Engine
Crankshaft
Crankcase

Quick Data

Air-cooled - AFC

Tightening Torques

connecting rod	35 Nm (26 ft lb)
case halves	
small	20Nm (15 ft lb)
large	30 Nm (22 ft lb)
flywheel	110 Nm (81 ft lb)
torque converter	
drive plate	90 Nm (66 ft lb)

Crankshaft End Play

new: 0.07-0.13 mm (0.003-0.005 in.)
wear limit: 0.15 mm (0.006 in.)

Diesel

Crankshaft End Play

new: 0.07–0.17 mm (0.003–0.007 in)
wear limit: 0.37 mm (0.015 in)

Water-cooled

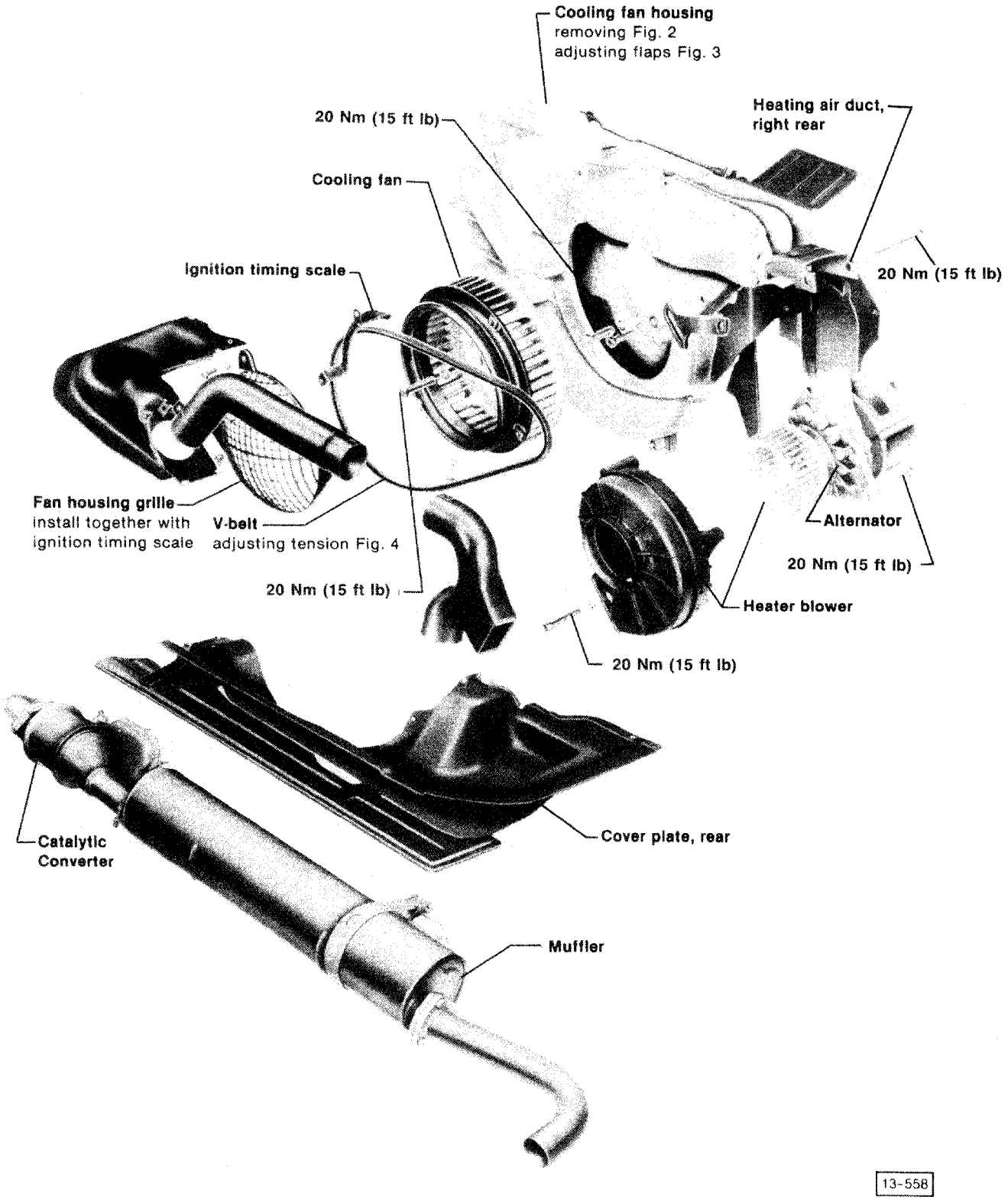
Tightening Torques

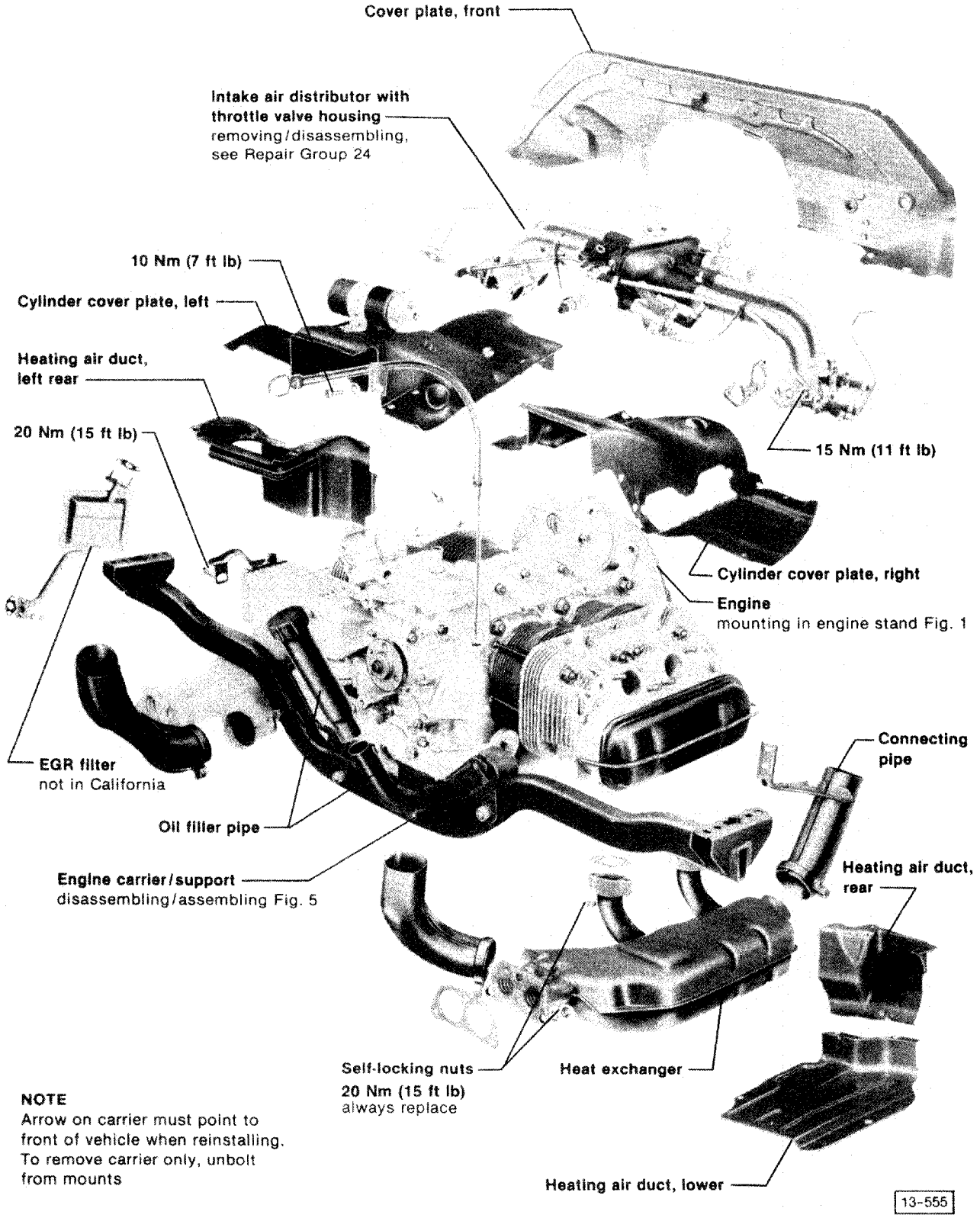
connecting rod	45 Nm (33 ft lb)
case halves	
small	20 Nm (15 ft lb)
large	30 Nm (22 ft lb)
flywheel	110 Nm (81 ft lb)
torque converter	
drive plate	90 Nm (66 ft lb)

