spring and fit tensioning nut.



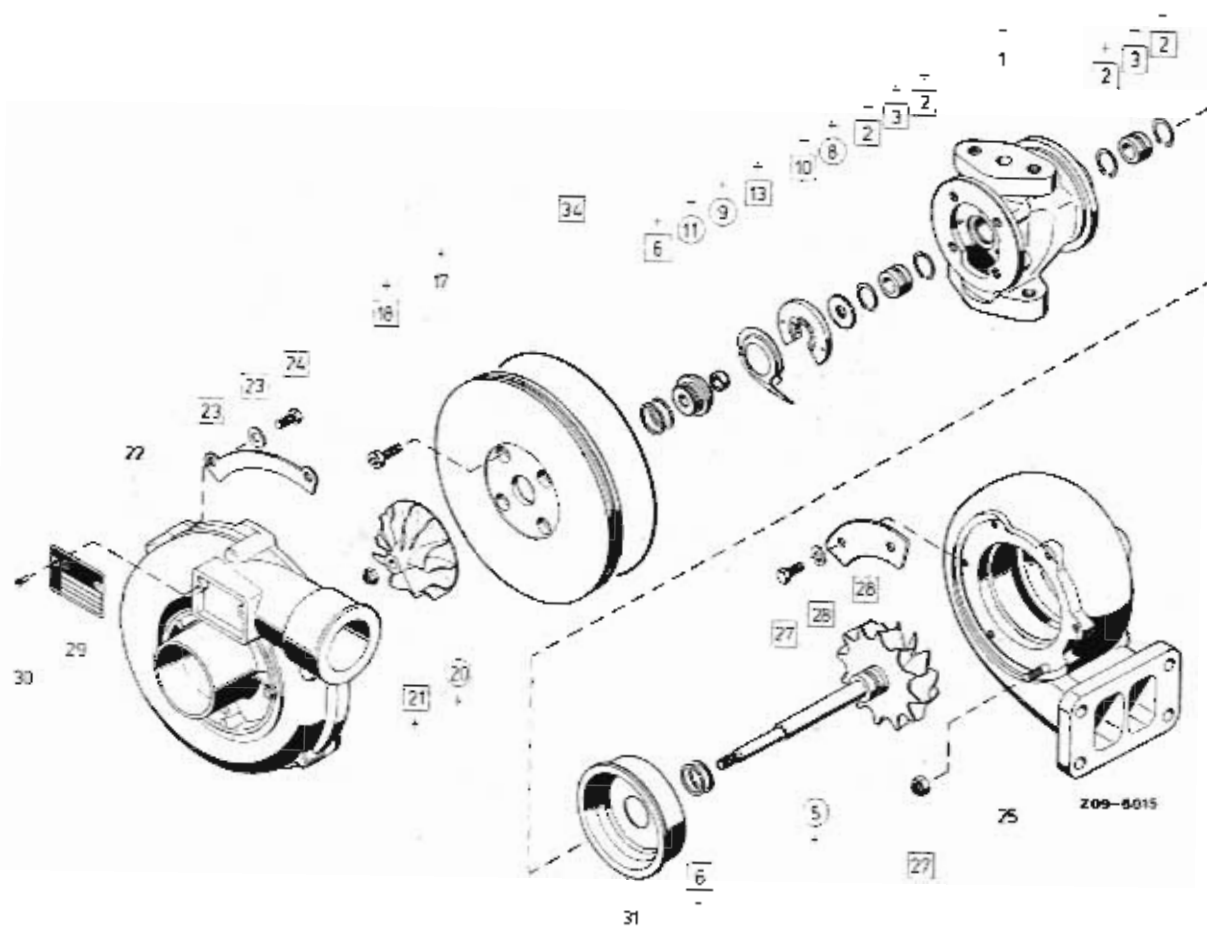
8 Clamp nozzle holder by the wrench faces in the vice (use protective jaws) and tighten nozzle tensioning nut to 40 – 50 Nm.





Turbocharger

09.13 Exploded Views, Sectional Views



Turbocharger

- | | |
|--|---|
| 1 Bearing housing | 24 Hexagon bolt |
| 2 Circlip | 25 Turbine housing |
| 3 Bearing bush | 27 Hexagon bolt,
hexagon nut |
| 5 Rotor | 28 Tensioning segment turbine
end spring lock washer |
| 6 Piston rings | 29 Rating plate |
| 8 Bearing collar | 30 Blind rivet |
| 9 Bush | 31 Heat shield |
| 10 Axial bearing disc | 34 O-ring |
| 11 Gasket bush | |
| 13 Oil wiper | |
| 17 Rear wall | |
| 18 Cylinder bolt | |
| 20 Compressor wheel | |
| 21 Shaft nut | |
| 22 Compressor housing | |
| 23 Tensioning segment compressor
end spring lock washer | |
| | □ Spare parts set |
| | + Body group assembly |
| | ○ Running parts |

Fault	Cause	Remedy
Cloudy exhaust and drop in power	Air filter heavily fouled	Clean or replace air filter element.
	Turbine or compressor wheel rubbing against housing	Repair or replace turbocharger
	Foreign body in exhaust cross section	Remove foreign body.
	Fouled compressor	Clean compressor of dirt and deposits
	Leak between exhaust manifold and exhaust gas turbocharger	Re-seal turbocharger to exhaust manifold. Note: In some cases, new engines of different engine types do not have any gaskets at the connection flange joint of the turbocharger.
	Engine brake flap sticks	Check engine brake flap and setting, correct if necessary
	Charge air line misshapen	Replace charge air line
	Air deficiency	Check flange and hose connections between turbocharger and charge air line for leaks, seal if necessary.
	Exhaust line downstream of turbocharger or silencer fouled or damaged	Check exhaust line, clean or repair or replace silencer.
	Oil separator damaged or dirty.	Replace oil separator.
Oil level in turbocharger increases, oil flows out over the seal at the turbine and compressor end.	The reduced line cross section due to carbon deposits causes increase in the flow resistance in the oil return line.	Clean or replace oil return line
Oil supply at turbocharger leaking	Gasket defective	Replace gasket at oil connection
Whistling noises in the area of the turbocharger	Leaks at:	Replace defective gaskets.
	Flange connections or gaskets of air and exhaust line or intake lines.	Check whether flange and connections are twisted and whether tight.

09.13 Turbocharger (Troubleshooting)

Fault	Cause	Remedy
Whistling noises in the area of the turbocharger	Flange seals (inaccurate shape)	Check whether gaskets project into pipe cross sections. If this is the case, replace gasket.
	Hose or plug connections	Check that connections are in proper condition and tight
	Cylinder head cover Centre web of cylinder head cover on engine 352 A twisted or cracked	Check seal on centre web of cylinder head cover. Replace cylinder head cover if necessary, carefully tighten cover. Tightening torque 25 Nm.
	Rotor rubbing due to excessive bearing play	Detach lines and check housing on turbine and compressor ends for rub marks. If rub marks are present, replace turbocharger.
Oil pressure deficiency on engine 352 A	Oil overpressure valve in oil cooler incorrectly installed.	Correctly install oil overpressure valve.
Oil pressure deficiency in all turbocharged engines	Hydraulic oil line to turbocharger damaged	Replace hydraulic oil line.
Oil dirty	Oil filter fouled, incorrect oil filter installed	Replace oil filter. Install oil filter complying with valid spare parts documents. Note: Determine precise diagnosis for fouling of oil and eliminate. The turbocharger requires clean oil due to its high speed. Check whether correct grade of oil filled in (see oil tag or entry in maintenance booklet). Pour in grade of oil complying with Service Product Specifications, Sheet 220.

Checking the Turbocharger in the Vehicle

Unscrew intake line at turbocharger inlet and exhaust line at turbine housing. Turn rotor at compressor wheel out or at turbine wheel, checking that it runs evenly and freely. Turn back and forward several times until the rotor is free of oil carbon deposits. The rotor is centrifugally stabilized. It runs in its bearings with relatively large play.

To check the end play, move the rotor in the longitudinal direction and check whether it is possible to feel the turbine or compressor wheel rubbing. If no rubbing is detectable on both sides, the end play is ok.

To check the radial play, deflect the rotor in the radial direction and turn. If no rubbing is detected, the radial play is ok.

If the turbine or compressor wheel is rubbing, remove the turbocharger, repair or replace.

Oil Leaks on Turbocharger

On all the types of turbochargers which we use, the oil-carrying bearing housing with piston rings is sealed to the spiral housing carrying air or exhaust gas. The function of this seal is based on the overpressure prevailing in the compressor housing. At elevated idling speed and when coasting, however, a vacuum may occur which promotes the outflow of oil and slightly moistens the charge air passages with oil.

The normal development of oil vapour in the air intake system does not harm the engine. A certain quantity of oil is necessary for lubricating the intake valves. If the charge air passages at the clean air end have slight traces of oil, this is no reason to remove the exhaust gas turbocharger.

Completely dry air intake passages do not exist since a slight oil precipitation is always present in the charge air passages as a result of oil vapours from the crankcase breather. A further cause of oil leaks may be a damaged (deformed) or dirty oil return line. The resulting reduction in the line cross section may cause an increase in flow resistance in the oil return line as a result of which the oil level in the turbocharger rises and the oil may flow out through the seal at the turbine and compressor end. In this case, clean or replace the oil return line.

Installing an Exchange Turbocharger

Before fitting the turbocharger, a very careful check must be made of the intake line and the flange manifold upstream of the compressor, the exhaust manifold and the exhaust line as well as the oil feed and oil return lines for foreign bodies, impurities and signs of damage. The seal caps at the openings of the turbocharger must not be removed until just shortly before installation. Before connecting the oil feed line, clean engine oil should be tilted into the bearing housing through the oil inlet hole, turning the rotating parts by hand so that the bearings are provided with a film of oil.

Note: After the engine has been shut down for a prolonged period and each time the oil and filter are changed, crank the engine with the starter before actually starting the engine to avoid premature bearing wear due to a shortage of oil until the oil pressure gauge indicates pressure. The engine brake must be switched on when doing this or the stop cable set to "Stop" otherwise the engine will start.

The starter must not be operated for more than 20 seconds otherwise it will overheat and may be damaged. If no oil pressure is indicated after this period, interrupt the starting operation and repeat it after approx. one minute.

Notes for Driving

The following points should be noted to avoid any damage to the turbocharger caused by incorrect starting and shutting down of the engine:

After starting the engine, do not rev up immediately, but run at idling speed until a constant oil pressure is indicated. After this, engine speed and load can be increased.

Do shut down engine from high revs, but run at idling speed for a short period to reduce the exhaust gas temperature. This avoids the engine heating up after being shut down.



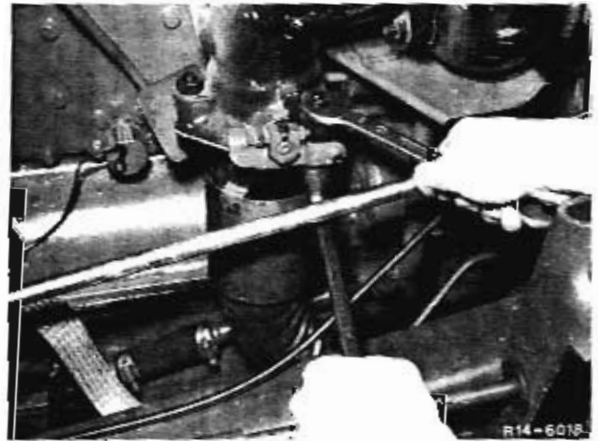
Removing and Installing Turbocharger 09.13

Tightening Torques in Nm

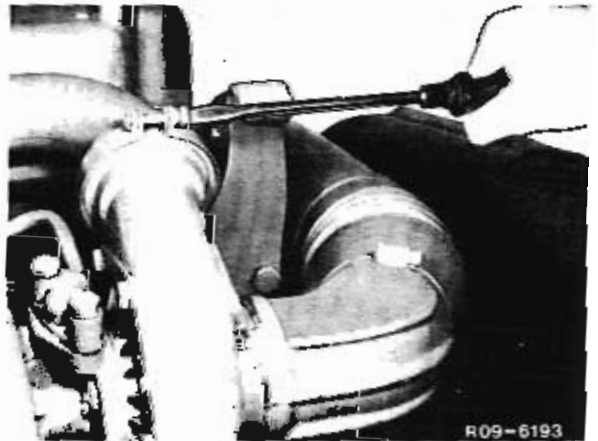
Exhaust gas turbocharger at exhaust manifold		55 - 75
Oil pressure line at turbocharger	M 8	25
Oil return line at turbocharger	M 8	25

Removing

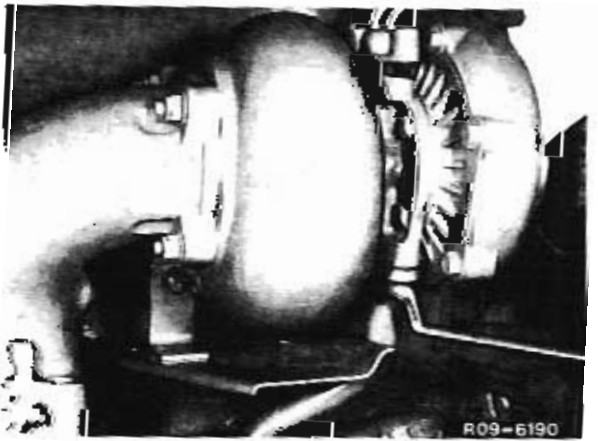
- 1 Remove exhaust pipe at flange manifold.
- 2 Release both actuating linkages at the throttle valve lever and detach.



- 3 Remove intake line and pipe to charge air cooler.

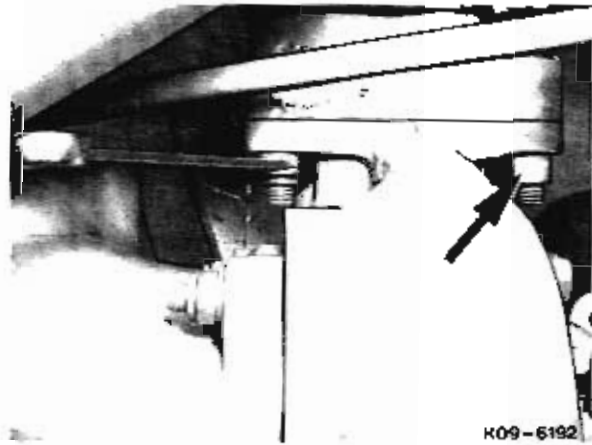


- 4 Unscrew oil feed and oil return line at turbocharger.



09.13 Removing and Installing Turbocharger

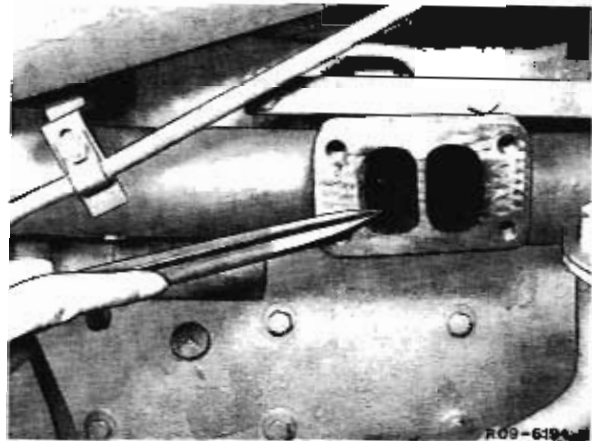
5 Unscrew the turbocharger at the exhaust manifold and remove together with heat shield.



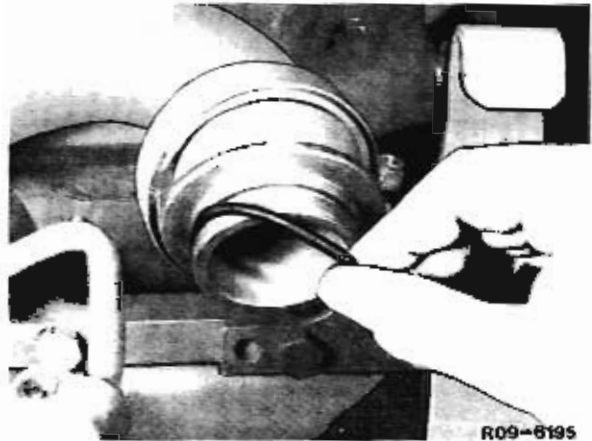
Installing

1 Clean the sealing faces on the exhaust manifold and turbocharger.

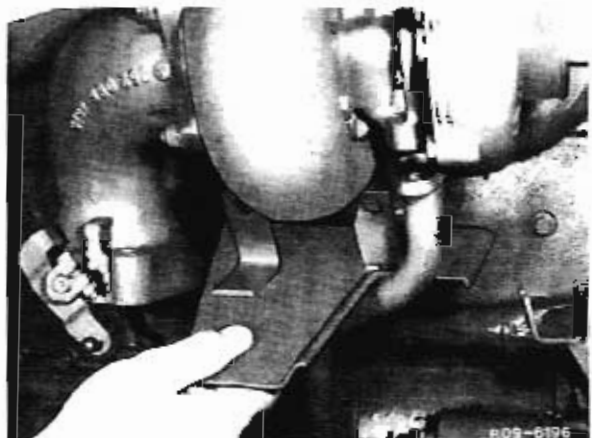
2 Insert the stay bolt in the exhaust manifold.



3 Fit sealing ring to charge air pipe.

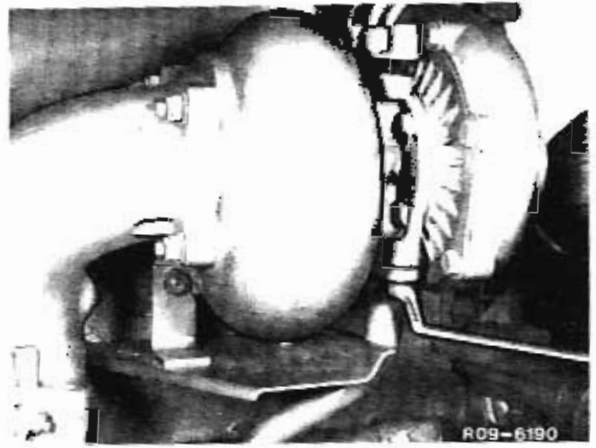


4 Install turbocharger with heat shield at exhaust manifold with 55 to 75 Nm.

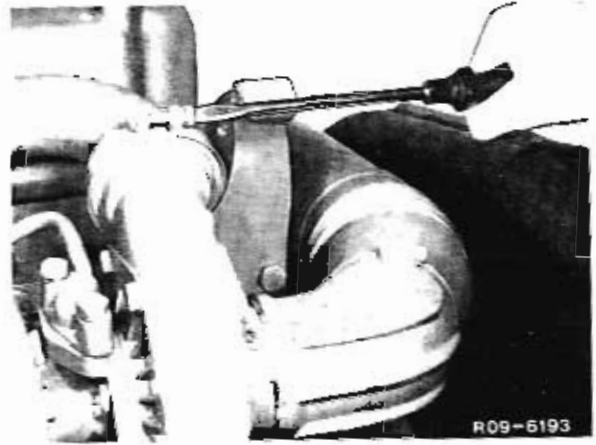


Removing and Installing Turbocharger 09.13

- 5 Install oil feed and oil return line with new gasket to turbocharger with 25 Nm

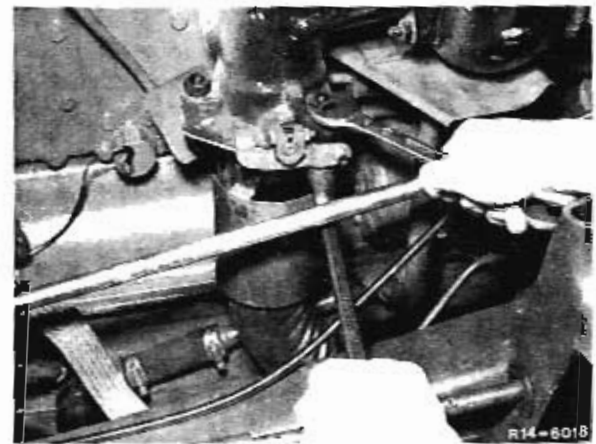


- 6 Install intake line and pipe to charge air cooler.



- 7 Attach both actuating linkages at the throttle valve lever and secure.

- 8 Fit exhaust pipe to flange manifold.

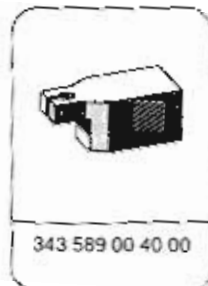




Data

Make		End Play	Radial Play
Garret Ai Research		0.10	0.75
Kühnle Kopp u. Kausch	3 LKS	0.15	0.65
	K 27	0.15	0.46

Special Tools

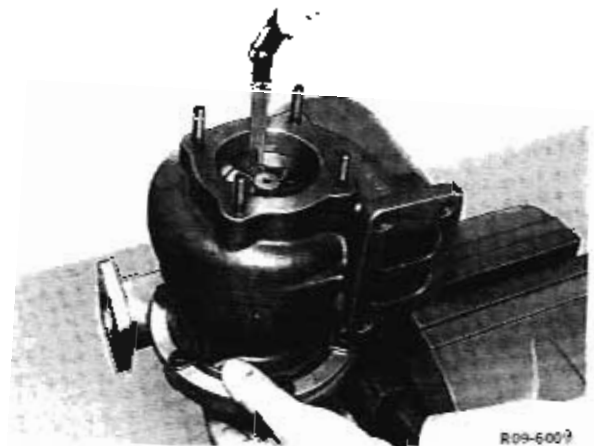


Measuring Radial Play

(The radial play is only measured at the turbine end.)

- 1 Press turbine wheel to the side, measure the gap between turbine wheel and housing with feeler gauge and note.
- 2 Press turbine wheel in the opposite direction and measure the gap with feeler gauge and note.
- 3 The difference between the two values obtained is the radial play.

Note: Perform measurement at least 2 different points.



Measuring End Play

- 1 Clamp turbocharger in vice (turbine end up).
- 2 Mount measuring tip of dial gauge to shaft end of turbine wheel.
- 3 Press rotor shaft down and set dial gauge to "0".
- 4 Press rotor shaft against dial gauge and read off play.