Crankshaft End Play

new: 0.07-0.13 mm (0.003-0.005 in.)
wear limit: 0.15 mm (0.006 in.)

Index


Cooling fan housing
removing Fig. 2
adjusting flaps Fig. 3
20 Nm (15 ft lb)
Heating air duct, right rear
Cooling fan
Ignition timing scale
20 Nm (15 ft lb)
Fan housing grille
install together with ignition timing scale
V-belt
adjusting tension Fig. 4
Alternator
20 Nm (15 ft lb)
20 Nm (15 ft lb)
Heater blower
20 Nm (15 ft lb)
Catalytic Converter
Cover plate, rear
Muffler
13-558



NOTE
Arrow on carrier must point to front of vehicle when reinstalling. To remove carrier only, unbolt from mounts

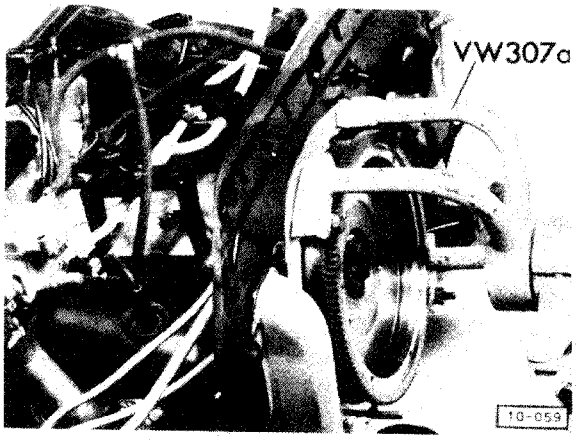


Fig. 1 Engine, mounting in engine stand

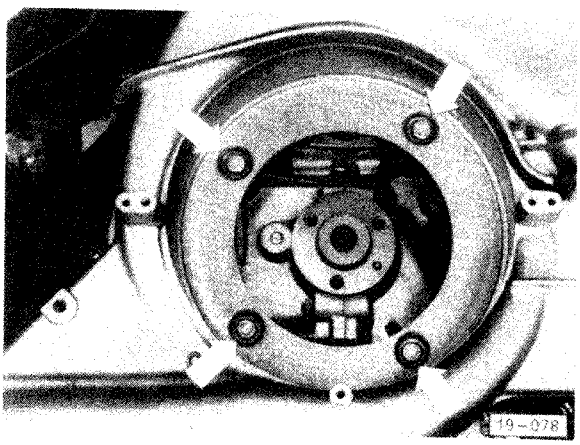


Fig. 2 Cooling fan housing, removing

— remove bolts (arrows) and detach

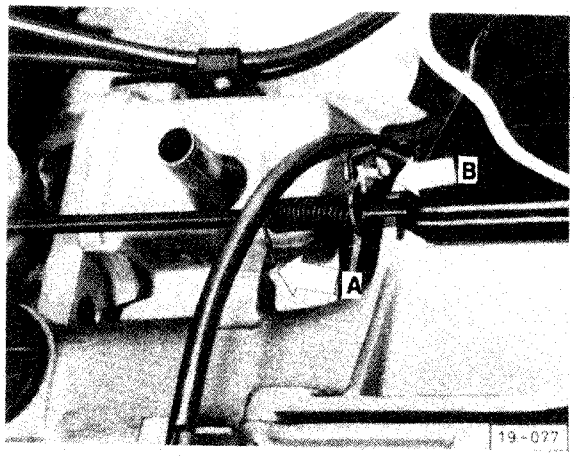


Fig. 3 Cooling air flaps, adjusting

- bent ends of return spring must rest on boss of cooling fan housing (arrow **A**) and on cable guide (arrow **B**)