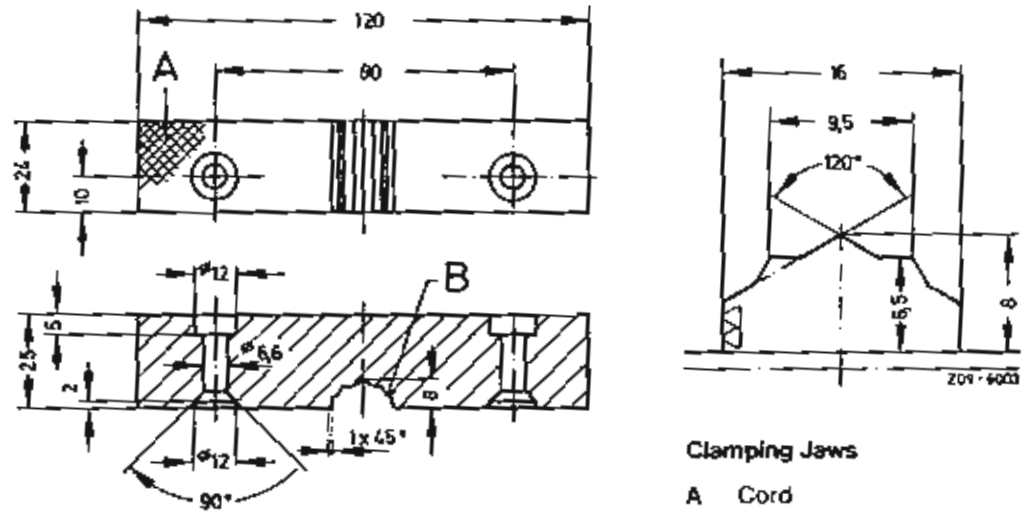
Dial gauge 001 589 53 21 00
Dial gauge holder 343 589 00 40 00



Disassembling and Assembling Turbocharger 09.13

Turbocharger removed

Aids for Making in the Shop

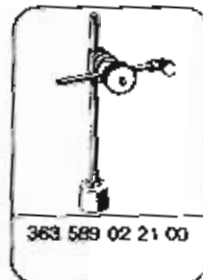


Shop Equipment

"Leister Gibli 2" hot air fan

Supplier:
 Karl Leister
 CH 6056 Kagiswil

Special Tools



Tightening Torques in Nm

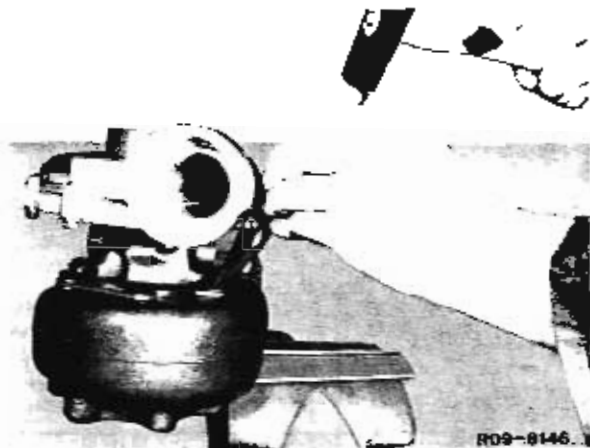
Shaft nut		12
Compressor rear wall at bearing housing	with washer	10
	without washer	8
Compressor housing		7
Turbine housing		20

09.13 Disassembling and Assembling Turbocharger

Disassembling

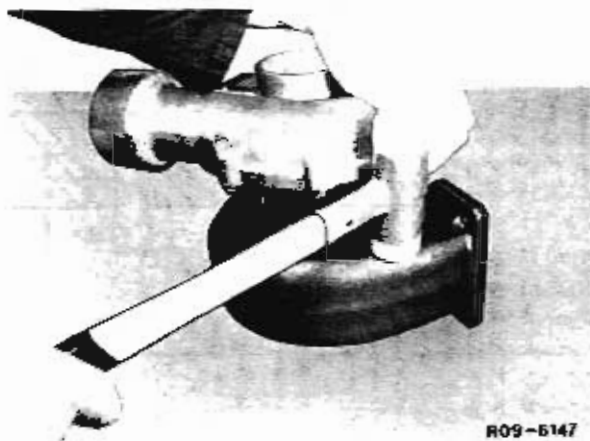
Note: The clamping jaws should be made in the shop (see dwg. p. 09.13 - 530/1).

- 1 Mark position of turbine housing relative to bearing housing.
- 2 Release the tab washer at the clamping segments of the turbine housing.

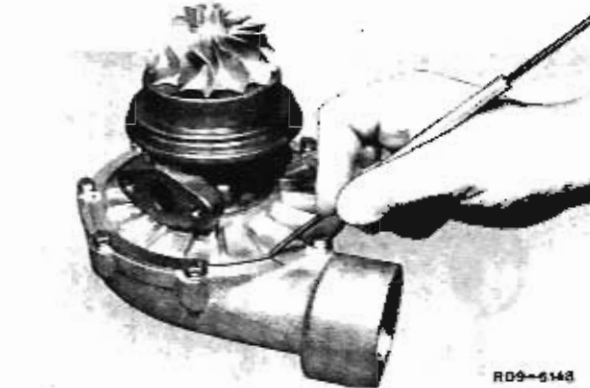


- 3 Slacken the fastening bolts from the turbine housing and remove together with clamping segments and tab washers.
- 4 Knock turbine housing down off bearing housing with a soft hammer.

Note: Ensure that the blades of the turbocharger shaft are not damaged when detaching the turbine housing.

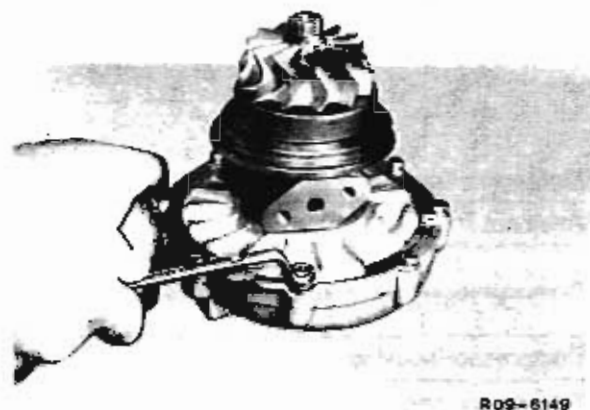


- 5 Mark bearing housing relative to compressor rear wall and compressor rear wall relative to compressor housing.



- 6 Unscrew compressor housing from compressor rear wall.
- 7 Detach compressor housing from the bearing housing by light blows from a soft hammer and remove.

Note: Ensure that the blades of the compressor wheel are not damaged by twisting when detaching the compressor housing.



Disassembling and Assembling Turbocharger 09.13

- 8 Clamp rotor at hub and unscrew shaft nut.

Note: When slackening the shaft nut, ensure that the rotor is not damaged by being twisted. Always use a T socket wrench for slackening the shaft nut to avoid any bending moments acting on the rotor.



R09-6011

- 9 Heat up compressor wheel with hot air fan (max. 130° C).

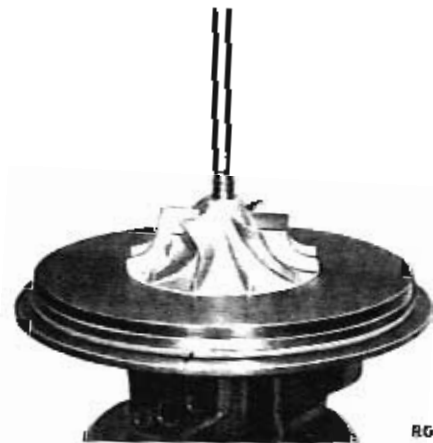


R09-6120

- 10 Press rotor shaft out of the compressor wheel.

Note: Centre heat shield to avoid damaging the piston rings and heat shield.

- 11 Take bearing housing, heat shield and piston rings off the rotor shaft.



R09-6121

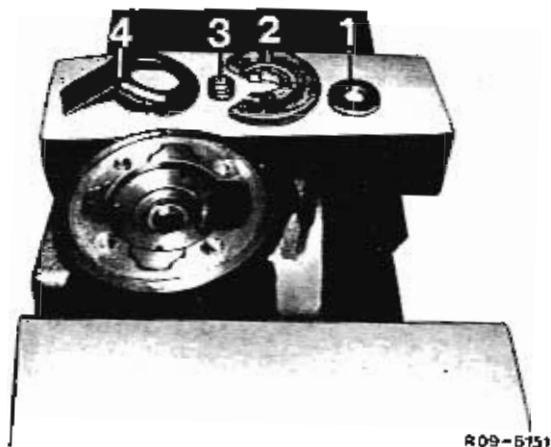
- 12 Unscrew the compressor rear wall and remove together with sealing bush and piston rings.



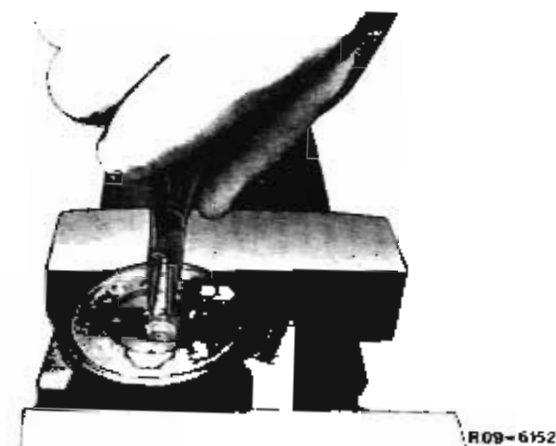
R09-6150

09.13 Disassembling and Assembling Turbocharger

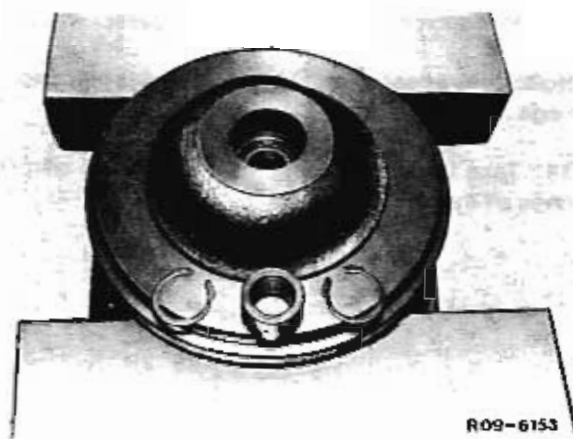
13 Remove oil scraper (4), bush (3), axial bearing disc (2) and bearing collar (1).



14 Remove bearing bush at compressor end from the bearing housing.



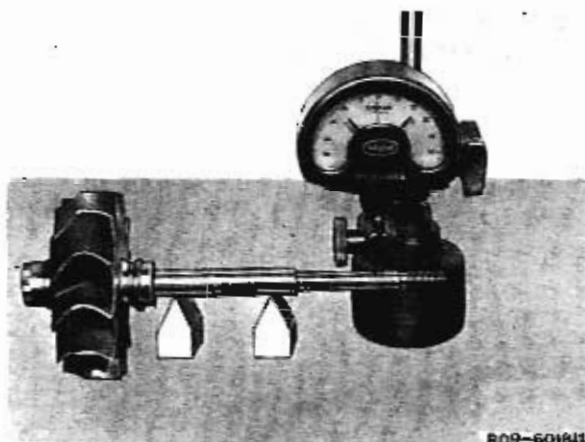
15 Remove bearing bush at turbine end from the bearing housing.



Assembling

Note: Clean all parts and check for signs of damage. Check housings and impellers for cracks, foreign bodies and rub marks. Check piston ring seals for signs of wear. Examine impellers for bent or broken blades.

1 Check rotor shaft for concentricity. Place rotor shaft on 2 prisms at the level of the bearing points and check concentricity 20 mm from the end of the rotor with a dial gauge. Permissible runout 0.007 mm



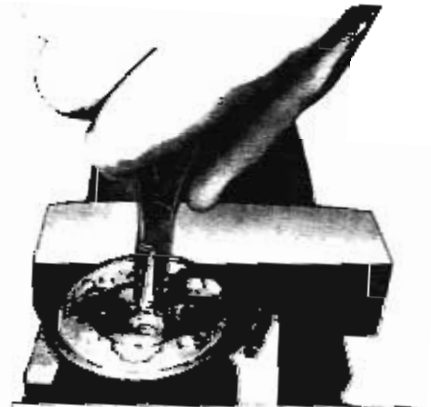
Holder 363 589 02 21 00
Dial gauge 001 589 53 21 00

Disassembling and Assembling Turbocharger 09.13

2 Insert circlip into the bearing housing, oil bearing bush at the turbine end, insert and fit second circlip.

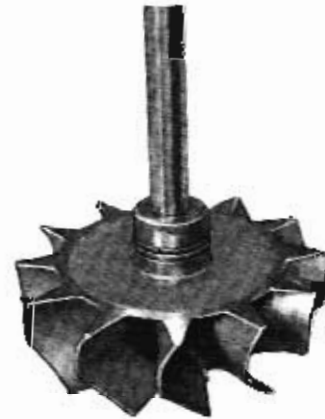
Note: Insert circlips so that that the rounded end is pointing toward the bearing.

3 Turn bearing housing round and install bearing bush at compressor end with circlips.



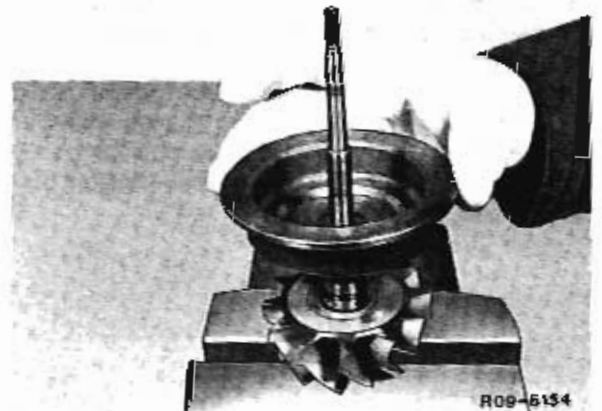
R09-6152

4 Fit piston rings 180° offset to rotor shaft and centre.



R09-6154

5 Fit heat shield over the piston rings onto the rotor shaft.



R09-6154

6 Fit bearing housing over the piston rings onto the rotor shaft so that the flange faces for the oil feed and return lines are at 90° to the respective piston ring gap.

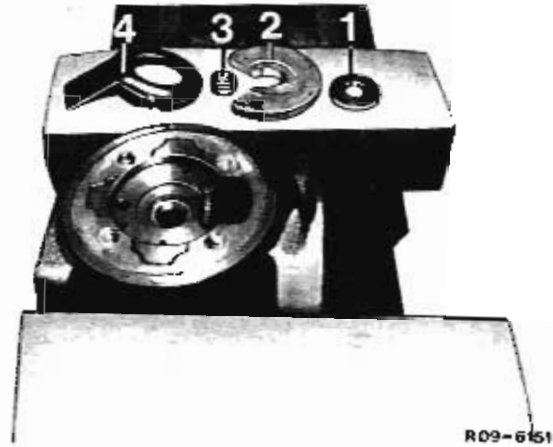
Note: After fitting the bearing housing, the heat shield must still turn freely.



R09-6155

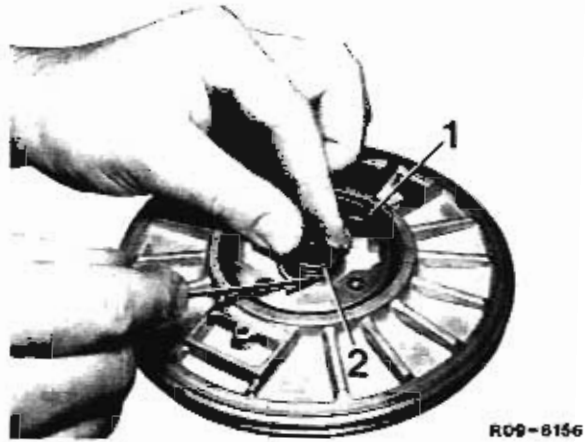
09.13 Disassembling and Assembling Turbocharger

7 Insert bearing collar (1) and bush (3). Insert axial bearing (2) oil groove toward bearing housing so that the holes fit into the centering pins. Fit oil scraper (4).



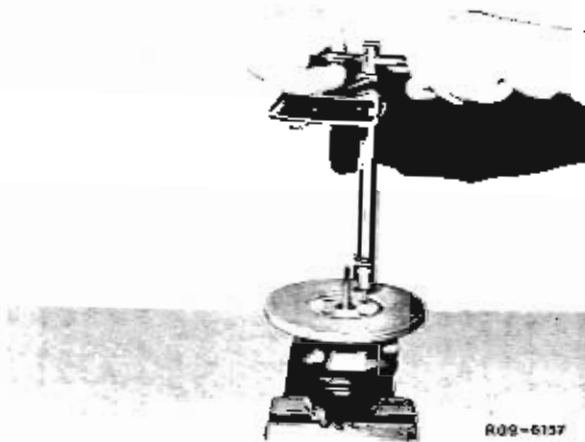
8 Fit piston rings on sealing bush 180° offset.

9 Insert sealing bush with piston rings into the compressor rear wall so that the flange faces for the oil feed and return lines are at 90° to the particular piston ring gap.



10 Coat the sealing face between bearing housing and compressor rear wall with sealing compound 001 997 37 20.

11 Fit the compressor rear wall aligned with the mark relating to the bearing housing, coat fastening bolts with Loctite 640, insert and tighten, holding the bearing body tight.



12 Fit O-ring onto compressor rear wall.



- 13 Heat compressor wheel on a hot plate to max. 130° C and fit onto the rotor shaft.

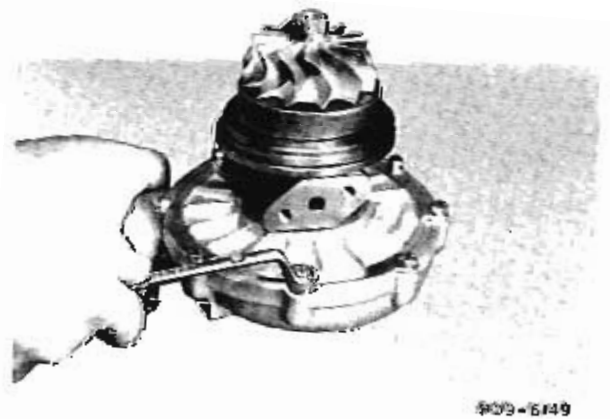


- 14 Coat shaft nut with Loctite 640, fit and torque to 12 Nm with special tool.

Note: When tightening the shaft nut, ensure that the rotor is not damaged by being twisted.



- 15 Fit compressor housing aligned to the mark relating to the compressor rear wall, fit clamping elements and torque fastening bolts crosswise with 7 Nm.

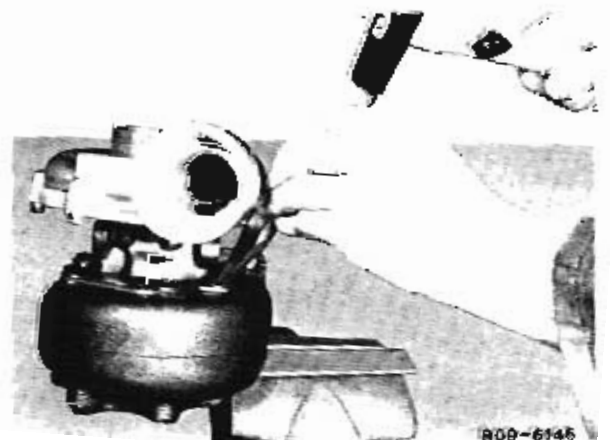


- 16 Fit turbine housing aligned to the mark relating to the bearing housing, fit clamping elements and tab washers. Insert fastening bolts with hot lubricating paste and torque crosswise with 20 Nm.

- 17 Secure fastening bolts.

- 18 Check that turbocharger shaft runs freely.

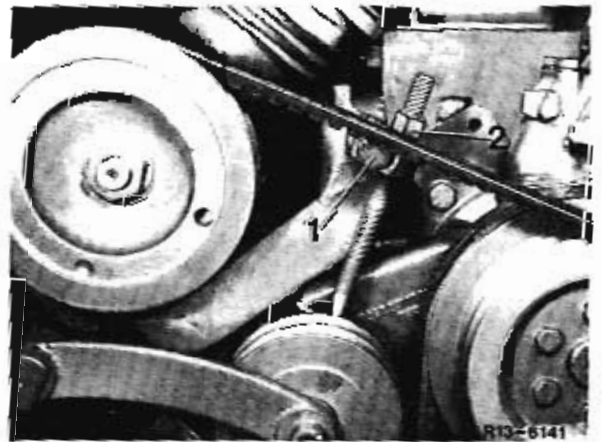
Note: Before the turbocharger is operated, the bearing housing must be filled with engine oil through the oil feed bore.



Removing

1 Slacken clamping bolt (1) and release V-belt for air compressor by means of tensioning bolt (2).

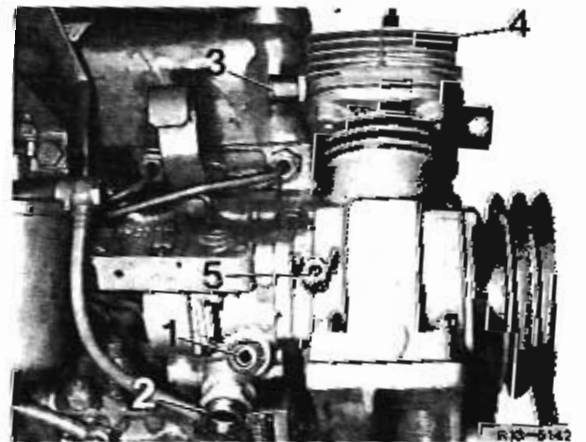
2 Take off V-belt.



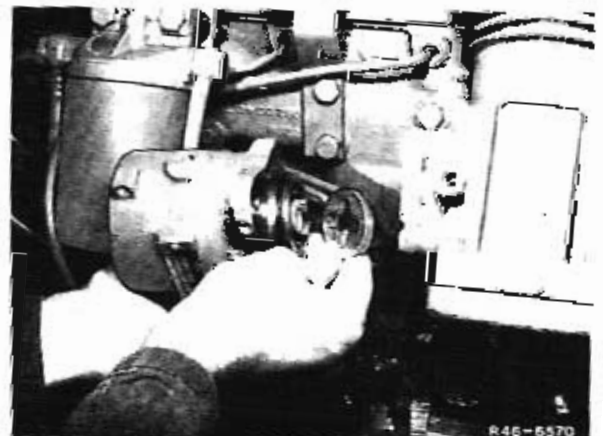
3 Remove oil delivery line (1) and oil return line (2) at power steering pump.

4 Remove intake air line (3) and delivery air line (4) at the air compressor.

5 Remove oil pressure line at the air compressor (5).

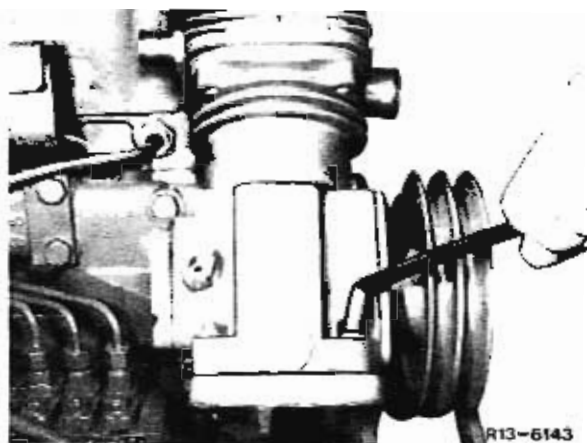


6 Remove power steering pump and take off together with driving disc.

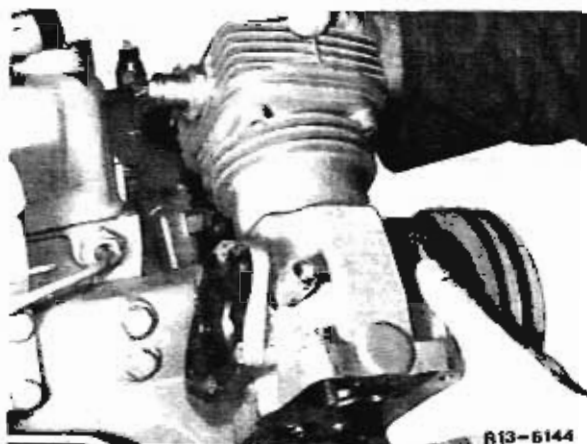


13.13 Removing and Installing Belt-Driven Air Compressor

7 Unscrew air compressor.



8 Take off air compressor.



Note: If an oil leak exists between air compressor bracket and timing case, the seals on the intermediate piece in the timing case (1) should be replaced.



Installing

Note: When installing a new air compressor or exchange engine due to air compressor damage, check the pressure air lines between air compressor and four-circuit protection valve for carbon deposits. If the line cross section is constricted, replace lines, pressure governor and four-circuit protection valve.

1 Coat seating ring for oil return with brake cylinder grease and insert into the air compressor.

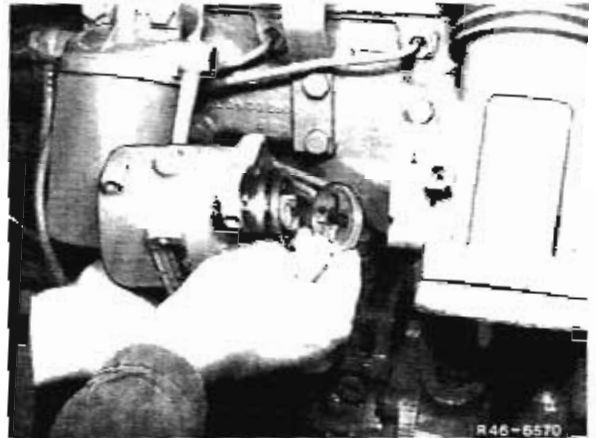


Removing and Installing Belt-Driven Air Compressor 13.13

- 2 Mount air compressor on bracket and fix.



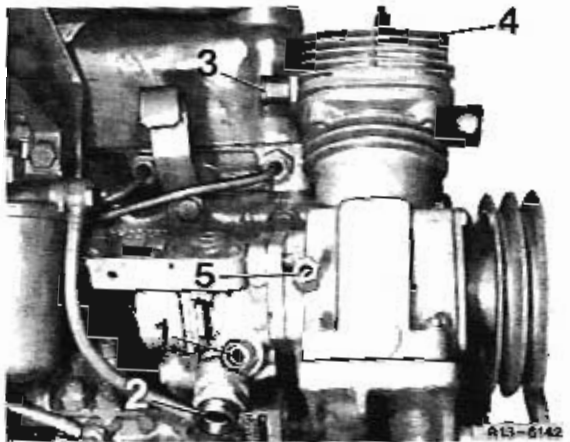
- 3 Fix power steering pump and driving disc to air compressor.



- 4 Connect oil delivery line (1) and oil return line (2) to the power steering pump.

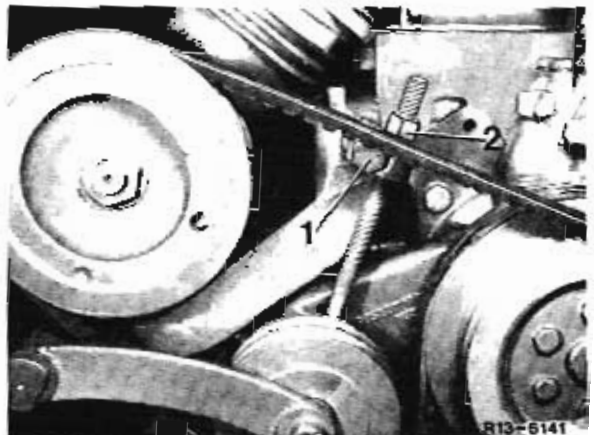
- 5 Fit intake air line (3) and delivery air line (4) at the air compressor.

- 6 Fit oil pressure line to air compressor (5).



- 7 Fit V-belt for air compressor, tension (2) and tighten clamping bolt (1).

- 8 Check tension of V-belt.

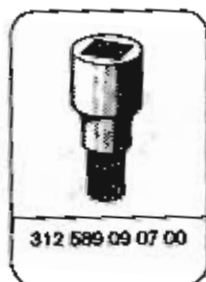


Removing and Disassembling Camshaft Air Compressor 13.13

352 A

77 mm dia. air compressor

Special Tools



Removing and Disassembling Air Compressor

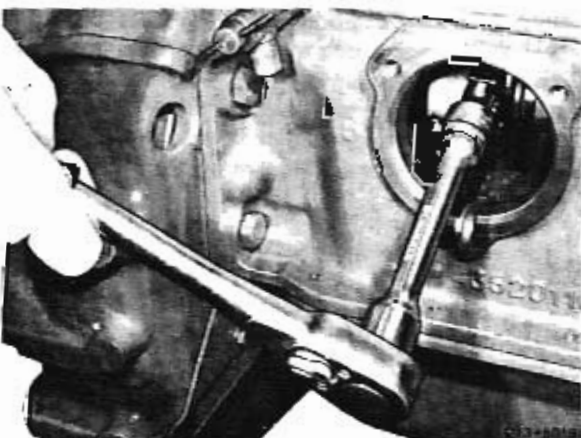
- 1 Remove intake hose and delivery line.
- 2 Unscrew cylinder head and take off with gasket.
- 3 Unscrew cylinder liner and pull off over the piston.



- 4 Release piston pin.
- 5 Press out piston pin and take off together with piston.

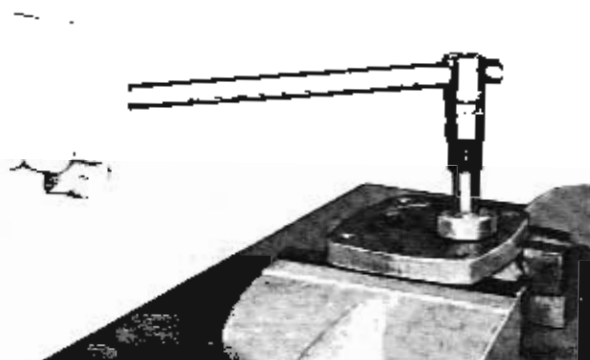


- 6 Unscrew connecting rod and take off together with connecting rod cover and bearing shells.



13.13 Removing and Disassembling Camshaft Air Compressor

7 Unscrew suction valve cap from cylinder head using special tool. Remove valve spring, valve washer and suction valve seat.

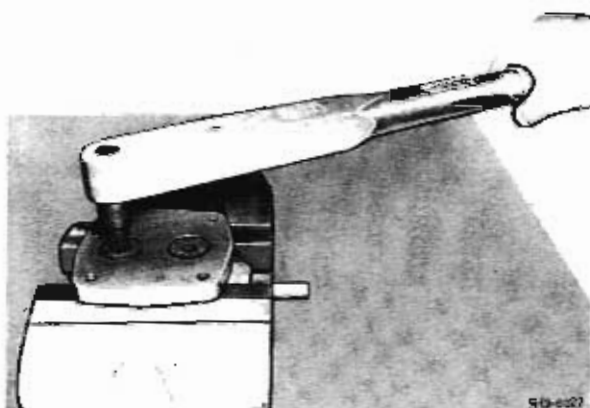


Pin wrench socket 321 589 02 07 00

8 Unscrew delivery valve seat from cylinder head using special tool and take off together with valve washer, valve spring and spring housing.

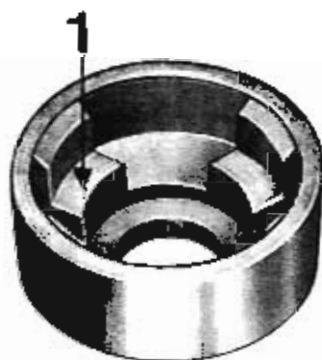
9 Take piston rings off piston using pliers 000 589 37 37 00.

10 Clean all parts with benzene.



Stud wrench socket 312 589 09 07 00

Note 1: If complaints are received regarding excessive filling time of air compressor or if the camshaft is fractured, the stop shoulders of the delivery valve must be checked for wear.



1 Stop shoulder

R13-6026

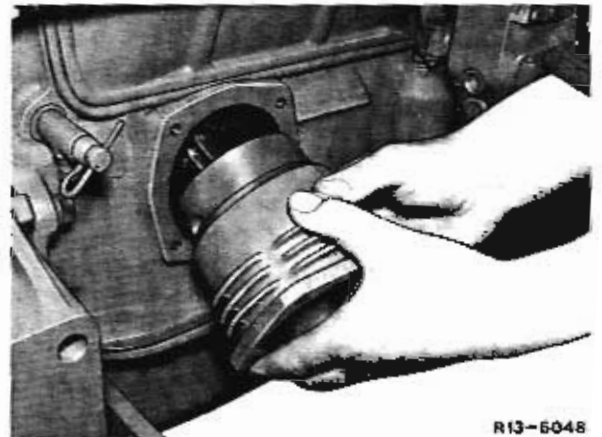
Note 2: When installing a new air compressor or exchange engine due to air compressor damage, check the delivery air lines between air compressor and four-circuit protection valve for carbon deposits. If the line cross section is constricted, replace lines, pressure governor and four-circuit protection valve.

Special Tools

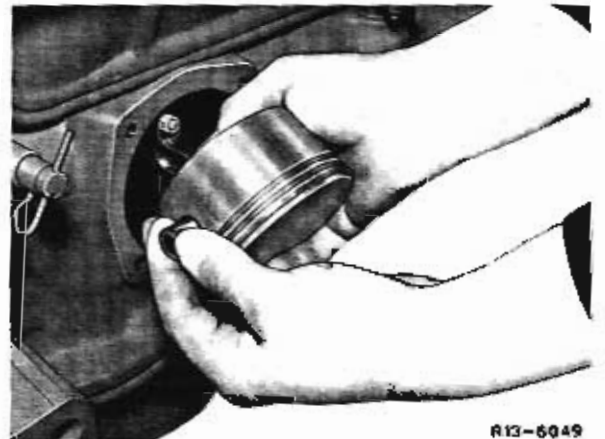


Removing and Disassembling Air Compressor

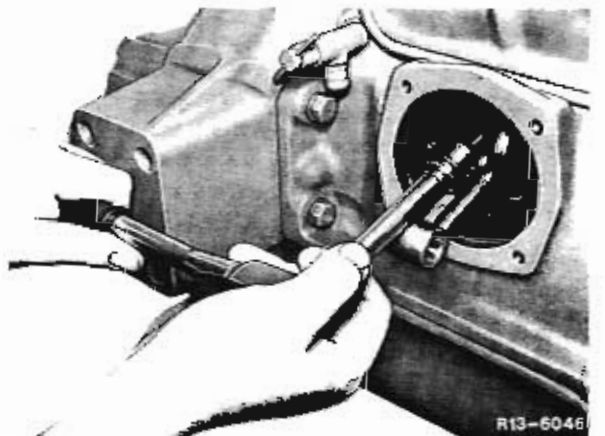
- 1 Remove intake hose and delivery line.
- 2 Unscrew cylinder liner together with cylinder head and take off cylinder head with gasket.
- 3 Pull of cylinder liner over the piston.



- 4 Release piston pin.
- 5 Press out piston pin and take off together with piston. Take piston rings off piston with pliers 000 589 37 37 00.

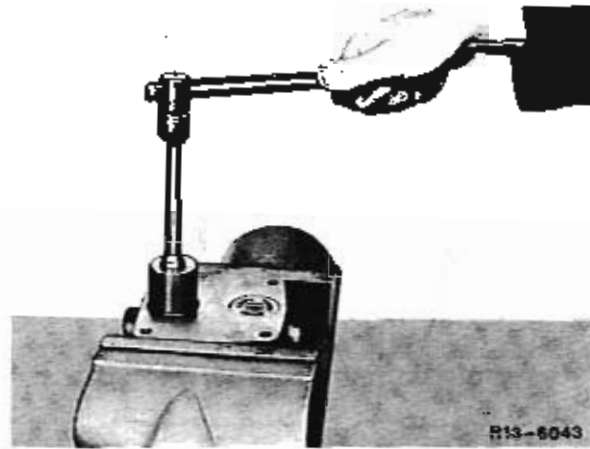


- 6 Unscrew connection rod and take off together with connecting rod cover and bearing shells.



13.13 Removing and Disassembling Camshaft Air Compressor

7 Unscrew suction valve cap from cylinder head using special tool. Take off valve washer, spring lock washers, second valve washer and suction valve seat.

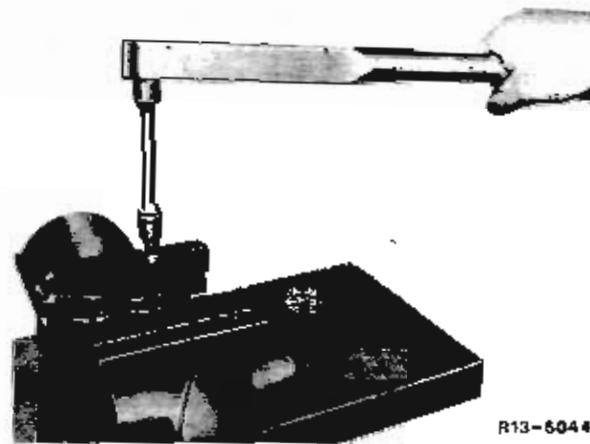


Pin wrench socket 352 589 03 07 00

8 Slacken cap nut and take delivery valve complete out of the cylinder head.

9 Disassemble delivery valve.

10 Clean all parts with benzene.



Note: When installing a new air compressor or exchange engine due to air compressor damage, check the delivery air lines between air compressor and four-circuit protection valve for carbon deposits. If the line cross section is constricted, replace lines, pressure governor and four-circuit protection valve.

Assembling and Installing Camshaft Air Compressor 13.13

OM 352 A
OM 362 LA

Data

Bore	77	94
Stroke	30	30
Total displacement	140 cm ³)	208 cm ³)
Delivery l/min at rated engine speed	85	130
Max. operating pressure	7,35 and 8,1 bar overpressure, resp.	7,35 and 8,1 bar overpressure, resp.

Filling Times

Stroke	Bore	Displacement cm ³)	Operating pressure bar	Delivery ¹⁾ l/min at rated engine speed	Volume of compr. air reservoir(s) in l	Filling time in sec. at engine cutoff speed with new air compressor ¹⁾		
						from 0 to 7,35 bar ²⁾	from 0 to 8,1 bar ²⁾	from 0 to 10 bar ²⁾
30	77	140	7,35	-	35+25	230	-	-
					40	170	-	-
					60 40+40	230 340	-	-
			8,1	-	30+30+10	-	410	-
					20+20	-	230	-
					20+20+10 20+20+20+20 20+20+20+20+10	-	290 470 530	-
30	94	208	7,35	140 at 1 bar back pressure	40	110	-	-
					40+20	160	-	-
					60	160	-	-
					35+25	160	-	-
					40+40	225	-	-
					40+60 40+20+20	280 225	-	-
			8,1	140 at 1 bar back pressure 133 at 8,1 bar back pressure	30+30	-	180	-
					20+20	-	120	-
					20+20+10	-	150	-
					30+30+10	-	210	-
					20+20+20+20	-	250	-
					30+30+10+20 20+20+20+20+10	-	280 280	-
8,1 (brake system) 10 (air suspension)		30+30+30+30	-	-	395			
		30+30+10+30+30	-	-	430			
		20+20+30+30	-	-	330			
		20+20+30+30+10	-	-	360			

¹⁾ Check delivery and filling time only when engine at operating temperature. If the max. permissible filling times are exceeded, the air compressor must be replaced or repaired unless any other causes (e.g. leaks) can be found in the braking system.
²⁾ The max. still permissible filling time is approx. 30% more than the times measured with new air compressor.

13.13 Assembling and Installing Camshaft Air Compressor

Cylinder Liner and Piston

Nom. dia.	77 mm		94 mm	
Rep. Stages	Bore dia.	Piston dia.	Bore dia.	Piston dia.
Standard	<u>77,015</u>	<u>76,995</u>	<u>94,015</u>	<u>93,880</u>
	<u>76,985</u>	<u>76,965</u>	<u>93,985</u>	<u>93,850</u>
Standard I	<u>77,090</u>	<u>77,070</u>	<u>94,090</u>	<u>93,956</u>
	<u>77,060</u>	<u>77,040</u>	<u>94,060</u>	<u>93,925</u>
Standard II	<u>77,140</u>	<u>77,120</u>	<u>94,140</u>	<u>94,005</u>
	<u>77,110</u>	<u>77,090</u>	<u>94,110</u>	<u>93,975</u>
Rep. Stage I	<u>77,265</u>	<u>77,245</u>	-	-
	<u>77,235</u>	<u>77,215</u>	-	-
Rep. Stage II	<u>77,515</u>	<u>77,495</u>	-	-
	<u>77,485</u>	<u>77,465</u>	-	-
Piston play	0,010 - 0,030		0,068 - 0,092	
Piston projection	0,1 - 0,3		0,25 - 0,70	

Note: Piston and liner must always be installed together with the same size classes.

Piston Rings for 77 mm Nom. Dia.

Groove	Piston ring designation	Annular groove width	Vertical play	End clearance
I	Taper face ring	2,5 + 0,020	0,010 - 0,042	0,30 - 0,50
II	Taper face ring	2,5 + 0,020	0,010 - 0,042	0,30 - 0,50
III	Oil scraper ring	3,0 + 0,020	0,010 - 0,042	0,30 - 0,50
IV	Bevelled ring	4,0 + 0,020	0,010 - 0,042	0,25 - 0,50

Note: On OM 352 A up to engine end No. 329 566 the bevelled ring of groove IV was installed in groove III and the oil scraper ring of groove III in groove IV. The piston ring grooves were designed to match the piston rings fitted. The oil bores in the groove for the oil scraper ring are no longer provided from engine end No. 329 566.

The pistons of the new version can be interchanged complete with rings with the pistons of the previous version.

Piston Rings for 94 mm Nom. Dia.

Groove	Piston ring designation	Annular groove width	Vertical play	End clearance
I	Oil scraper ring	<u>2,530</u> <u>2,510</u>	0,020 - 0,055	0,25 - 0,40
II	Oil scraper ring	<u>2,530</u> <u>2,510</u>	0,020 - 0,055	0,25 - 0,40
III	Oil scraper ring	<u>2,530</u> <u>2,510</u>	0,020 - 0,055	0,25 - 0,40

Assembling and Installing Camshaft Air Compressor 13.13

Connecting Rod

Nom. dia. of piston	77 mm	94 mm
Basic bore in connecting rod	$\frac{35,016}{35,000}$	$\frac{35,016}{35,000}$
Basic bore for connecting rod bush	$\frac{19,021}{19,000}$	$\frac{19,021}{19,000}$
Distance from centre camshaft journal to centre piston pin bore	$\frac{92,000}{91,950}$	$\frac{97,000}{96,950}$
Perm. deviation of axle parallelism	0,03 ¹⁾	0,01
Width of connecting rod at	connecting rod eye	$\frac{21,935}{21,883}$
	piston pin eye	$\frac{22,300}{22,200}$
Radial play of connecting rod bearing journals	0,040 - 0,066	0,020 - 0,066
End play of connecting rod bearing journals	0,065 - 0,317	0,065 - 0,317

¹⁾ Over 100 mm length

Camshaft Journals and Connecting Rod Bearings

Stages	77 mm		94 mm	
	Journal dia.	Piston bore when installed	Journal dia.	Piston bore when installed
Standard	$\frac{32,000}{31,984}$	$\frac{32,050}{32,040}$	$\frac{32,000}{31,984}$	$\frac{32,050}{32,020}$
Standard I	$\frac{31,900}{31,884}$	$\frac{31,950}{31,940}$	$\frac{31,900}{31,884}$	$\frac{31,950}{31,920}$
Rep. Stage I	$\frac{31,750}{31,734}$	$\frac{31,800}{31,790}$	$\frac{31,750}{31,734}$	$\frac{31,800}{31,770}$
Rep. Stage II	$\frac{31,500}{31,484}$	$\frac{31,550}{31,540}$	$\frac{31,500}{31,484}$	$\frac{31,550}{31,520}$
Rep. Stage III	$\frac{31,250}{31,234}$	$\frac{31,300}{31,290}$	$\frac{31,250}{31,234}$	$\frac{31,300}{31,270}$

Connecting Rod Bush

Nom. dia. of piston	77 mm	94 mm
Outer diameter	$\frac{19,048}{19,035}$	$\frac{19,048}{19,035}$
Inner diameter	$\frac{16,035}{16,025}$	$\frac{16,035}{16,025}$
Overlap of connecting rod bush in connecting rod	0,014 - 0,048	0,014 - 0,048
Length of connecting rod bush	$\frac{22,1}{21,9}$	$\frac{27,8}{27,6}$

13.13 Assembling and Installing Camshaft Air Compressor

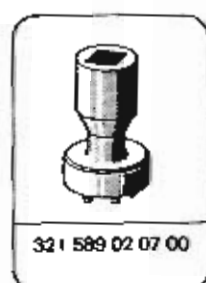
Piston Pin

Air compressor dia.	77 mm	94 mm
Piston pin OD	$\frac{16,015}{16,012}$	$\frac{16,015}{16,012}$
Bore in piston	$\frac{16,045}{16,041}$	$\frac{16,022}{16,018}$
Piston pin play in connecting rod bush	0,010 - 0,023	0,010 - 0,023
Piston pin play in piston	0,026 - 0,033	0,03 - 0,010
Length of piston pin	$\frac{66,00}{65,70}$	$\frac{66,00}{65,70}$

Tightening Torques In Nm

Nom. dia. of piston	77 mm	94 mm
Connecting rod	15	15
Cylinder liner at crankcase	35	-
Cylinder head at liner	35	-
Suction valve in cylinder head	100 - 120	180
Delivery valve in cylinder head	100 - 120	10
Preassembly delivery valve	-	20
Cylinder head in cylinder liner at cylinder crankcase	-	35

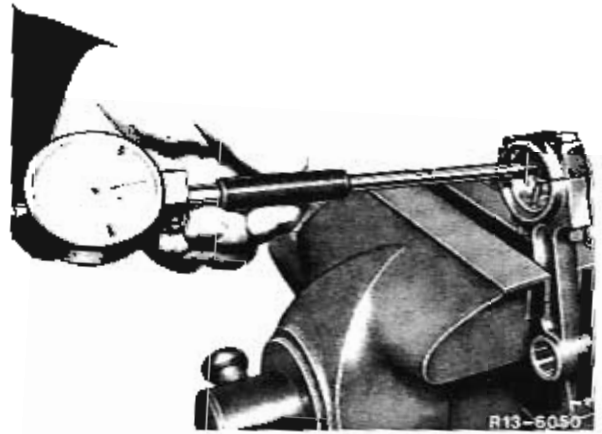
Special Tools



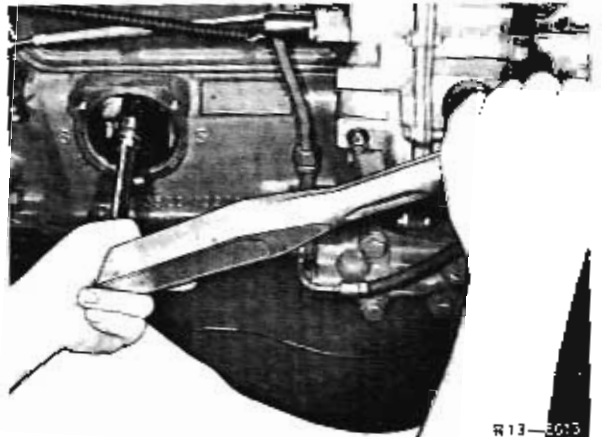
Assembling and Installing Air Compressor 77 mm dia. air compressor

- 1 Install bearing shells in connecting rod and connecting rod cover.
- 2 Screw connecting rod cover onto connecting rod.
- 3 Set 18 – 15 mm dia. internal measuring instrument with 25 – 50 mm dia. micrometer and measure bore at 3 points vertically and at approx. 30° each from parting points.
- 4 Unscrew connecting rod bearing cover.

Dial gauge 001 589 53 21 00



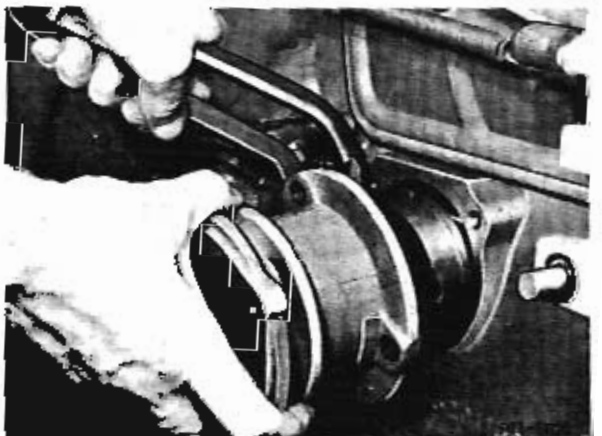
- 5 Measure connecting rod bush inner diameter with 10 – 18 mm dia. internal measuring instrument. Set instrument with 0 – 25 mm dia. micrometer for this purpose.
- 6 Screw connecting rod with bearing shells and bearing cover onto camshaft journal with 15 Nm.



- 7 Install piston rings on piston with pliers 000 589 37 37 00.
- 8 Place piston against connecting rod and install piston pin.
- 9 Secure piston pin with circlip.



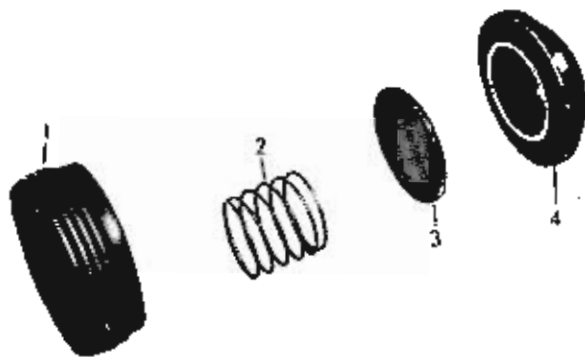
- 10 Compress piston rings on the outer dia. of piston using special tool. Press on cylinder liner with seal over piston.
- 11 Screw cylinder liner tight on crankcase.