— press flaps into closed position and tighten cable clamp

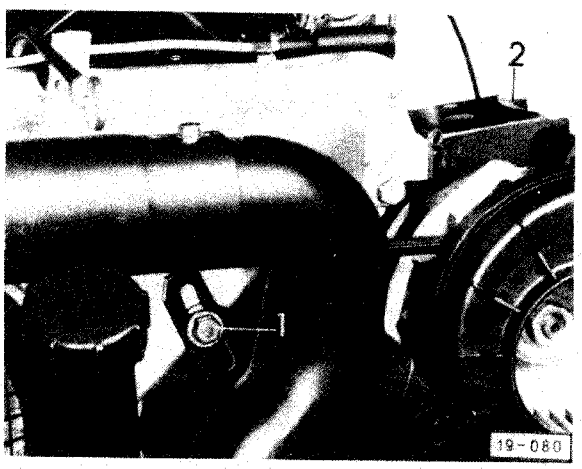


Fig. 4 Alternator V-belt, adjusting

— after loosening bolts **1** and **2**, move alternator to tension V-belt
— tighten bolts **1** and **2** to 20 Nm (15 ft lb)
— check belt tension by pressing belt firmly in center
- deflection: approx. 10–15 mm (3/8–9/16 in.)

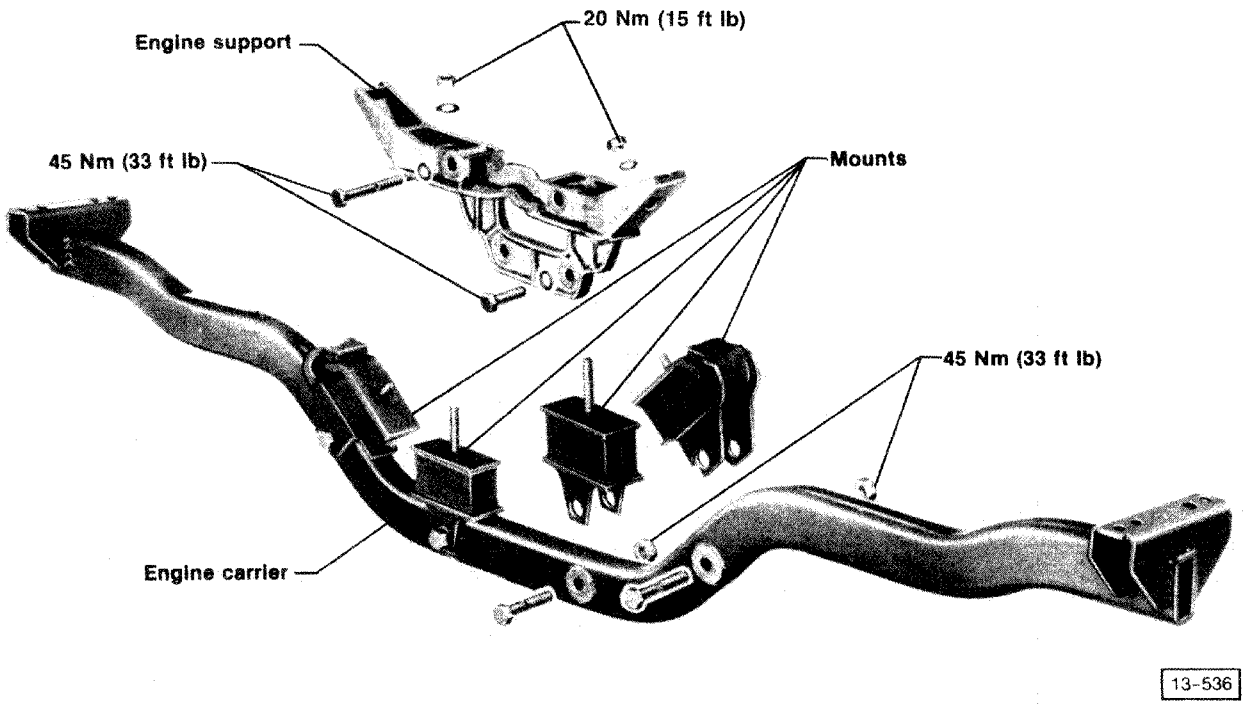
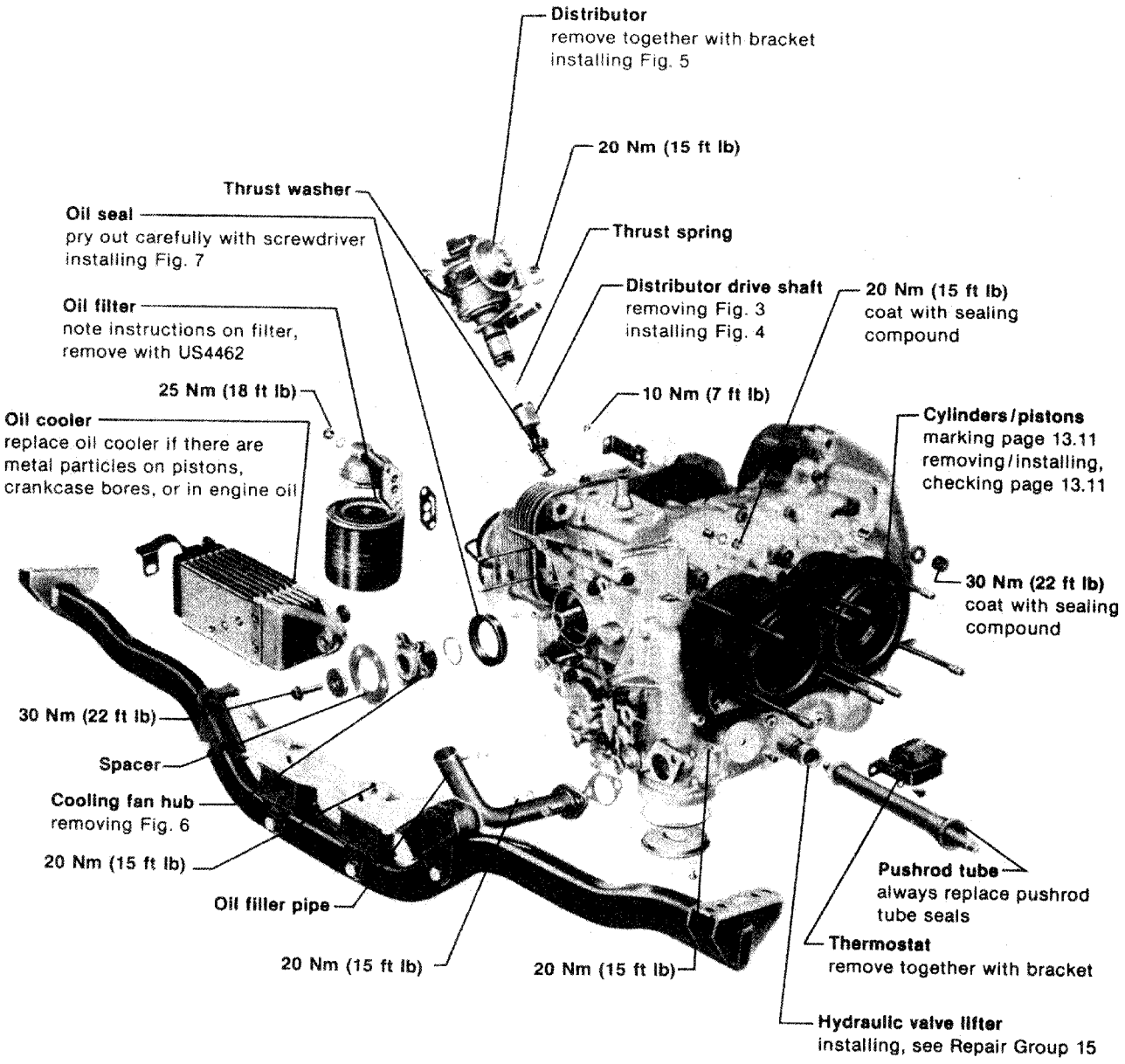