Tensioning strap 321 589 01 37 00
Pliers 321 589 00 37 00

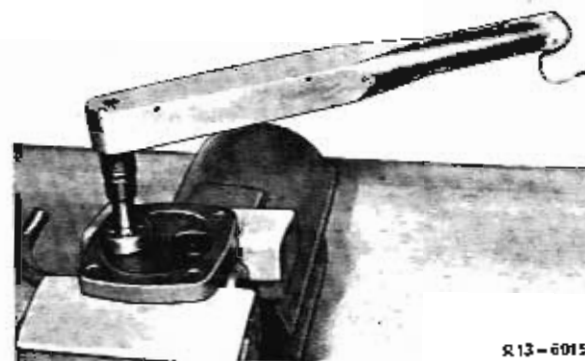
13.13 Assembling and Installing Camshaft Air Compressor

12 Insert suction valve components into cylinder head in the order: suction valve seat (4), valve disc (3), valve spring (2), and suction valve cap (1).



R 13-6014

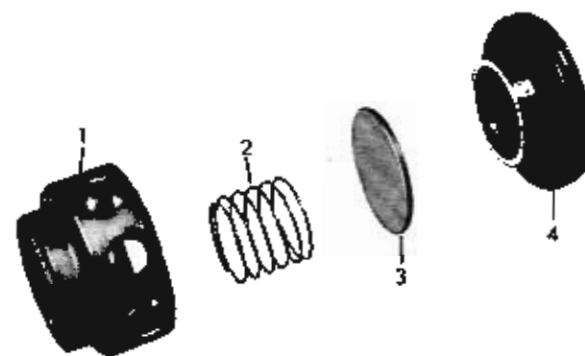
13 Tighten suction valve cap with special tool and torque wrench to 100 – 120 Nm.



Pin wrench socket 321 589 02 07 00

R 13-6015

14 Insert delivery valve components into cylinder head in the sequence: delivery valve seat (4), valve disc (3), valve spring (2) and spring housing (1).

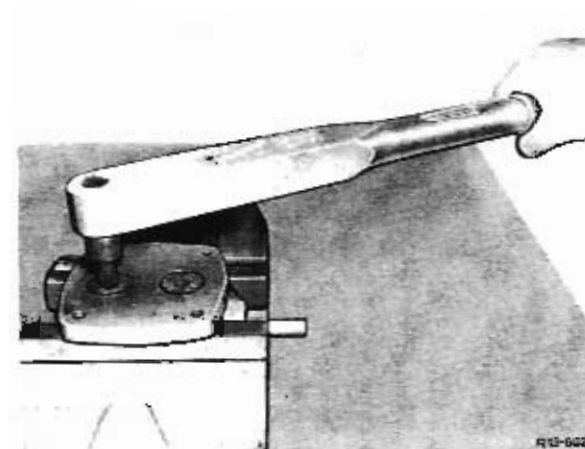


F 13-6016

15 Tighten delivery valve with special tool and torque wrench to 100 – 120 Nm.

16 Screw cylinder head onto cylinder liner with new gasket.

17 Install intake hose and delivery line.



Stud wrench socket 312 589 09 07 00

R 13-6022

94 mm dia. Air Compressor

- 1 Install bearing shells in connecting rod and connecting rod cover.
- 2 Screw connecting rod cover onto connecting rod.
- 3 Set 18 – 35 mm dia. internal measuring instrument with 25 – 50 mm dia. micrometer and measure bore at 3 points vertically and at approx. 30° each from parting points.
- 4 Unscrew connecting rod bearing cover.

Dial gauge 001 589 53 21 00

- 5 Measure connecting rod bush inner diameter with 10 – 18 mm dia. internal measuring instrument. Set instrument with 0 – 25 mm dia. micrometer for this purpose.

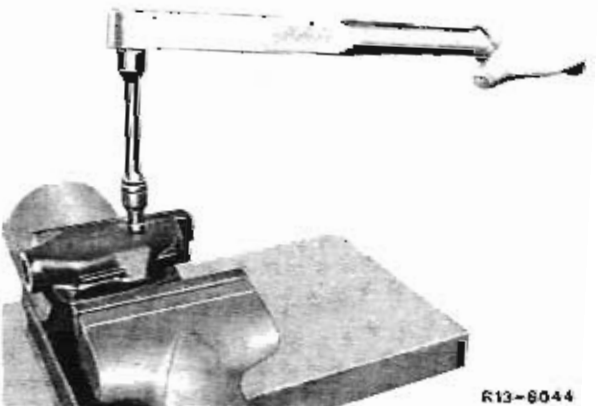
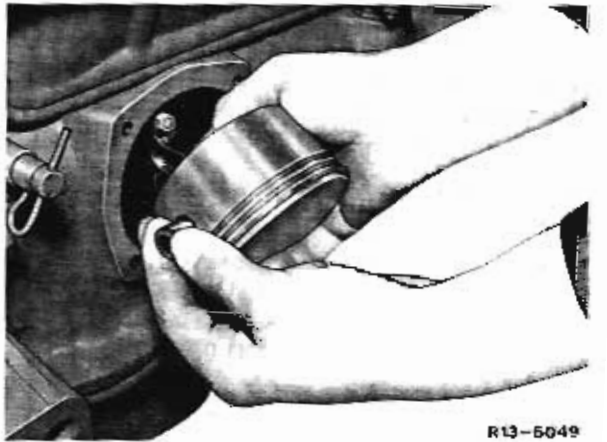
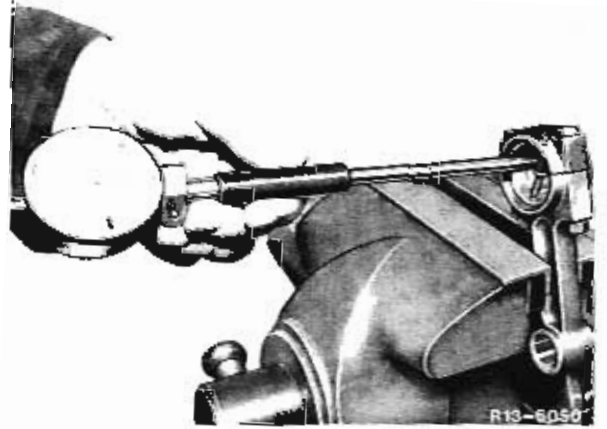
- 6 Screw connecting rod with bearing shells and bearing cover onto camshaft journal with 15 Nm.

- 7 Install piston rings on piston with pliers 000 589 37 37 00.

- 8 Place piston against connecting rod and install piston pin.

- 9 Secure piston pin.

- 10 Preassemble delivery valve with 20 Nm, insert in cylinder head and tighten cap nut to 10 Nm with torque wrench.



13.13 Assembling and Installing Camshaft Air Compressor

11 Insert suction valve into cylinder head in the sequence: valve seat (1), valve disc (2 without hole), spring lock washers (3), second valve disc (4 with hole) and suction valve cap (5).



R13-6053

12 Tighten suction valve with special tool and torque wrench to 180 ± 20 Nm.



Pin wrench socket 352 589 03 07 00

R13-6042

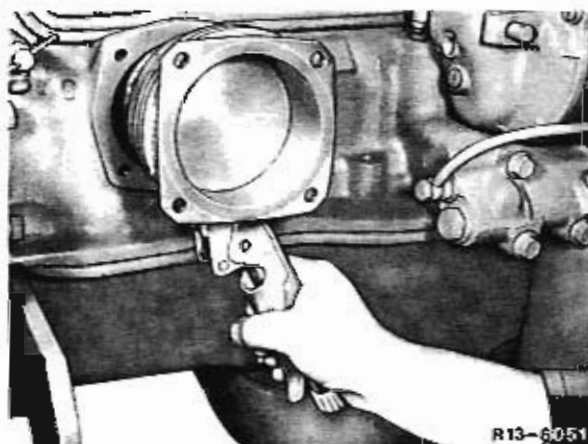
13 Compress piston ring on the outer dia. of the piston using special tool. Press cylinder liner over piston.

Note 1: The seal between cylinder crankcase and liner should be created with sealing compound conforming to DBL 6090.20.

Note 2: Pretighten liner crosswise with 2 bolts and measure piston projection.

Projection 0.25–0.45	thin gasket
	352 131 02 80
Projection 0.45–0.7	thick gasket
	352 131 03 80

Tensioning pliers 000 589 20 61 00



R13-6051

14 Fit cylinder head to cylinder liner with new gasket.

15 Screw cylinder head together with cylinder liner onto crankcase with 30 Nm.

16 Install intake hose and delivery line.

Data		"KG" Scale on Measuring Instrument	N
V-belt tension	new	40 - 45 ¹⁾	400 - 450 ¹⁾
	used	30 - 40	300 - 400

¹⁾ Set this value only when first fitting the V-belt.

Special Tools



Inspecting Condition of V-Belt

1 Inspect V-belt for cracks, oiling, overheating and wear.

Testing V-Belt Tension

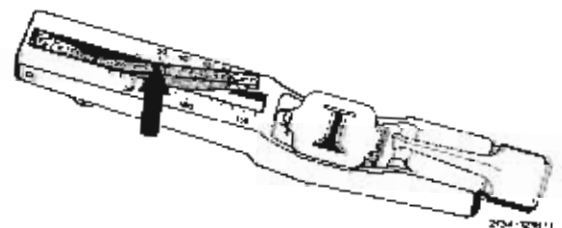
1 Place measuring instrument in the centre between two belt pulleys on the V-belt. The stop (arrow) of the instrument must rest against the side of the V-belt and the indicating arm must be recessed in the instrument.

2 With the pushbutton, apply an even, vertical pressure onto the top of the V-belt until the click spring can be heard and felt to engage.

3 To avoid any measuring errors, only exert pressure on the pushbutton and do not press again after releasing the click spring.

4 Carefully lift off measuring instrument without altering the position of the indicating arm. Read off tension at the intersection of the indicating arm and "KG" scale (arrow).

5 If the measured value is less than the specified value, the belt must be retensioned.

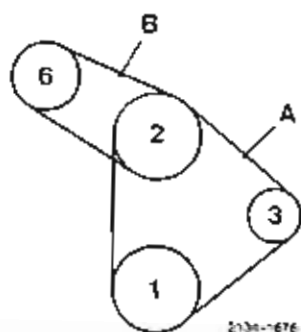


13.13 Testing, Retensioning V-Belt

Retensioning V-Belt

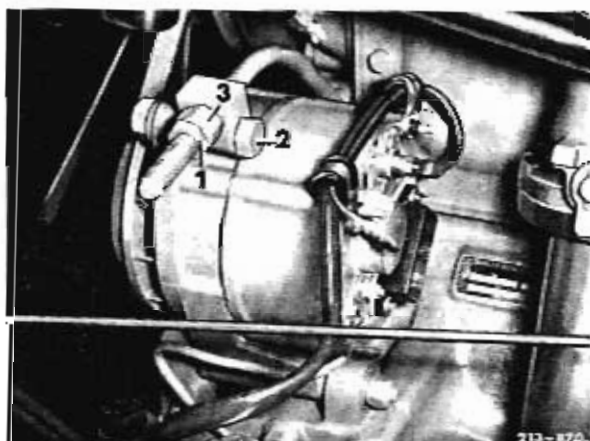
Note: Observe the specified sequence of operations to prevent any damage to the Silent bushes by mixing up the tensioning bolt bearings.

- 1 Crankshaft
- 2 Coolant pump
- 3 Alternator
- 6 Power steering pump
Air compressor



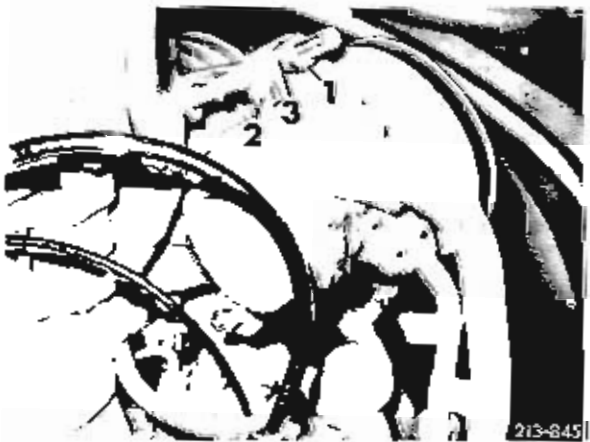
V-Belt A

- 1 Slacken lock nut (1).
- 2 Slacken nut of clamping bolt (2).
- 3 Retension V-belt to specified setting with tensioning nut (3).
- 4 Tighten nut of clamping bolt.
- 5 Tighten lock nut.



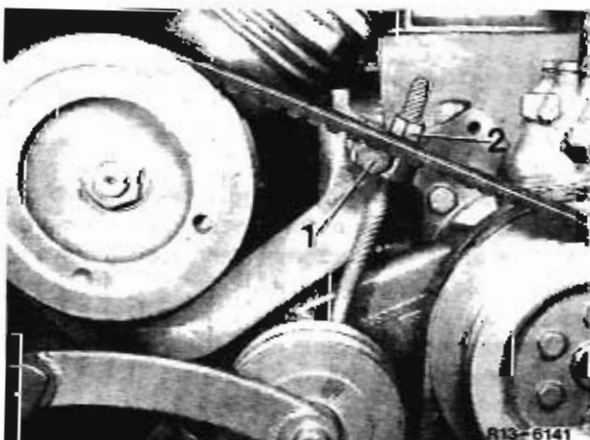
V-Belt B (352 A)

- 1 Slacken lock nut (1).
- 2 Slacken nut of clamping bolt (2).
- 3 Retension V-belt to specified setting with tensioning nut (3).
- 4 Tighten nut of clamping bolt.
- 5 Tighten lock nut.



V-Belt B (362 LA)

- 1 Slacken clamping bolt (1).
- 2 Retension V-belt to specified setting with tensioning nut (2).
- 3 Tighten clamping bolt.

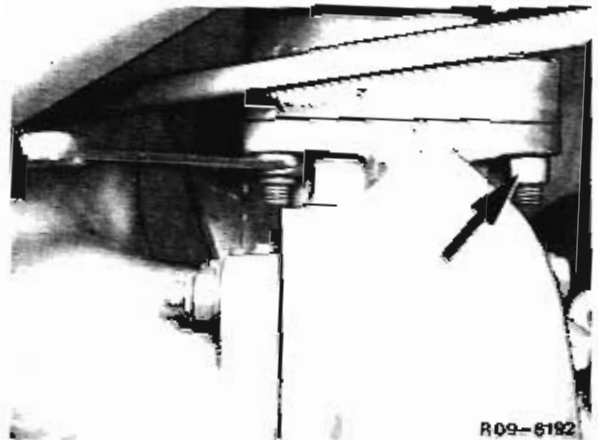


Tightening Torques in Nm

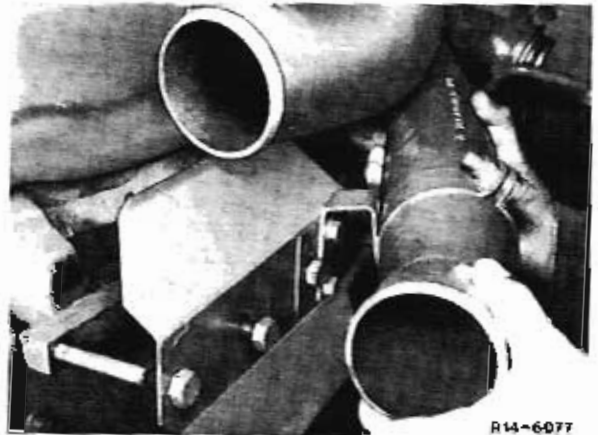
Exhaust manifold at cylinder head	60
Turbocharger at exhaust manifold	55-75
Oil delivery line at turbocharger M 8	25
Oil return line at turbocharger M 8	25
Oil delivery line at oil cooler M 14	40

Removing

1 Remove turbocharger.



2 Remove hose to charge air cooler at charge air pipe.



3 Slacken front fastening bolts for exhaust manifold and take off heat shield with charge air pipe.

4 Remove oil delivery line for turbocharger.

5 Slacken rear fastening bolts and take off exhaust manifold together with gaskets.



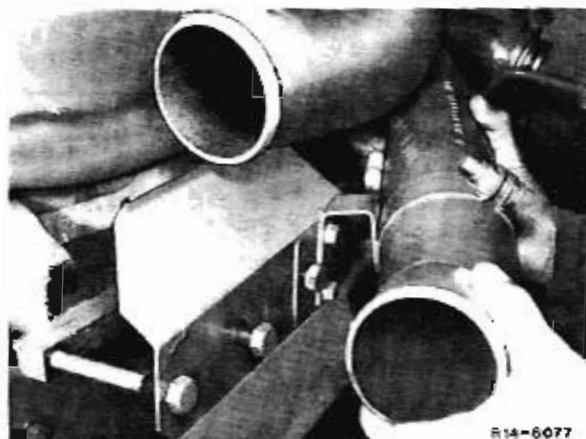
14.13 Removing and Installing Exhaust Manifold

Installing

1 Fit exhaust manifold together with new gaskets to the cylinder head and screw in rear fastening bolts.

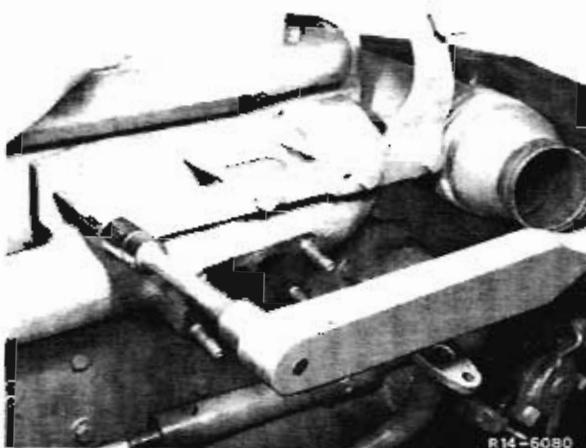


2 Install heat shield and charge air pipe with front fastening bolts.

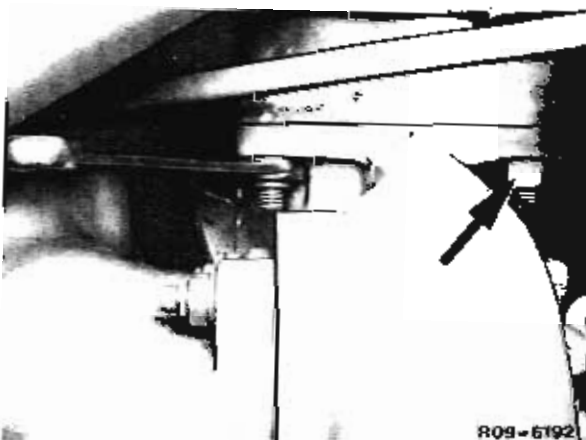


3 Screw exhaust manifold onto cylinder head with 50 Nm.

4 Fit oil delivery line for turbocharger to oil cooler.



5 Install turbocharger.



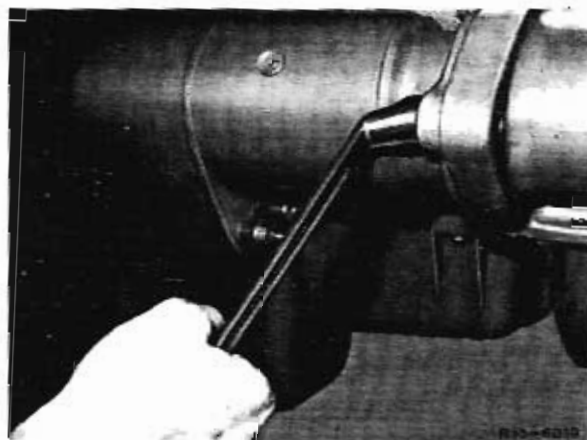
Tightening Torques in Nm

Starter at cylinder crankcase

80

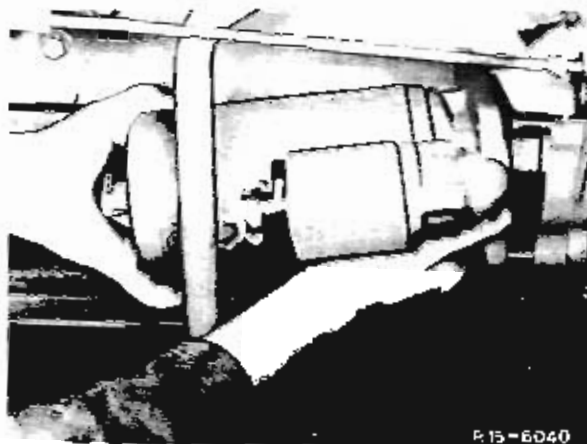
Removing

- 1 Disconnect battery cables.
- 2 Slacken electrical connections at starter.
- 3 Unscrew fastening nuts.
- 4 Take out starter from below.



Installing

- 1 Insert starter from below in stay bolt.
- 2 Tighten fastening nuts with 80 Nm.
- 3 Attach electrical connections to starter.
- 4 Connect battery cables.



P.15-6D40

The oil consumption of an engine can be exactly determined only by an oil consumption test run together with a fuel consumption measurement. Determining oil consumption with the aid of the oil dipstick does not provide the necessary accuracy.

During the running-in period of the engine (up to approx. 20,000 km), an increased oil consumption is perfectly normal. During this period no oil consumption test run should be performed.

Since oil consumption depends to a great extent on the style of driving, i.e. on vehicle load and engine speed, a test stretch of at least 200 km should be driven under normal vehicle operating conditions. The test run is conducted by the customer or the driver himself.

The fuel consumption should also be determined during the oil test run since only a comparison between fuel and oil consumption enables proper account to be given to different operating conditions (hill climbing, town traffic, dump truck operation, trailer operation etc.).

Before conducting the oil consumption test run, the engine should be closely examined for any leak points which may cause a loss of oil (e.g. at the oil filter, oil cooler, cylinder head covers etc.).

The oil consumption should be determined as follows:

1. Have available a clean vessel and weigh the vessel when empty.
2. Warm up engine. The coolant temperature should be 60–100 °C.
3. Position the vehicle on even ground and mark the position so that the vehicle can be driven into the same position after the test run.
4. Move the hand accelerator knob to the Stop position. Check the regulating lever on the injection pump whether it is in fact at the Stop position.
5. Unscrew the screw plug on the oil pan and allow the warm oil to flow for 20 minutes into the clean vessel which has previously been put in place. After the oil has drained for 15 minutes, start the engine for 10 seconds, operating the engine brake at the same time.
6. Fill the fuel tank up to 2 cm below the edge of the filler neck and mark or note the exact height of the fuel level.

7. Screw in the plug of the oil pan again and tighten.

8. Weigh the vessel with the drained oil on a weighing machine with a gram scale and bring the quantity of oil to the specified weight according to the particular filling quantity (weight of oil + weight of oil vessel).

9. Carefully pour the weighed quantity of oil into the engine, ensuring that none is spilled. The vessel which must be re-used after the test run must not be used for any other purpose nor cleaned in the meantime otherwise this may cause weighing errors.

10. Drive the vehicle for at least 200 km under the conditions specified above (possibly normal vehicle operation for a day).

11. After returning from the test run, immediately position the vehicle on the marked spot.

12. Place the vessel which was used previously below the vehicle and drain the oil. The drainage time should again be 20 minutes. After 15 minutes, start the engine for 10 seconds, operating the engine brake at the same time (important: note Point 4!). Then insert the screw plug and tighten.

13. Weigh the vessel with oil again and determine the oil consumption. This is obtained from the difference in weight between the two measurements prior to and following the test run.

The oil consumption (b_{oil}) is usually stated in litres and is calculated from the difference in weight determined, the specific density of the oil used and the distance travelled on the basis of the formula given on the back of this test sheet.

4. Fill up the fuel tank to the level prior to the consumption test run and determine the quantity of fuel consumed during the test run.

The fuel consumption (B_{fuel}) is usually stated in ltrs./100 km. The conversion to 100 km is performed using the formula stated on the back of this test sheet.

15. The ratio of the oil consumption to the fuel consumption in ‰ can be calculated using the formula stated.

An oil consumption of 1‰ of fuel consumption is perfectly normal.

Meßblatt für Ölverbrauchsmessung bei Nutzfahrzeugen

Test Sheet for Oil Consumption Test for Commercial Vehicles

Niederlassung / Vertretung
Branch / Agency

Kunde
Customer

Messung ausgeführt: Datum / Name
Measurement carried out: Date / Name

Typ Type	Fahrgestell-Nr. Chassis No.	Erstzulassung Original Registration
Rep.-Auftrag Nr. Repair order No.	Motor-Nr. Engine No.	Tachometerstand: km / Meilen Speedometer reading: km / miles

Achtung! Vor der Meßfahrt Unterlagen des Kunden über Ölverbrauch genau prüfen
Important: Check customer's documentation on oil consumption carefully prior to test drive

Einsatz des Fahrzeuges: (z. B. Fernverkehr, Klipperbetrieb, Anhängerbetrieb usw.)
Application of vehicle: (e.g. Long-distance driving, tipper operation, trailer operation, etc.)

Gesamtgewicht – Motorwagen Gross weight – Truck	l	Außentemperatur Ambient temperature	°C
Gesamtgewicht – Anhänger/Auflieger Gross weight – Trailer/Semi-trailer	l	Öldruck im Leerlauf (bei betriebswarmem Motor) Oil pressure, idling (with engine hot)	kp/cm ²
Ölsorte Oil brand		Kühlwassertemperatur Cooling water temperature	°C
Gewicht des leeren Meßgefäßes Weight of empty measuring receptacle	g	km-Stand nach der Meßfahrt Mileage (km reading) after test drive	km
Gewicht des Meßgefäßes mit Öl Weight of measuring receptacle with oil		km-Stand vor der Meßfahrt Mileage (km reading) prior to test drive	km
vor der Meßfahrt prior to test drive	g	Laufstrecke Distance covered	km
nach der Meßfahrt after test drive	g	nachgefüllte Kraftstoffmenge nach der Meßfahrt Amount of fuel added after test drive	l litrs.
Gewicht des verbrauchten Öls Weight of oil consumed	g		

Ölverbrauch
Oil consumption

$$b = \frac{\text{Gewicht des verbrauchten Öls (g)} \\ \text{Weight of Oil consumed (grams)}}{0,85 \times \text{Laufstrecke (km)} \\ \text{Distance covered (km)}} = \frac{\text{}}{0,85 \times \text{}} = \frac{\text{}}{\text{}} \text{ l/1000 km} \\ \text{ltrs/1000 km}$$

1) Spez. Gewicht des Öls = 0,85 g/cm³
Specific gravity of the Oil = 0,85 g/cm³

Kraftstoffverbrauch während der Meßfahrt (vor und nach der Meßfahrt bis 2 cm von der Oberkante Einfüllstutzen auffüllen)
Fuel consumption during test drive (prior to and after test drive refill up 2 cm from upper edge of filler neck)

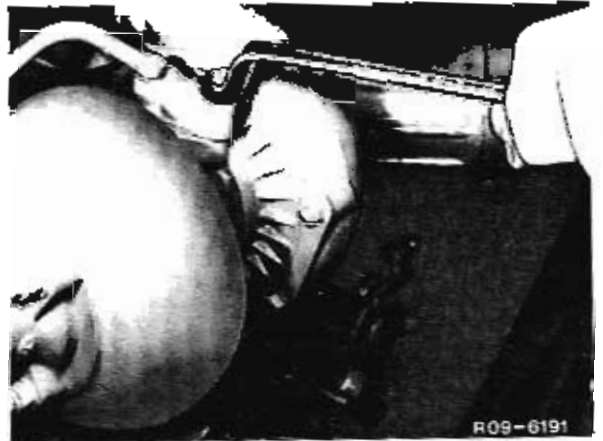
$$B \cdot \text{Kraftstoff} = 100 \times \frac{\text{Kraftstoffverbrauch in l} \\ \text{Fuel consumption, litrs}}{\text{Laufstrecke in km} \\ \text{Distance covered, km}} = 100 \times \frac{\text{l} \\ \text{litrs}}{\text{km}} = \frac{\text{l}}{\text{km}} \cdot 100 \text{ km} \\ \text{ltrs/100 km}$$

Ölverbrauch in % zum Kraftstoffverbrauch
Oil consumption as a percentage of fuel consumption

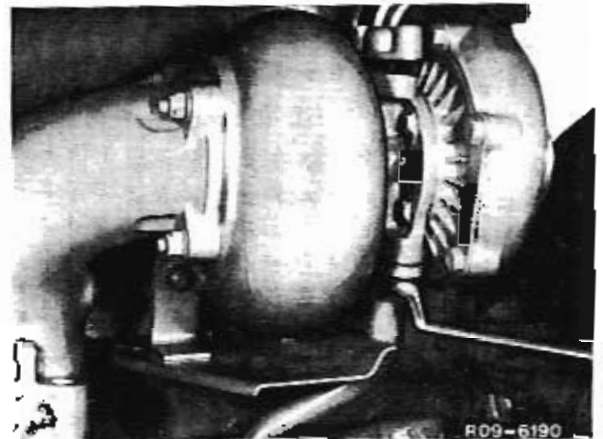
$$\% = 10 \times \frac{b = \text{Ölverbrauch l/1000} \\ b = \text{Oil consumption ltrs/1000}}{B = \text{Kraftstoffverbrauch l/100} \\ B = \text{Fuel consumption ltrs/100}} = 10 \times \frac{\text{l/1000 km} \\ \text{ltrs/1000 km}}{\text{l/100 km} \\ \text{ltrs/100 km}} = \%$$

Removing

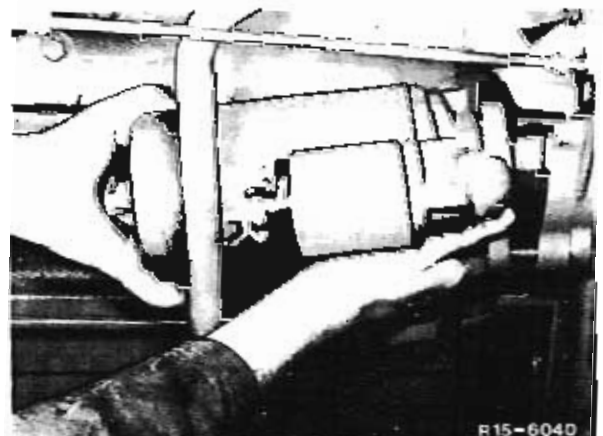
- 1 Drain coolant.
- 2 Remove oil delivery line at main oil passage, exhaust manifold and turbocharger.
- 3 Detach compressed air cylinder for engine brake.



- 4 Remove oil return line at oil pan and turbocharger.
- 5 Remove flange manifold at turbocharger and exhaust manifold.

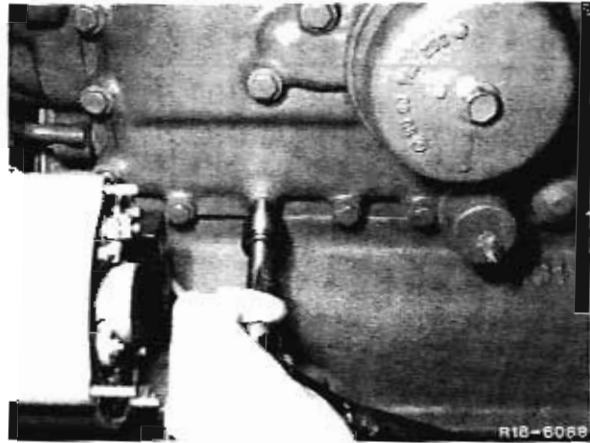


- 6 Remove starter.

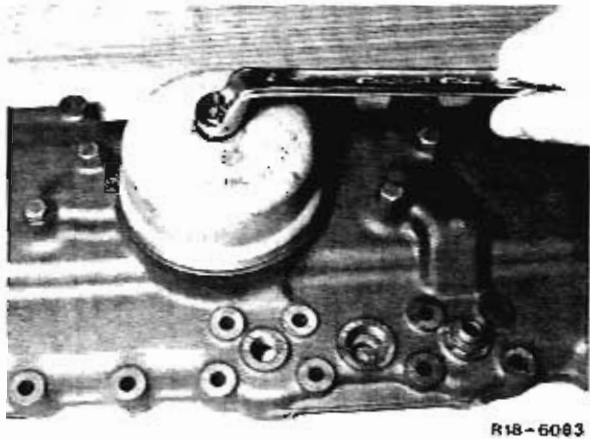


18.13 Removing Oil Cooler

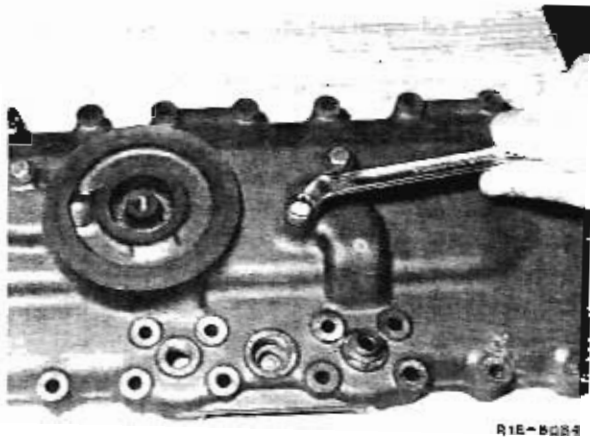
7 Unscrew oil cooler and disassemble.



8 Unscrew filter bowl with element and remove.
Only on OM 352 A from engine No. 528 530
up to engine end No. 673 404



9 Unscrew disc oil cooler and remove.
Only on OM 352 A from engine end No. 528 530
up to engine end No. 673 404



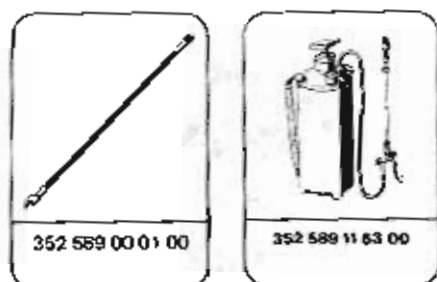
Spring for Bypass Valve in Oil Cooler

OD	Wire thickness	Set to	Length of spring un-tensioned	Initial spring tension		Final spring tension	
				Length	Load	Length	Load
mm	mm	bar (kp/cm ²)	mm	N (kp)	mm	N (kp)	
17,0	1,25	1,5 - 2 (1,5 - 2)	25,5	12	20 (2,0)	9,0	24,4 (2,44)

Tightening Torques in Nm

Oil cooler at cylinder crankcase	35
Oil overpressure valve at oil cooler	60
Exhaust manifold	60

Special Tools



Note 1: If engine damage occurs to an engine equipped with a disc-type oil cooler where severe bearing wear or formation of metal chips is determined, the oil cooler should be replaced. The disc-type oil cooler cannot be properly cleaned under workshop conditions due to its design.

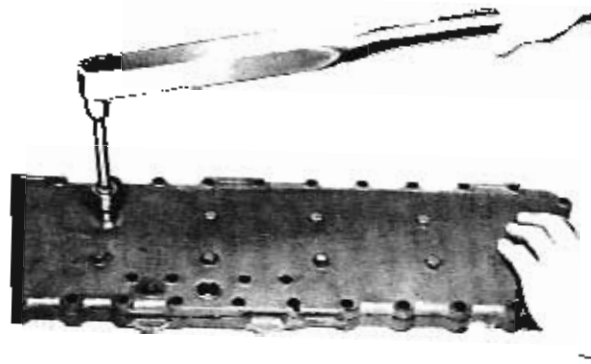
If the oil cooler is not replaced, there is a risk of the engine failing after a relatively short operating period with bearing damage due to dirt and abrasion residues which are still present in the oil cooler.

In the event of engine damage due to water in the oil, dust wear or fracture of an engine component - without the formation of metal chips, it is sufficient to thoroughly flush out the disc-type oil cooler for example with benzene. Remove/install oil cooler for this purpose. **Do not use water for cleaning.**

18.13 Installing Oil Cooler

Note 2: To avoid bearing damage, the engine oil circuit should be bled after installing the oil cooler but before operating the engine.

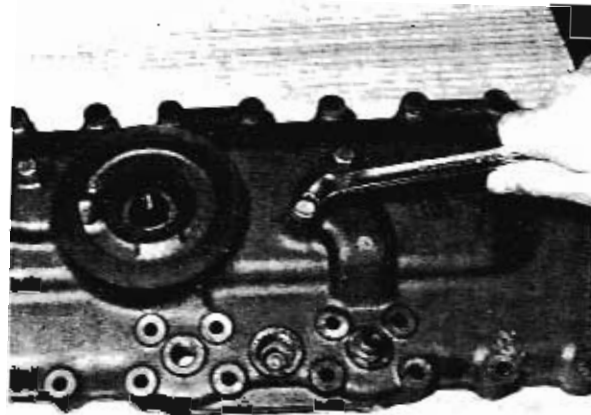
1 Insert new gasket and sealing rings between the two halves of the oil cooler and assemble oil cooler.



R18-6064

2 Fit new gaskets and bolt disc-type oil cooler onto housing cover.

Note: Items 2 + 3 only on OM 352 A engines from engine end No. 528 530 up to engine end No. 673 404



R18-6084

3 Insert filter element into filter bowl, fit round cord ring and bolt filter bowl onto housing cover with 40–45 Nm.



R18-6086

4 Install new gasket between oil cooler and cylinder crankcase and torque oil cooler to cylinder crankcase with 35 Nm.

5 Fit bypass valve to oil cooler with 60 Nm.

6 Install oil pressure pickup.



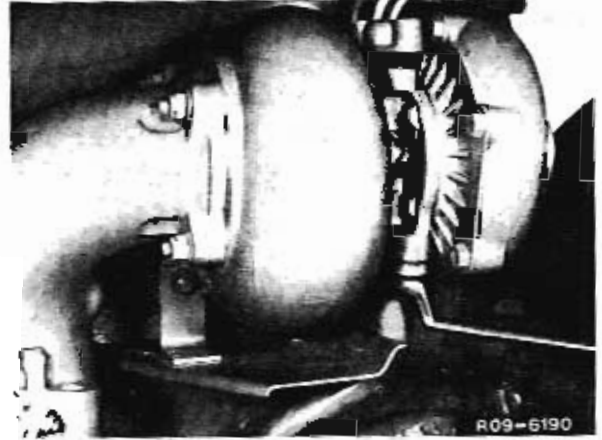
R18-6088

7 Fit flange manifold to turbocharger and exhaust manifold.

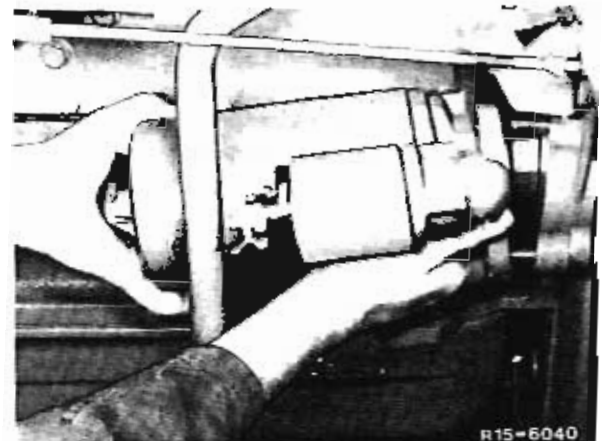
8 Attach regulating linkage and return spring for engine brake.

9 Fit oil pressure line to main oil passage and turbocharger, fit exhaust manifold and turbocharger.

Fit oil return line to oil pan and turbocharger.



10 Install starter.



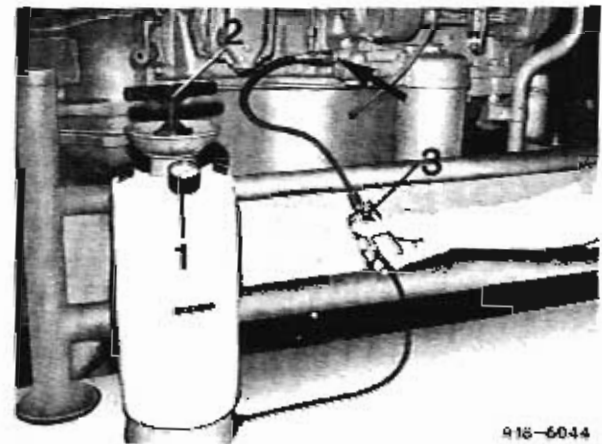
11 Remove connection for injection pump lubrication from oil filter housing and screw connecting hose.

12 Remove cylinder head cover.

13 Fill oil filling cylinder with approved grade of oil and close.

14 Produce an overpressure of approx. 3 bar with the hand pump (2) installed in the oil filling cylinder.

- Oil filling cylinder 352 589 11 63 00
- 1 Pressure gauge
- 2 Hand pump
- 3 Shutoff valve
- Arrow: Connection injection pump lubrication



15 Open shutoff valve (3) long enough until the oil flows out free of bubbles at the rocker arms. The overpressure in the oil filling cylinder should not drop below 1.5 bar, pump up if necessary.

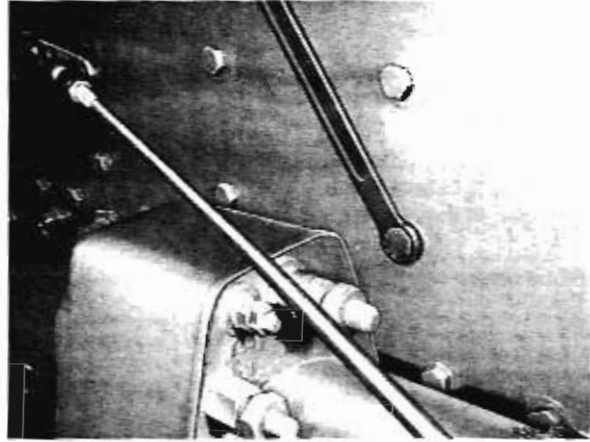
16 Take off connection hose and connect line for injection pump lubrication.

17 Fit cylinder head cover, check oil level and top up coolant.

18.13 Installing Oil Cooler

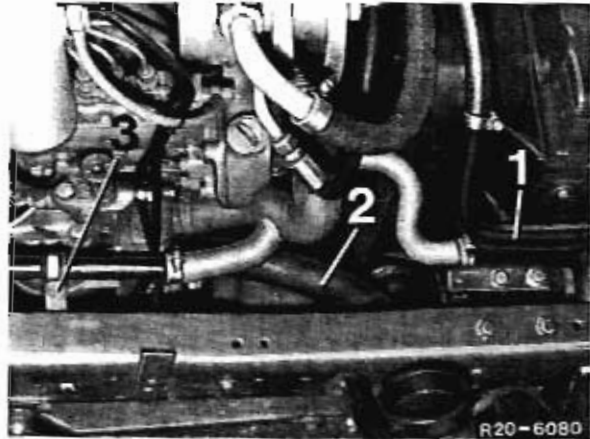
Note 1: Use special tool to tighten heat exchanger with starter fitted.

Open-end box wrench 352 589 00 01 00



Note 2 352 A: New engines are supplied according to the current series status only with disc-type oil cooler and combination oil filter-oil cooler. When installing in vehicles up to chassis end No. 829 878, the coolant line must be laid as shown in the photo opposite.

- 1 Heating pipe
- 2 Shaped brace
- 3 Bracket



Tightening Torques in Nm

Oil filter bowl at oil filter head

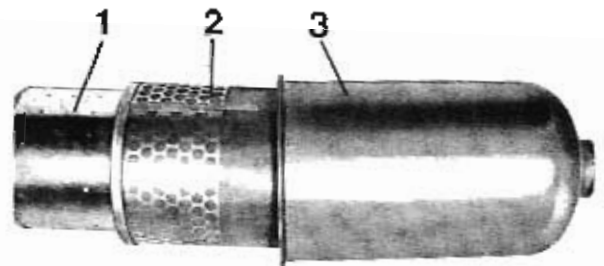
40-50

Removing

- 1 Unscrew oil drain plug on filter bowl and drain oil.
- 2 Unscrew centre screw. Remove oil filter bowl with sieve filter (full flow filter) and secondary flow cartridge.
- 3 Clean sieve filter in clean petroleum with a soft brush.

Note: Replace secondary flow cartridge.

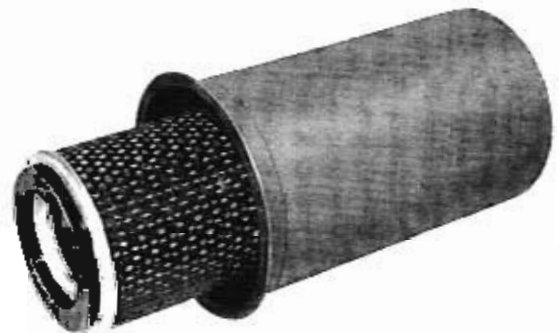
- 1 Secondary flow cartridge
- 2 Sieve filter
- 3 Oil filter bowl



R18-6062

- 4 Clean filter bowl, spring plate and centre screw.

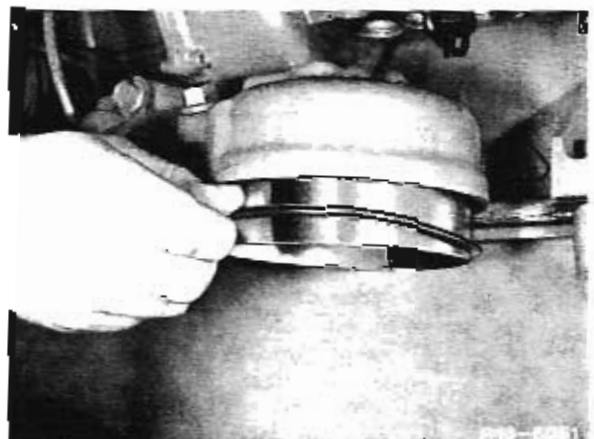
Note: On engines with the Kühnle, Kopp and Kausch 3 LK, K 27, Garrett Air Research and e B 32 Eberspacher charges running in plane bearings, oil filters without sieve filter are fitted only with a paper full flow oil filter element. These oil filters are identified by being painted yellow.



R18-6103

Installing

- 1 Fit oil drain plug to filter bowl.
- 2 Insert sieve filter and secondary flow cartridge or only paper full flow oil filter element in filter bowl.
- 3 Insert new seal (O-ring) to filter head.



18.13 Removing and Installing Oil Filter Elements

4 Fit filter bowl together with filter elements centrally on filter head. Tighten centre screw.

Note: Before starting, crank engine with the starter until the oil pressure gauge indicates pressure, at the same time pressing in Stop button fully to prevent the engine from starting. The starter must be operated for not more than 20 seconds otherwise it will overheat and this may cause damage. If no oil pressure is then indicated, the starting operation should be interrupted and repeated after one minute.



Spring for Bypass Valve in Oil Filter Support

OD	Wire thickness	Set to	Length of spring unextended	Initial spring tension		Final spring tension	
				Length	Load	Length	Load
mm	mm	bar (kp/cm ²)	mm	mm	N (kp)	mm	N (kp)
16,5	1,5	1,6 - 2,5 (1,6 - 2,6)	66	31	45 ± 3 (4,5 ± 0,3)	21,0	57 (5,7)

Tightening Torques in Nm

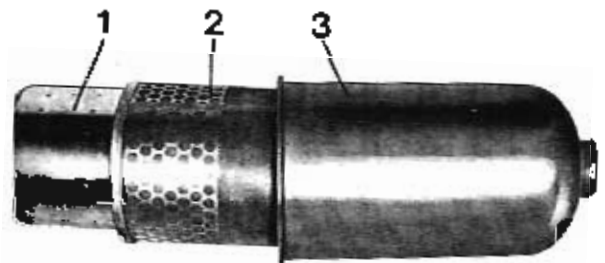
Oil filter support at cylinder crankcase

60

Disassembling

- 1 Remove oil filter elements.
- 2 Unscrew lube oil line.
- 3 Unscrew bypass valve for filter from support (352 A up to chassis end No. 829 878).
- 4 Unscrew oil filter support from cylinder crankcase and remove.
- 5 Clean all parts thoroughly, blow out with compressed air.