Fig. 5 Engine carrier/support, disassembling/assembling


Distributor
remove together with bracket
installing Fig. 5
20 Nm (15 ft lb)
Thrust washer
Oil seal
pry out carefully with screwdriver
installing Fig. 7
Thrust spring
Distributor drive shaft
removing Fig. 3
installing Fig. 4
20 Nm (15 ft lb)
coat with sealing
compound
Oil filter
note instructions on filter,
remove with US4462
25 Nm (18 ft lb)
10 Nm (7 ft lb)
Oil cooler
replace oil cooler if there are
metal particles on pistons,
crankcase bores, or in engine oil
Cylinders/pistons
marking page 13.11
removing/installing,
checking page 13.11
30 Nm (22 ft lb)
coat with sealing
compound
30 Nm (22 ft lb)
Spacer
Cooling fan hub
removing Fig. 6
20 Nm (15 ft lb)
Oil filler pipe
20 Nm (15 ft lb)
20 Nm (15 ft lb)
Pushrod tube
always replace pushrod
tube seals
Thermostat
remove together with bracket
Hydraulic valve lifter
installing, see Repair Group 15
13-559

WARNING

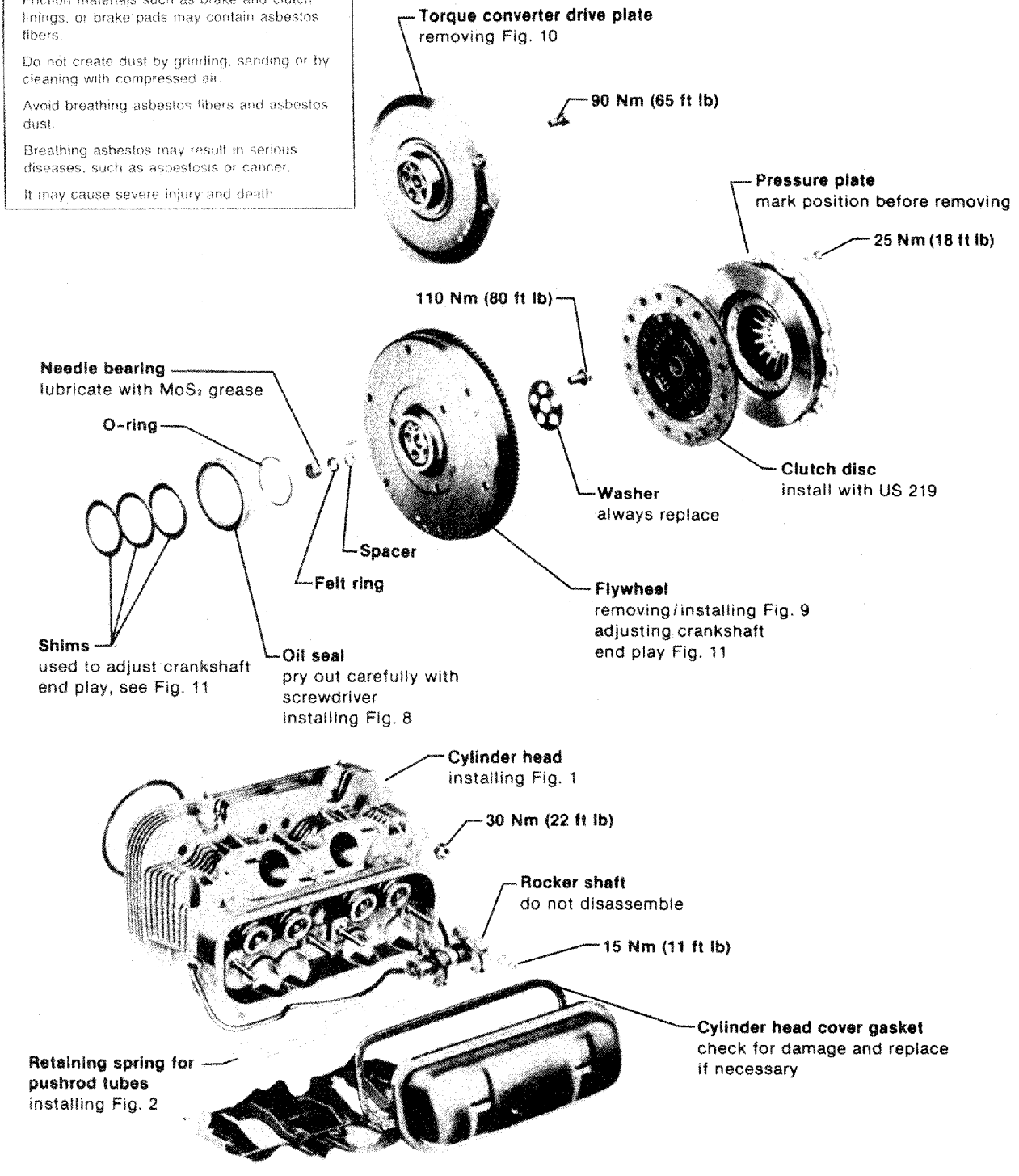
Friction materials such as brake and clutch linings, or brake pads may contain asbestos fibers.