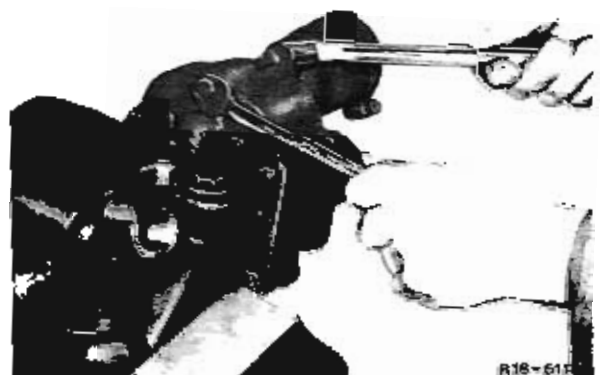
- 1 Secondary flow cartridge
- 2 Sieve filter
- 3 Oil filter bowl



R18-6062

Note: Items 6 + 7 only on engines OM 352 A from chassis end no. 829 879 OM 362 LA from start of production.

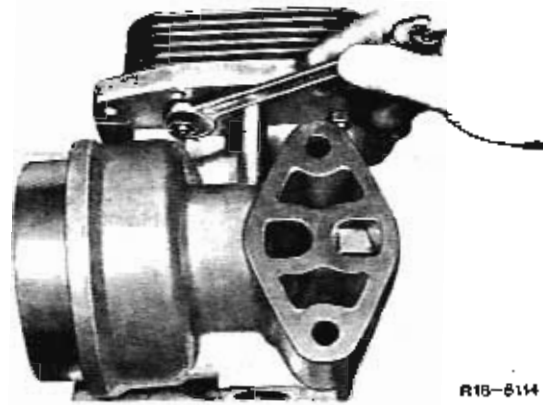
- 6 Unscrew oil cooler housing.



R18-6115

18.13 Disassembling and Assembling Oil Filter Support

7 Unscrew oil cooler and remove.

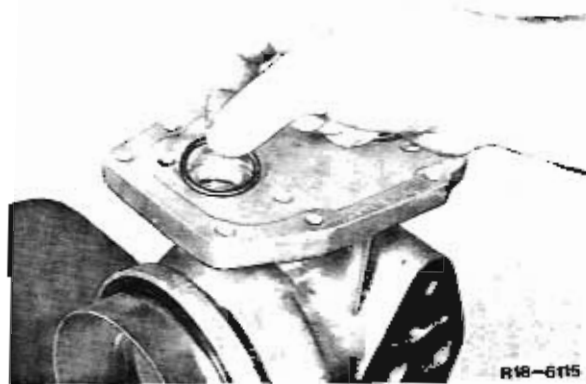


R18-614

Assembling

Items 1 - 3 only on engines OM 352 A from chassis end No. 829 879 OM 362 LA from start of production.

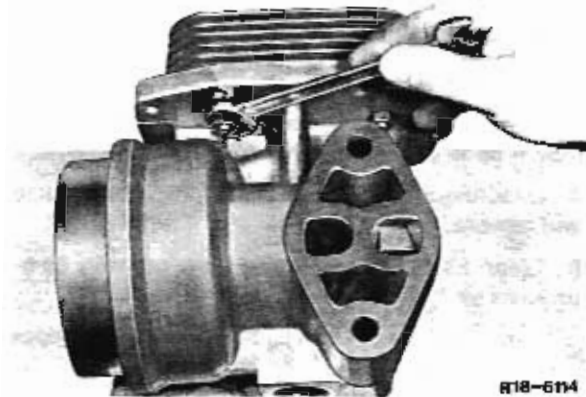
1 Insert new seals for oil cooler in the oil filter housing.



R18-615

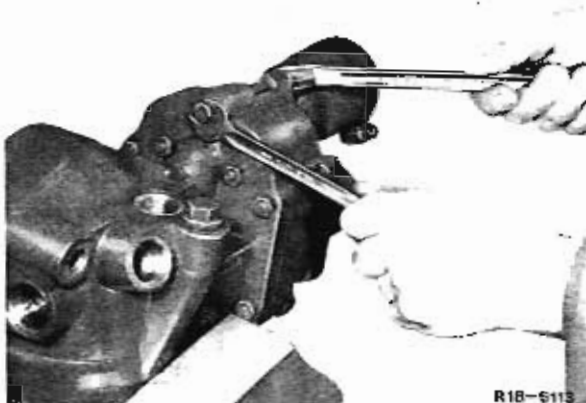
2 Bolt oil cooler onto oil filter support.

Note: If severe bearing wear or formation of metal chips are detected in the event of engine damage, the disc-type oil cooler should be replaced.



R18-614

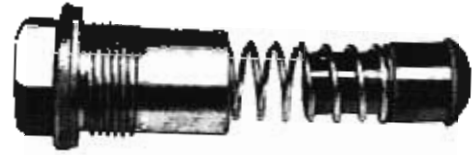
3 Bolt on oil cooler housing together with gasket.



R18-615

Disassembling and Assembling Oil Filter Support 18.13

- 4 Fit oil filter support with new gasket to cylinder crankcase and bolt tight with 60 Nm.
- 5 Test spring of bypass valve on suitable spring testing machine, replace if necessary.
- 6 Insert bypass valve components in filter support and tighten screw plug (352 A up to chassis end No. 829 878).

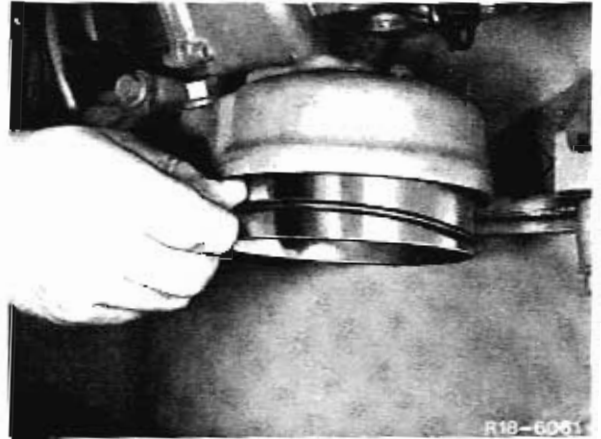


R18-6066

- 7 Connect lube oil line for injection pump.

Note: Hollow bolt with small hole – oil filter head;
hollow bolt with large hole – injection pump.

- 8 Insert seal for oil filter bowl.
- 9 Fit oil filter elements together with filter bowl to oil filter support.



R18-6061

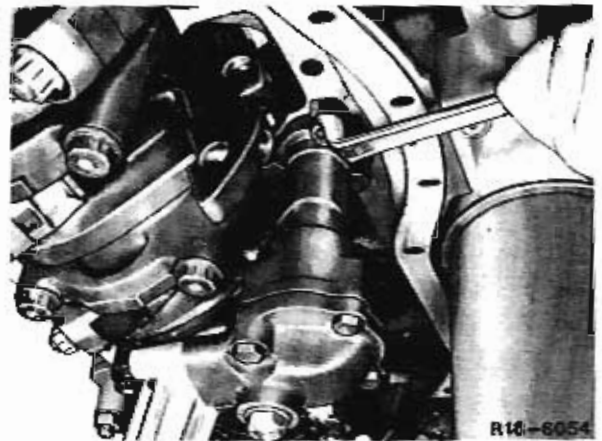


Tightening Torques in Nm

Oil pump at cylinder crankcase		35
Oil pan (cast iron)	M 6	12
	M 8	25
Oil pan (sheet metal)	M 6	8
	M 8	9

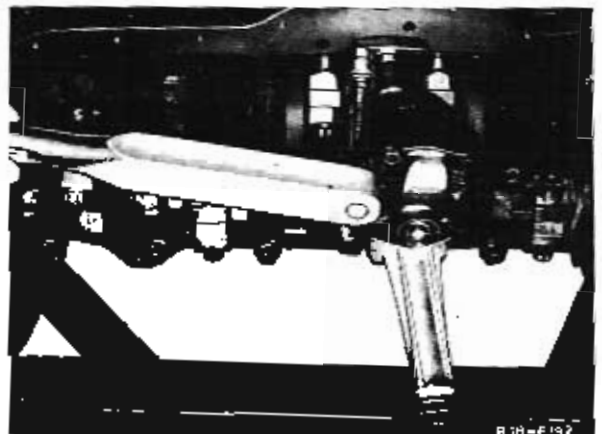
Removing

- 1 Drain oil.
- 2 Remove oil return line for turbocharger from oil pan.
- 3 Unscrew oil pan and take off.
- 4 Unscrew fastening bolts of oil pump and take oil pump together with suction basket out of the cylinder crankcase.

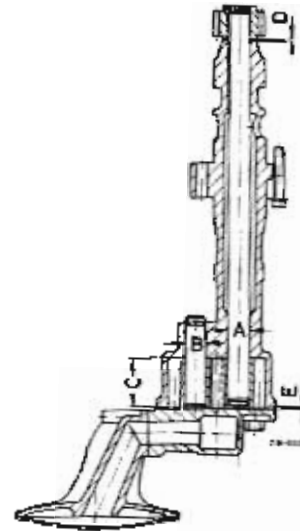


Installing

- 1 Insert oil pump into the cylinder crankcase and bolt tight with 35 Nm.
- 2 Fit oil pan with new gaskets.
- 3 Fit oil return line for turbocharger to oil pan.
- 4 Pour in oil.






Oil Pump Data

		352 A ¹⁾	352 A ²⁾	362 LA
Size A	Diameter in housing	$\frac{17,018}{17,300}$	$\frac{17,018}{17,000}$	$\frac{17,018}{17,000}$
	Diameter of input shaft	$\frac{16,984}{16,976}$	$\frac{16,984}{16,976}$	$\frac{16,984}{16,976}$
Size B	Diameter of oil pump axle	$\frac{15,039}{15,028}$	$\frac{15,039}{15,028}$	$\frac{15,039}{15,028}$
	Housing height for gear running	$\frac{40,025}{40,000}$	$\frac{47,025}{47,000}$	$\frac{50,025}{50,000}$
	Height of oil pump gear	$\frac{39,975}{39,936}$	$\frac{46,975}{46,936}$	$\frac{49,975}{49,936}$
Size C	Installation height of oil pump axle	$39,2 \pm 0,3$	45	$48 \pm 0,5$
Size D	Perm. clearance between drive helical gear and upper edge of pump housing when driving gear abutting upper edge of pump housing	0,04	0,04	0,01-0,04
Size E	Installation height of input shaft	0,5 - 0,8	$4,5 + 0,3$	$7,5 \pm 0,3$

Testing Oil Pump

Delivery in l/min measured with: SAE 10 oil	300 r/min	6,0	9,5	10
Oil temperature 50° C				
Oil back pressure 4 bar	1 400 r/min	43,0	54,0	61
Opening pressure of overpressure valve			$5,2 \pm 0,5$ bar	

¹⁾ Up to engine end No. 528 529

²⁾ From engine end No. 528 530

18.13 Disassembling and Assembling Oil Pump

	352 A ¹⁾	352 A ²⁾	362 LA
Radial play of input shaft	0,016 – 0,042	0,016 – 0,042	0,016 – 0,042
Radial play between oil pump gear and oil pump axle	0,011 – 0,040	0,011 – 0,040	0,011 – 0,040
Overlap between oil pump axle and housing	0,010 – 0,039	0,010 – 0,039	0,010 – 0,039
Radial play of oil pump gears between housing and gear	0,030 – 0,105	0,030 – 0,105	0,030 – 0,105
End play of oil pump gears between housing cover and gear	0,025 – 0,089	0,025 – 0,089	0,025 – 0,089
Backlash of oil pump gears	0,15 – 0,25	0,15 – 0,25	0,15 – 0,25

¹⁾ Up to engine end No. 528 529

²⁾ From engine end No. 528 530

Springs for Oil Overpressure Valves

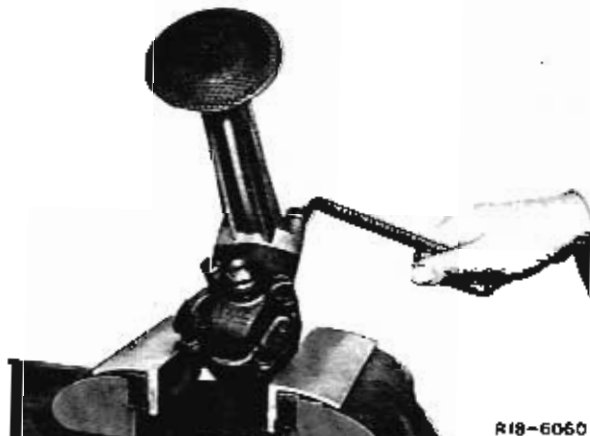
	OD mm	Wire thickness mm	Set to bar	Length of spring un-tensioned mm	Initial spring tension		Final spring tension	
					Length mm	Load N	Length mm	Load N
in oil pump	9,3	1,7	5,2 ± 0,5	49,4	45,4	43,9	36,2	145

Tightening Torques in Nm

Cover at oil pump	35
Suction basket at cover	30 – 40
Oil overpressure valve at cover	15 – 25

Disassembling

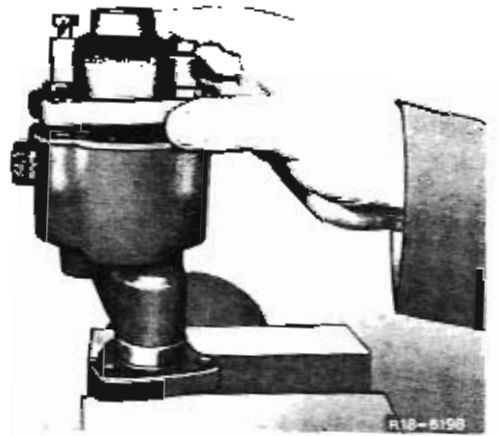
- 1 Clamp oil pump in vice, using soft vice jaws.
- 2 Unscrew suction basket from cover.



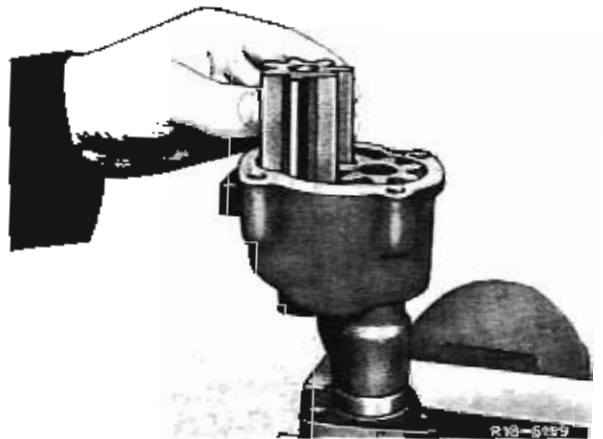
R18-6060

Disassembling and Assembling Oil Pump 18.13

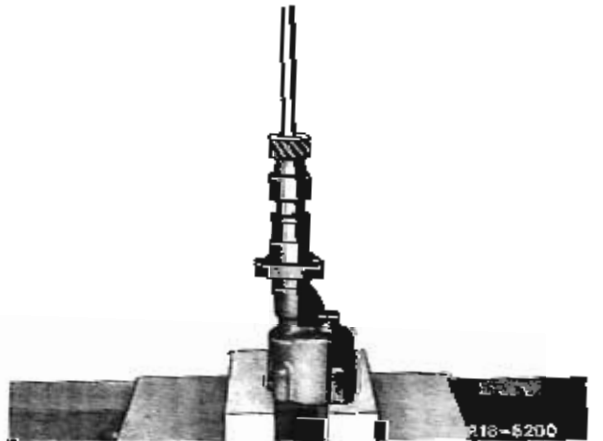
- 3 Unscrew plug of oil overpressure valve and take out together with spring, piston and valve housing.
- 4 Unscrew oil pump housing cover.



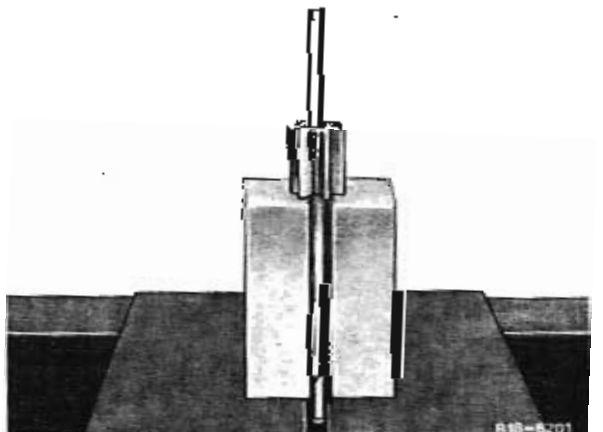
- 5 Take oil pump gear off oil pump axle.



- 6 Press helical gear off input shaft.
- 7 Take oil pump gear together with input shaft out of oil pump housing.

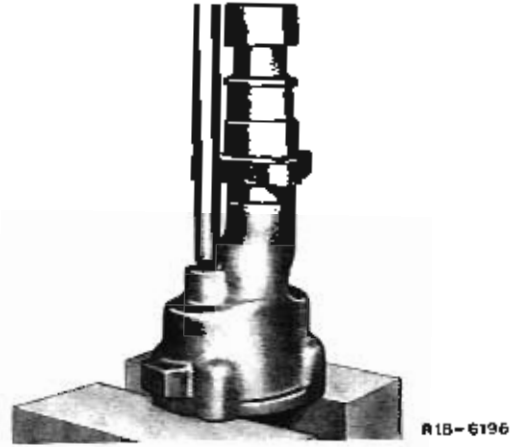


- 8 Press oil pump gear off input shaft.



18.13 Disassembling and Assembling Oil Pump

9 Press oil pump axle out of the housing.



Assembling

1 Press oil pump axle into the housing.



R18-6202

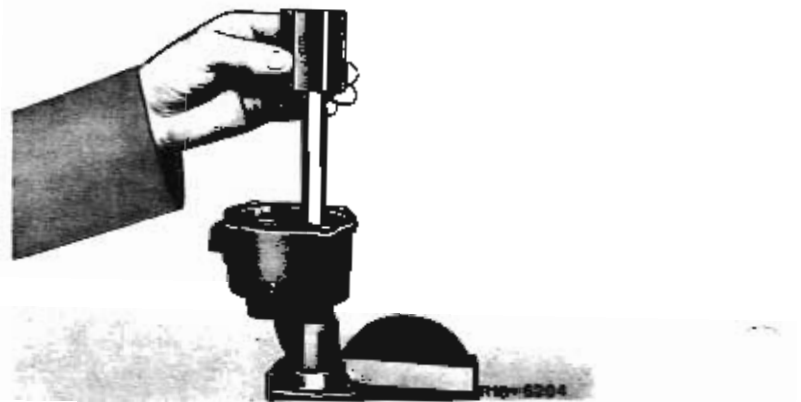
2 Press input shaft into the driving oil pump gear.

Note: Pay attention to installation height of the input shaft.



R18-6203

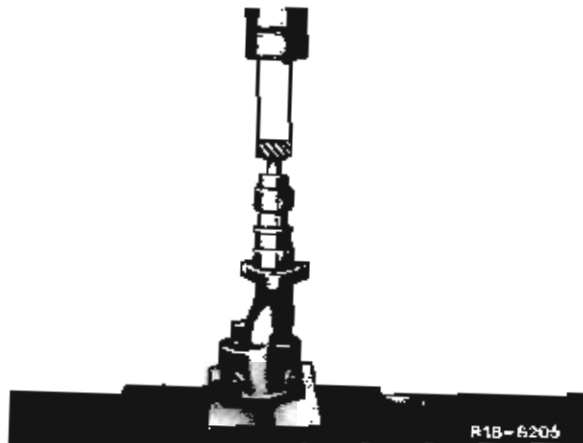
3 Insert input shaft together with gear in housing.



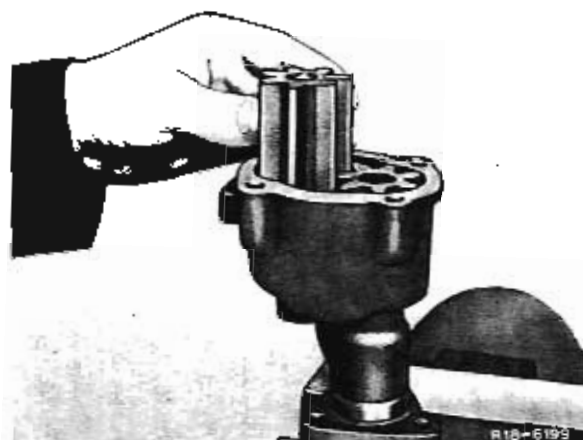
Disassembling and Assembling Oil Pump 18.13

4 Press helical gear onto input shaft.

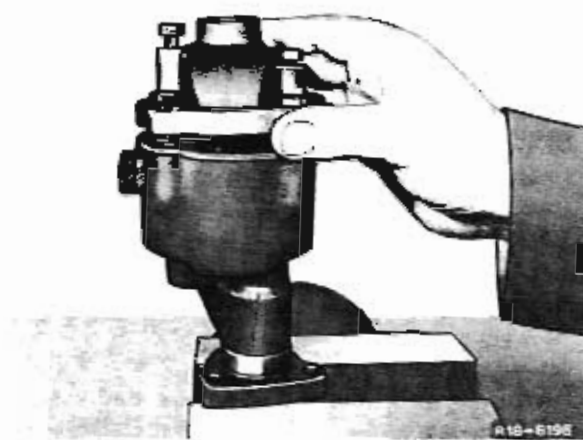
Note: Pay attention to end play of input shaft.



5 Fit oil pump gear onto oil pump axle.



6 Mount oil pump housing cover and torque with 35 Nm.

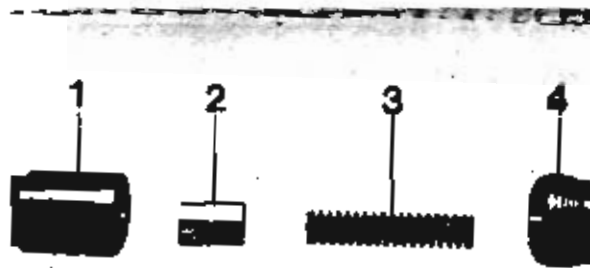


18.13 Disassembling and Assembling Oil Pump

7 Coat thread of oil overpressure valve with locking compound 002 989 93 71.

8 Insert oil overpressure valve into the housing cover in the sequence: valve seat (1), piston (2), spring (3) and screw plug (4) and tighten to 15 Nm with torque wrench.

9 Screw suction basket onto housing cover.



R18-8076

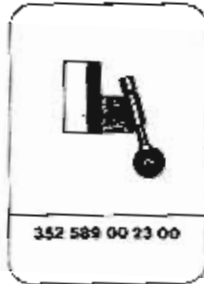
Removing and Installing Oil Injection Nozzle 18.13

Tightening Torques in Nm

Oil injection nozzle at cylinder crankcase

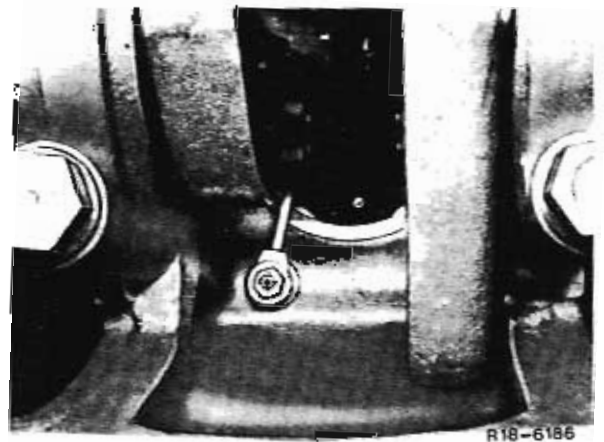
25 - 30

Special Tools



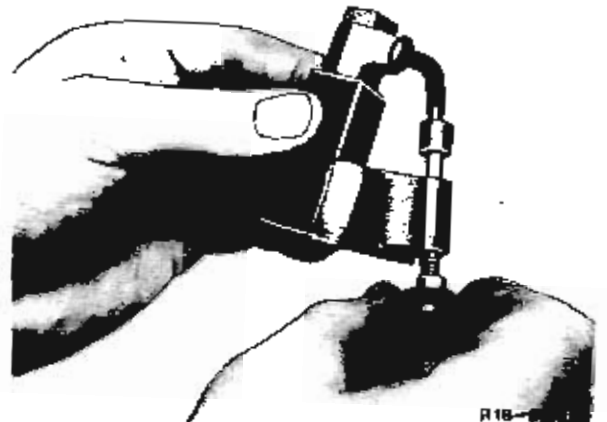
Removing

- 1 Remove oil injection nozzle from the cylinder crankcase.



Installing

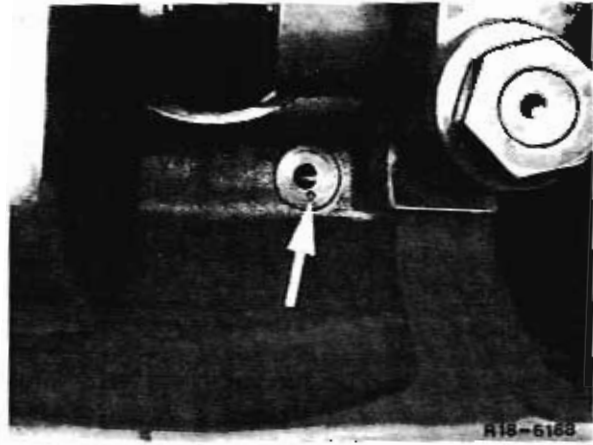
- 1 Check direction of injection of oil injection nozzle with special tool.



Test device 352 589 00 23 00

18.13 Removing and Installing Oil Injection Nozzle

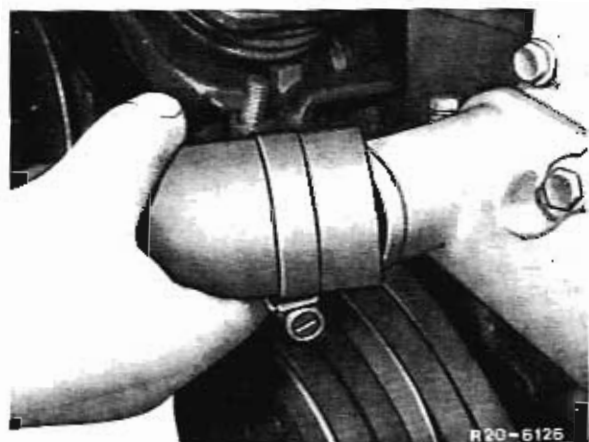
2 Insert oil injection nozzle into the cylinder crankcase so that the fit pin meshes into the hole in the cylinder crankcase (arrow) and tighten with 25 – 30 Nm.



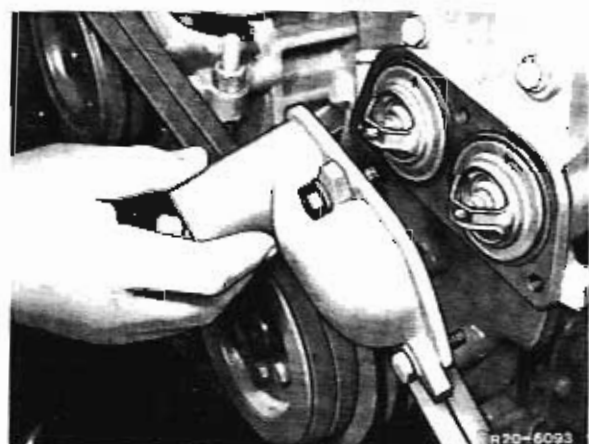
Removing and Installing Coolant Regulator 20.13

Removing

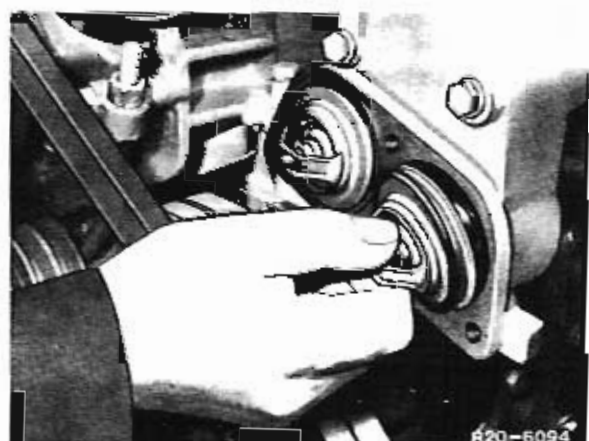
- 1 Drain coolant.
- 2 Remove coolant hose.



- 3 Unscrew cover and take off.



- 4 Take out coolant regulator together with seal.

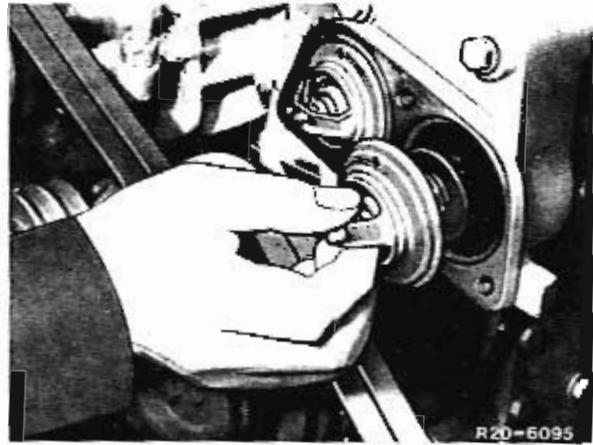


20.13 Removing and Installing Coolant Regulator

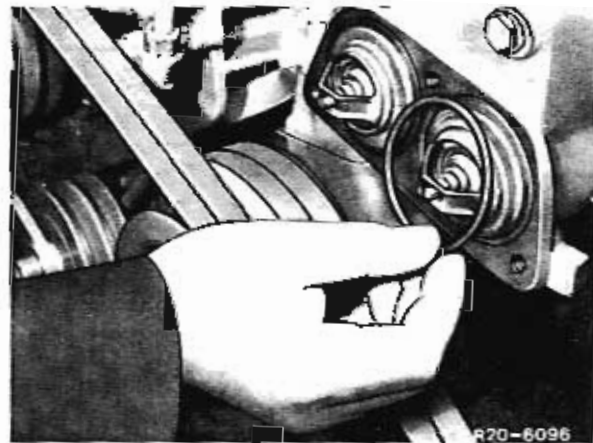
Installing

1 Insert coolant regulator into housing.

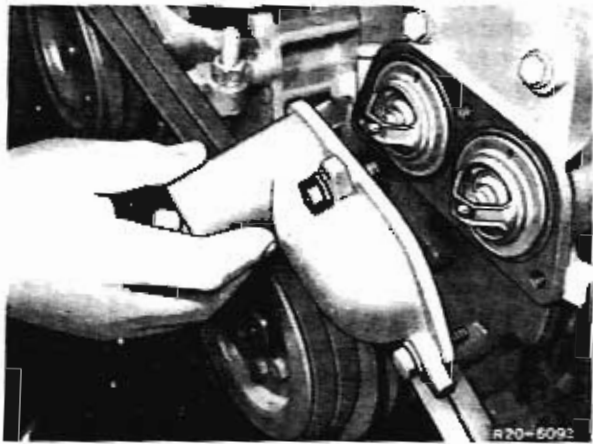
Note: Embossed arrow pointing vertically upward.



2 Insert seal.

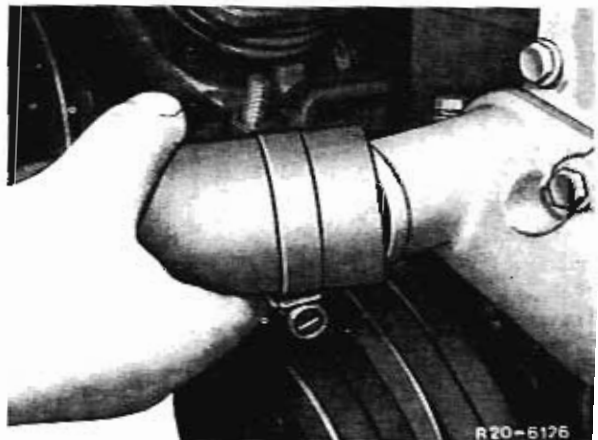


3 Screw on cover with 25 Nm.



4 Install coolant hose.

5 Top up coolant.



Data		Standard Version	Tropical Version
Start of opening at °C		83 ± 2	71 ± 2
Main valve	Stroke in mm	8	8
	Fully open at °C	95	85
Short-circuit valve	Stroke in mm	6 - 7,5	6 - 7,5
	Closed at °C	92	82
Leak water quantity of main valve at 1 bar and 20° C in l/min		0,67 - 1,17	0,67 - 1,17
Max. flow when main valve open and pressure of 1 bar in l/min		333	333

Testing Coolant Regulator

Fix the coolant regulator to a wire and suspend in the vessel with boiling water.

After 6-8 minutes, the main valve of the coolant regulator must be fully opened (approx. 8 mm).

Testing Start of Opening

1 Fix coolant regulator to a wire and suspend in a vessel filled with water.

2 Heat the water with a suitable source of heat.

Important: From approx. 8° below start of opening (depending on version) the heating-up rate must not exceed 1-2° C per minute.

Stir the water at the same time to achieve a uniform water temperature.

Note: On no account may a welding torch or blow lamp be used for heating the coolant regulator.



Degreasing

- 1 Completely drain coolant.
- 2 Remove thermostat insert and set heater lever to "warm".
- 3 Fill the cooling system with a 5% solution of water and a mildly alkaline cleaner such as P3-Croni (Supplier: Henkel) or Grisiron 7220 (Supplier: Farbwerke Hoechst) (50 g P3-Croni/1 litre water).
- 4 Warm up engine to approx. 80°C at medium speed and maintain this temperature for approx. 5 minutes. If necessary, the radiator may be covered.
- 5 Switch off engine and allow cooling system to cool to approx. 50°C.
- 6 Completely drain solution.
- 7 Immediately after this, fill cooling system twice with fresh water, warm up (approx. 5 minutes) and drain.

Deliming, Derusting

Note: Prior to deliming, the cooling system should always be degreased even if there is no visible oiling.

- 1 After the second flushing operation of degreasing, fill the cooling system with a 10% (100 g/l) solution of water and citric, tartaric or oxalic acid (available from the chemical trade), preference being given to the use of citric acid.
- 2 Warm up engine to approx. 80°C at medium speed and hold this temperature for approx. 10 minutes.
- 3 Switch off engine and allow to cool to approx. 50°C.
- 4 Completely drain delimiting solution.
- 5 Rinse out cooling system at least 3 times with fresh water, running the engine each time for 5 minutes.
- 6 Install thermostat insert with new seal.
- 7 Fill cooling system with specified coolant.

Note: Commercial products consisting of the acids mentioned above may also be used for delimiting and derusting.

Chromic acid or products containing chromate must not be used because of sewage disposal problems.

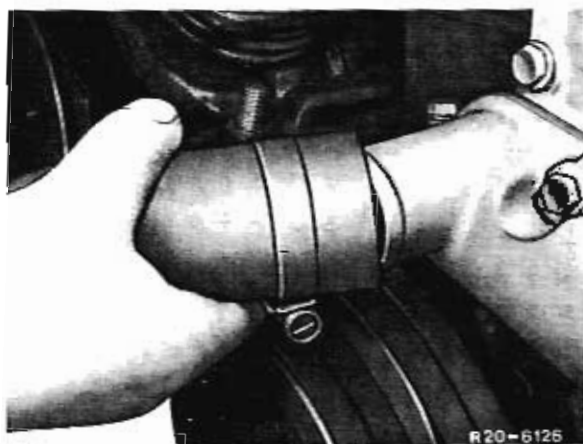
Removing and Installing Coolant Pump 20.13

Tightening Torques in Nm

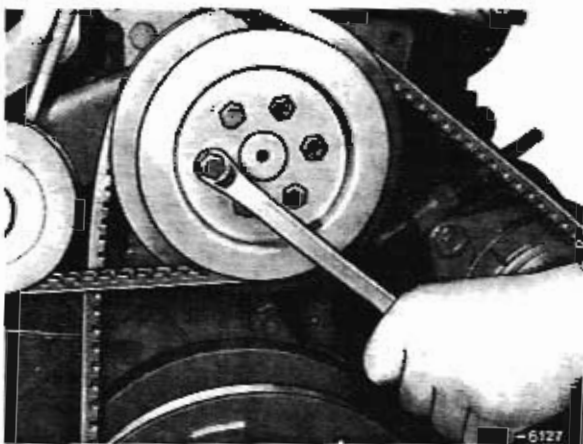
Coolant pump at cylinder crankcase	60
Belt pulley at coolant pump	33
Coolant regulator housing M 8	30

Removing

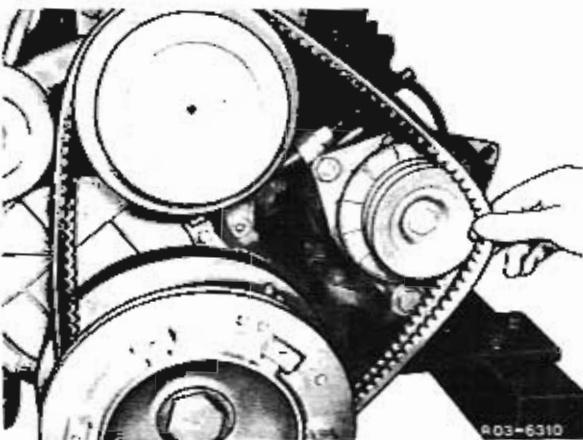
- 1 Drain coolant.
- 2 Take off coolant hose.



- 3 Slacken belt pulley.



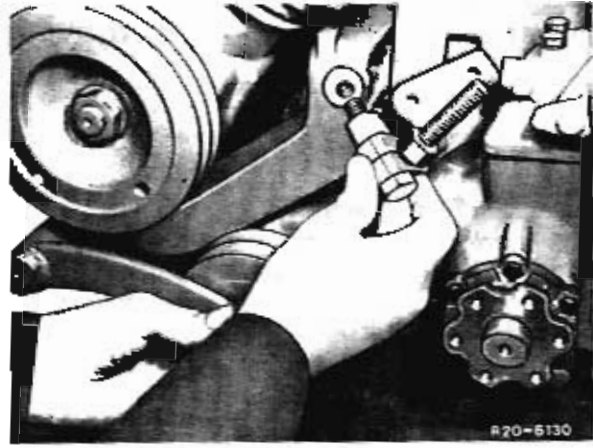
- 4 Take off V-belt.



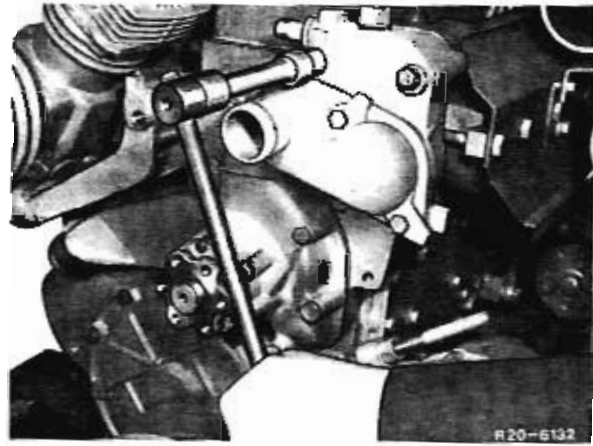
20.13 Removing and Installing Coolant Pump

5 Take off belt pulley.

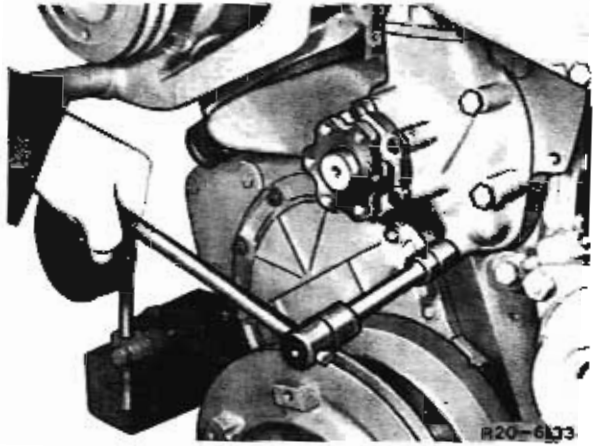
6 Remove clamping device for air compressor belt and bottom coolant hose.



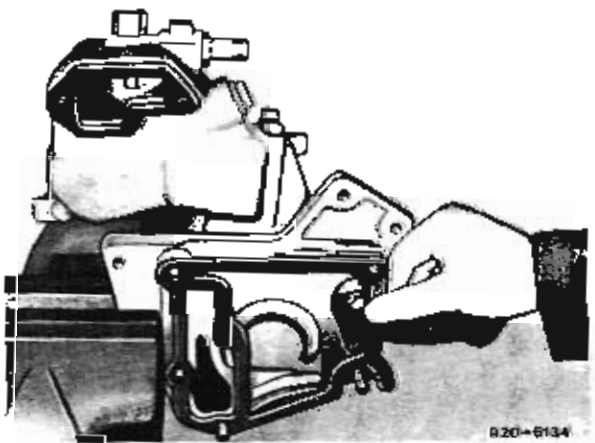
7 Slacken both bolts on the top coolant pipe.



8 Slacken coolant pump and remove.

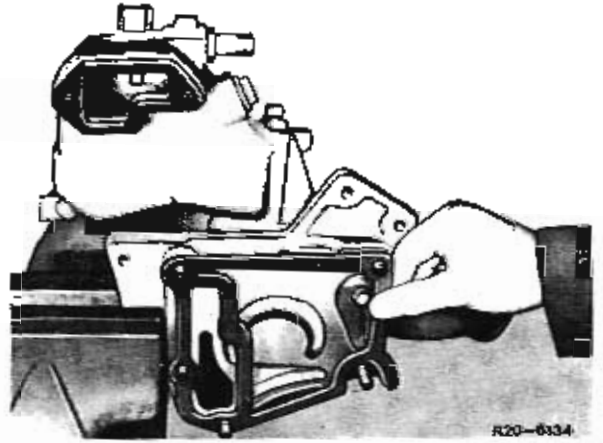


9 Take off gaskets and coolant regulator housing.

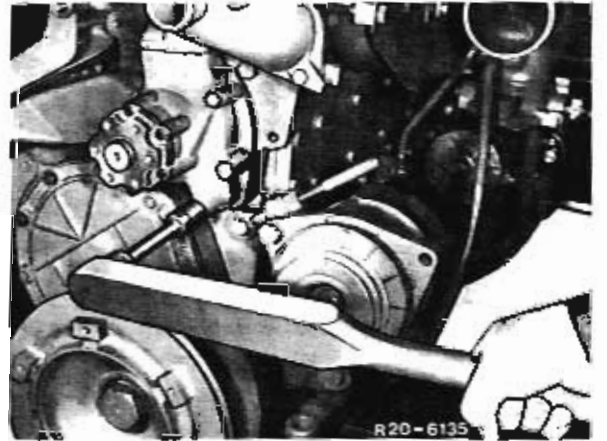


Installing

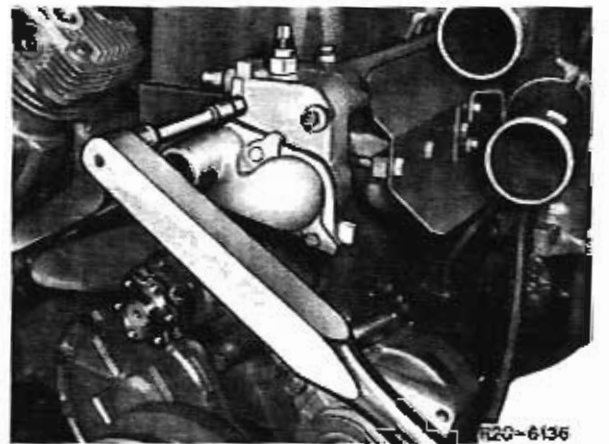
- 1 Fit coolant regulator housing with new gasket and slightly tighten bolts.
- 2 Fit new gaskets.



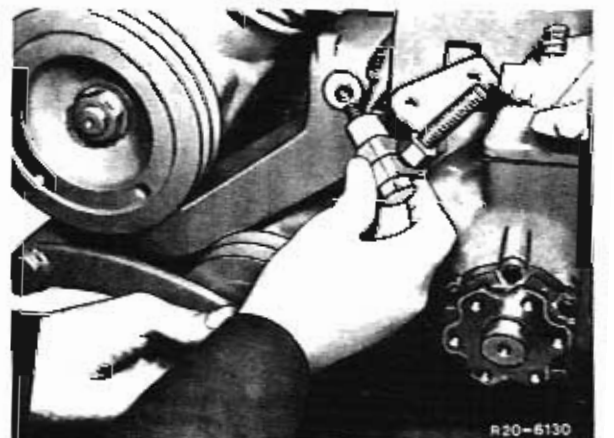
- 3 Fit coolant pump and torque with 60 Nm.



- 4 Tighten coolant regulator housing with new gasket to top coolant pipe as well as to pump housing with 30 Nm.



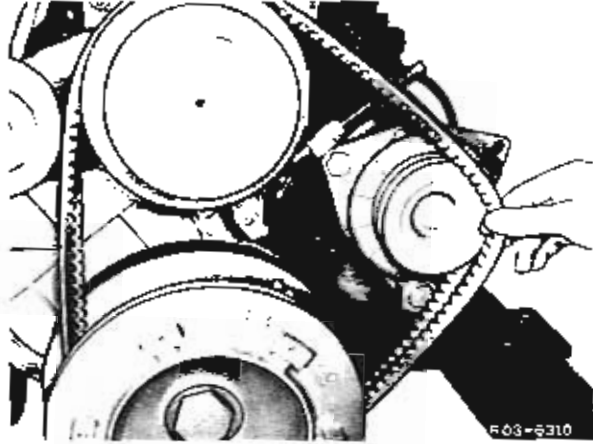
- 5 Install bottom coolant hose and tensioning device for air compressor belt.



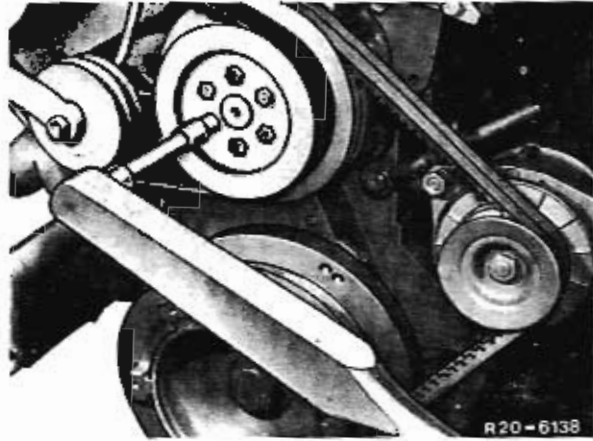
20.13 Removing and Installing Coolant Pump

6 Fit belt pulley.

7 Fit all V-belts.



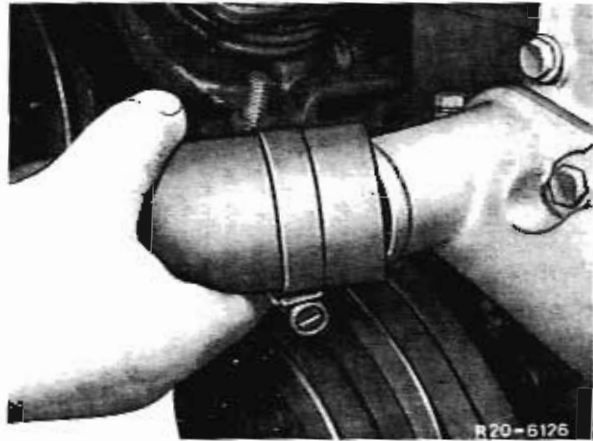
8 Tighten belt pulley with 33 Nm and tension V-belts.



9 Install coolant hose.

10 Pour in coolant.

Note: Add 1% refining agent the coolant all year round, i.e. even when antifreeze is used.

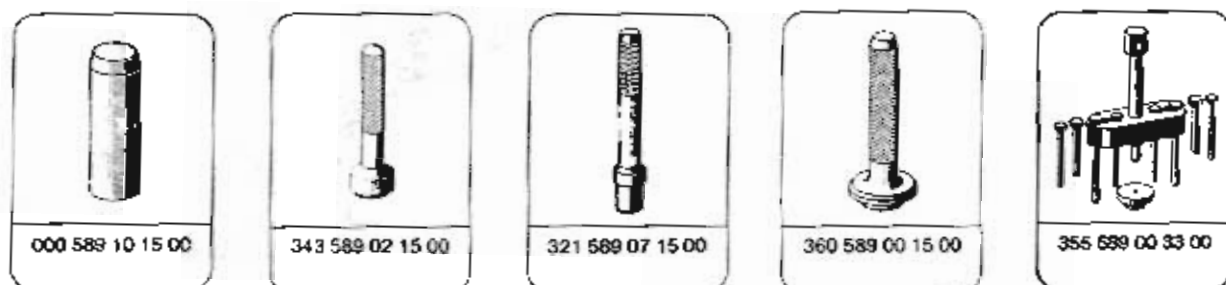


Disassembling and Assembling Coolant Pump 20.13

Data

		at impeller seat	15,039 15,028
Water pump shaft diameter	Bearing seat	large bearing	30,009 29,996
		small bearing	17,008 16,997
Shaft dia. for hub			29,054 29,041
Bore dia. in hub			29,021 29,000
Hub dia. for front seal			42,000 41,840
Shaft dia. for rear seal			17,008 16,997
Bore dia. in impeller			15,018 15,000
Pressing impeller onto coolant pump shaft		Flange face - impeller flush with housing flange	
Lubrication of coolant pump		Grease approx. 80 g	

Special Tools



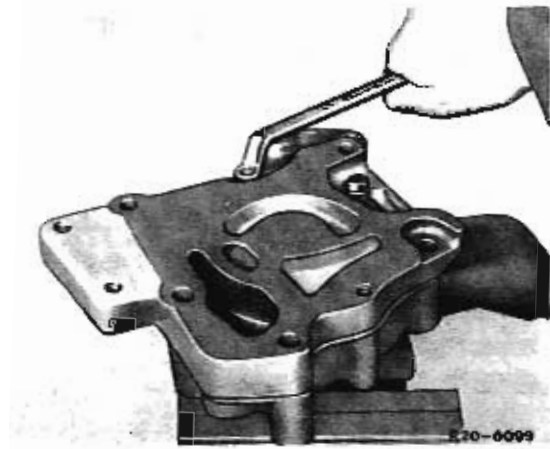
Disassembling

- 1 Unscrew coolant regulator housing from coolant pump.
- 2 Take off seal.



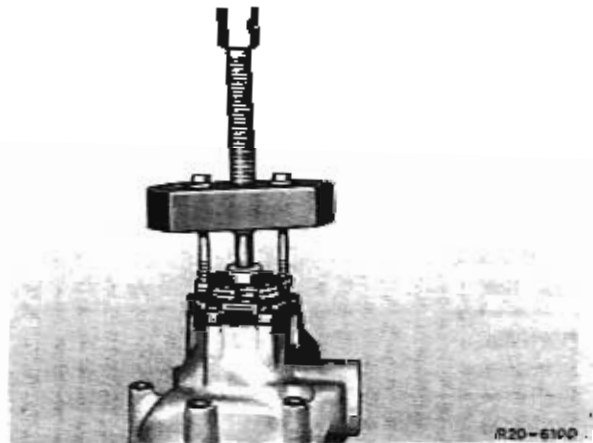
20.13 Disassembling and Assembling Coolant Pump

3 Unscrew closing cover of coolant pump.

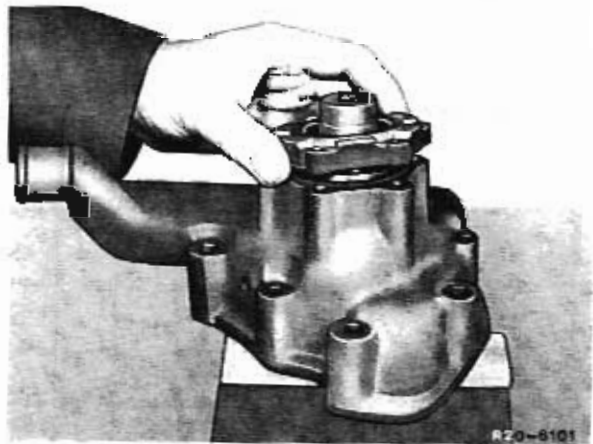


4 Pull off flange for belt pulley with special tool.

Puller 355 589 00 33 00

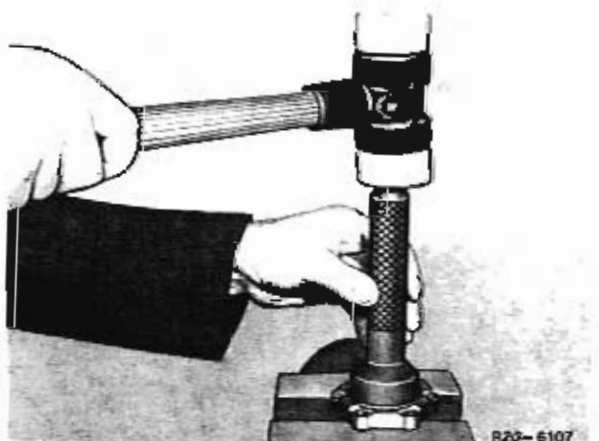


5 Unscrew seal holder and remove.

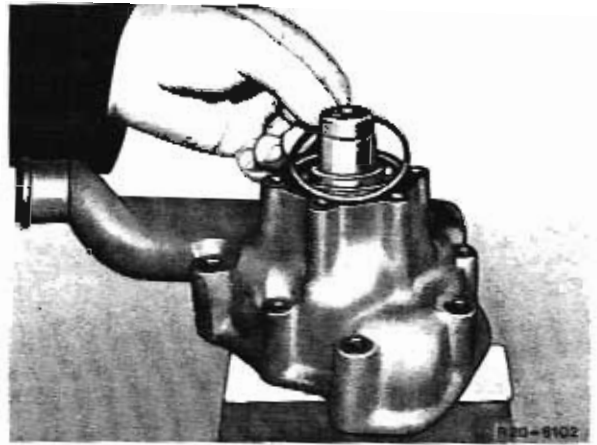


6 Remove radial seal from seal holder using special tool.

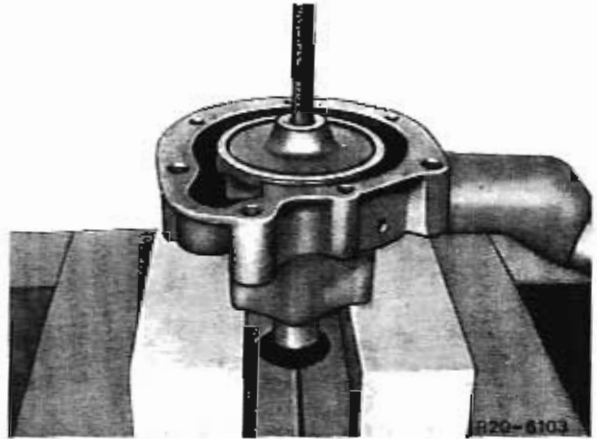
Drift 343 589 02 15 00



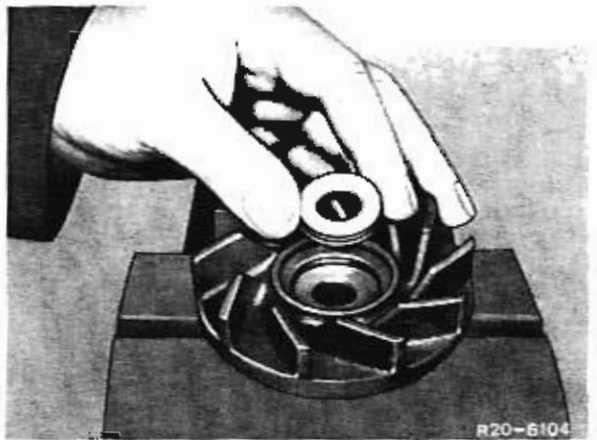
7 Take seal off coolant pump.



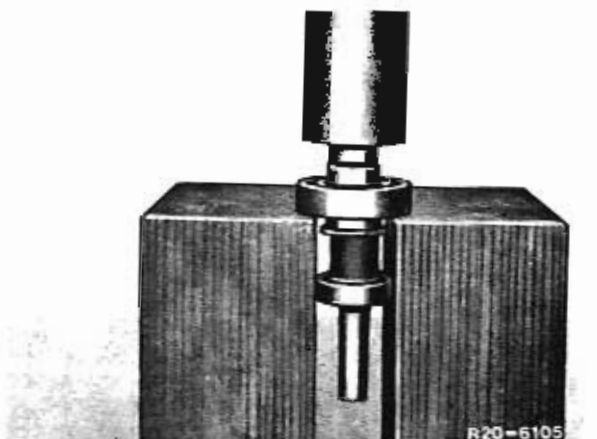
8 Press coolant pump shaft out of housing and remove impeller.



9 Take mechanical seal with angled cup seal out of impeller.

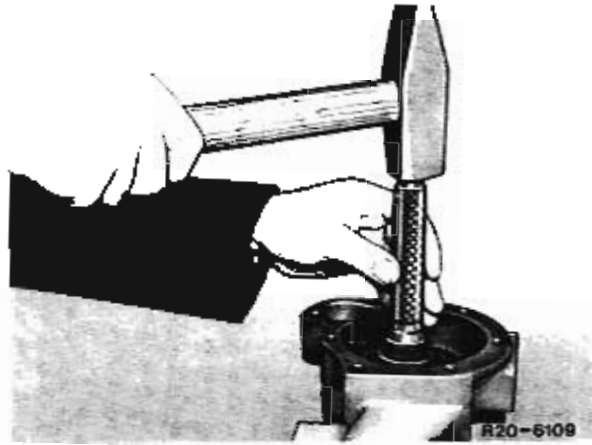


10 Press both deep-groove ball bearings off the shaft.



20.13 Disassembling and Assembling Coolant Pump

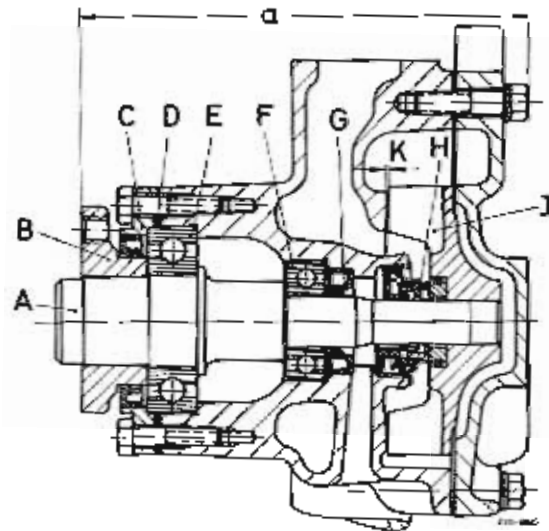
11 Remove mechanical seal and rear sealing ring from housing.



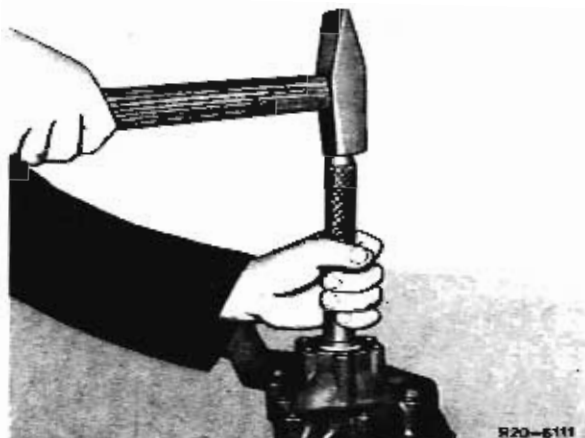
Assembling

Note: When installing an exchange engine, always ensure that the intermediate ring fitted between water pump and fan is of the same thickness as that fitted to the engine removed. If necessary, the intermediate ring must be replaced because the distance of 25 to 30 mm between radiator and fan must be maintained.

- a Inspection size 143.5 ± 0.5
- A Water pump shaft
- B Hub
- C Holder with front radial seal
- D O-ring
- E Large deep-groove ball bearing
- F Small deep-groove ball bearing
- G Rear radial seal
- H Mechanical seal
- J Impeller
- K Inspection size $0.5 \begin{smallmatrix} +0.5 \\ -0.2 \end{smallmatrix}$



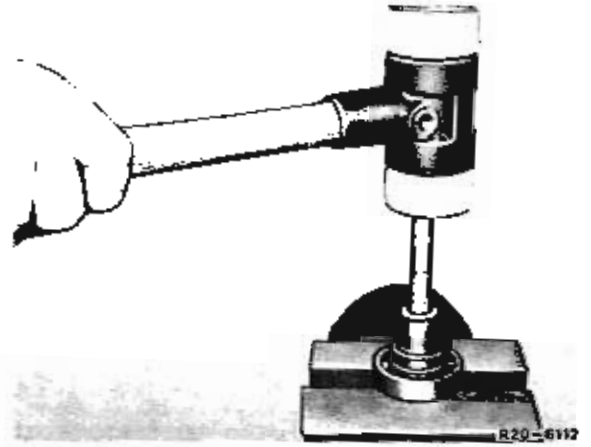
1 Insert the rear seal into the housing and knock in.



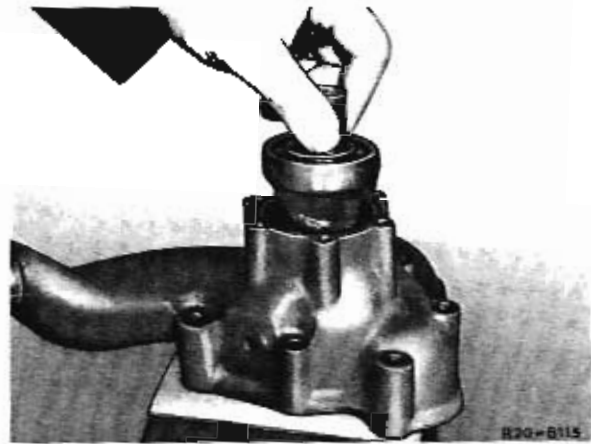
Drift 321 589 07 15 00

Disassembling and Assembling Coolant Pump 20.13

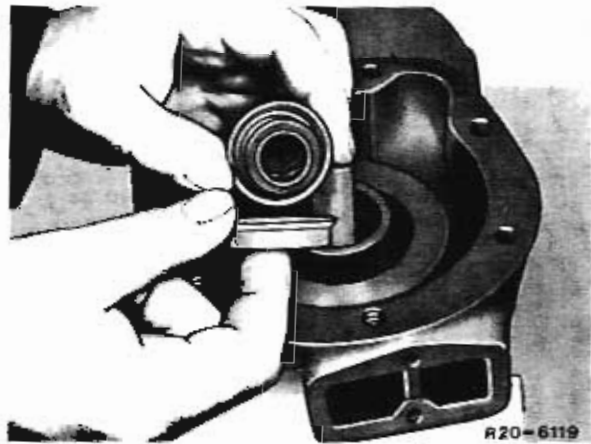
2 Pack both deep-groove ball bearings with grease and fit onto the pump shaft.



3 Pack the space between the two ball bearings with grease and insert pump shaft into the housing.



4 Take protection off the mechanical seal.

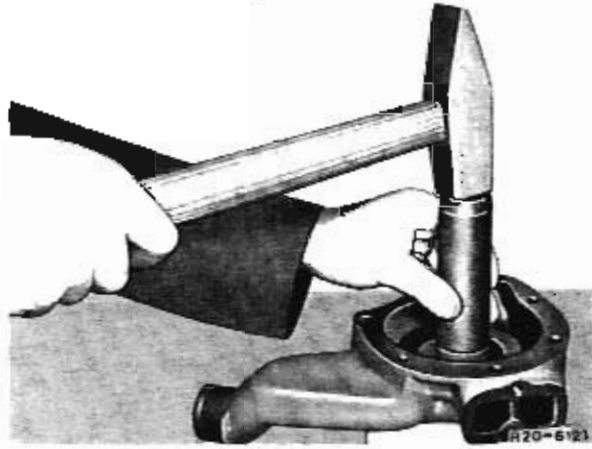


5 Insert the mechanical seal over the shaft into the pump housing.



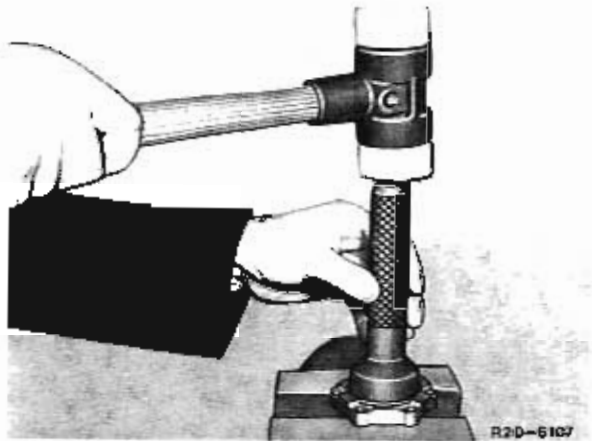
20.13 Disassembling and Assembling Coolant Pump

6 Fit mechanical seal.



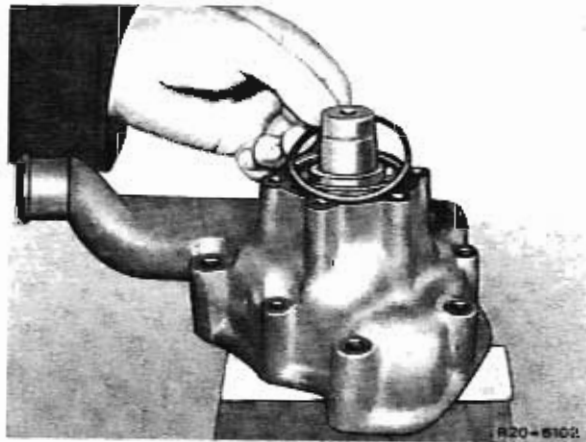
Drift 000 589 10 15 00

7 Install radial seal in seal holder.



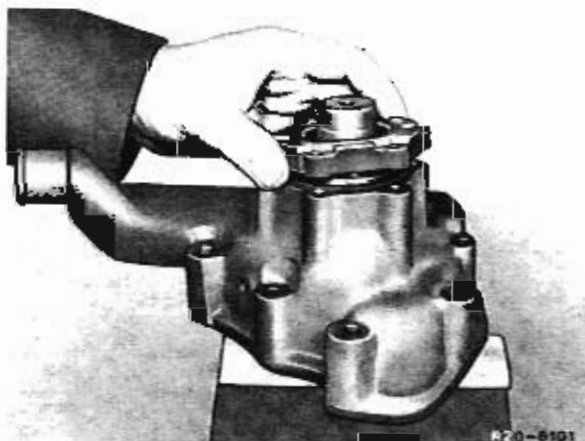
Drift 360 589 00 15 00

8 Fit seal to the coolant pump.



R20-6102

9 Install seal holder with shaft seal to the coolant pump.

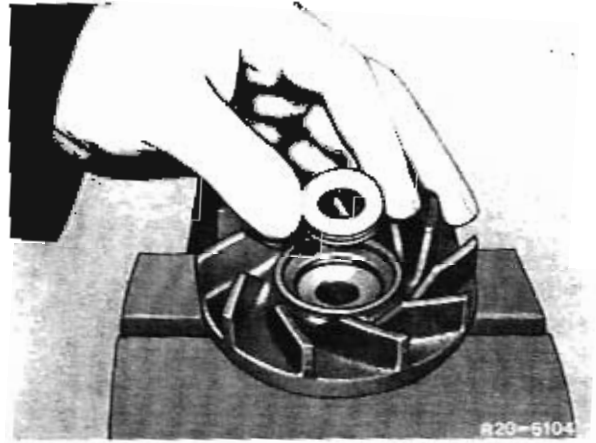


R20-6101

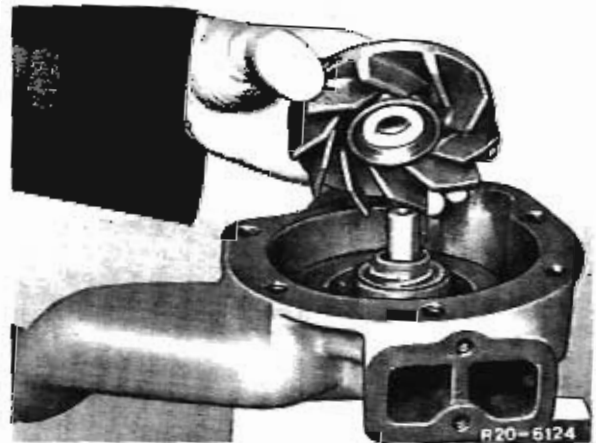
10 Clean floating ring of angled cup seal (3) of grease.

11 Insert angled cup seal with floating ring into the coolant pump wheel.

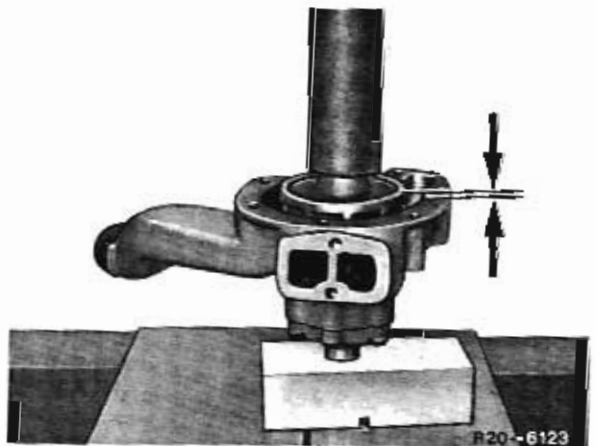
Note: Polished side up.



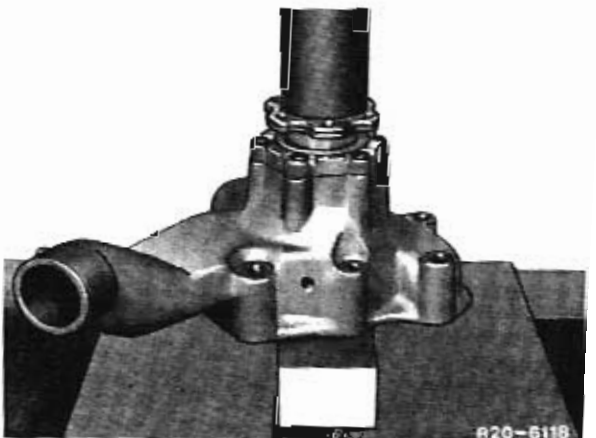
12 Fit coolant pump wheel with floating ring and cup seal over the shaft.



13 Press coolant pump wheel flush onto pump shaft
- max. difference $\pm 0,1$ mm.



14 Press on flange for belt pulley.

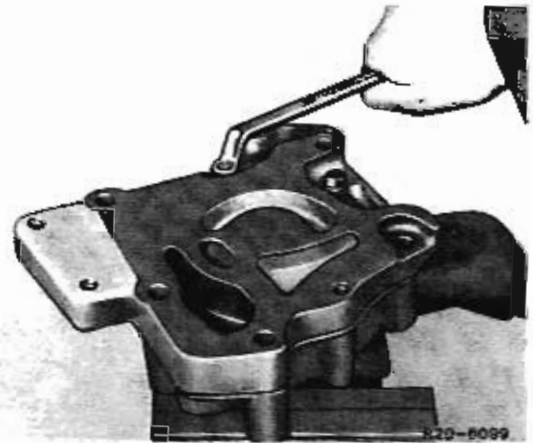
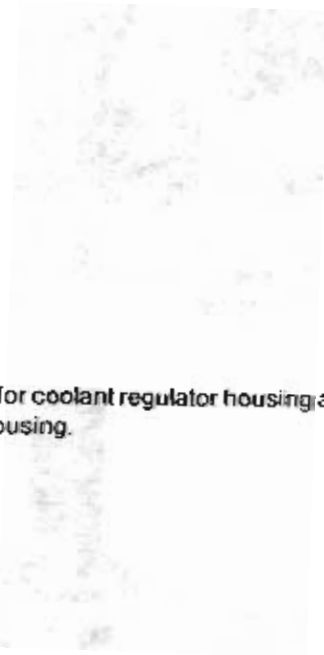


20.13 Disassembling and Assembling Coolant Pump

15 Fit gasket to coolant pump.



16 Install closing cover on the coolant pump.



17 Fit gasket for coolant regulator housing and install regulator housing.