Do not create dust by grinding, sanding or by cleaning with compressed air.

Avoid breathing asbestos fibers and asbestos dust.

Breathing asbestos may result in serious diseases, such as asbestosis or cancer.

It may cause severe injury and death.



13-559

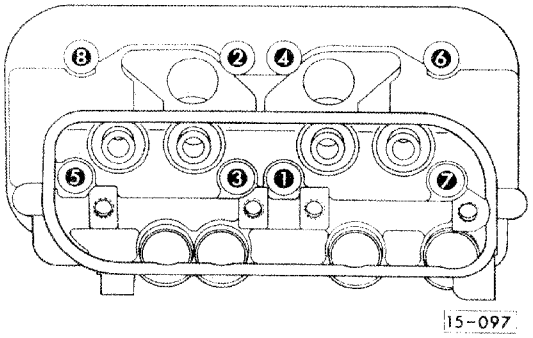


Fig. 1 Cylinder head, installing

— hand tighten nuts to align components, then torque to 30 Nm (22 ft lb) in sequence

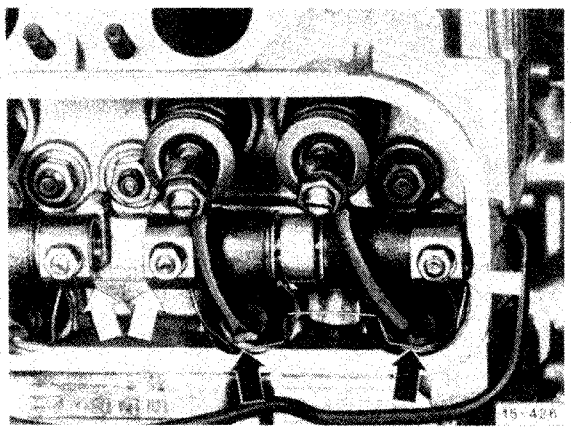


Fig. 2 Retaining spring for push rod tubes, installing

- spring must rest on tubes (black arrows) and engage supports (white arrows)

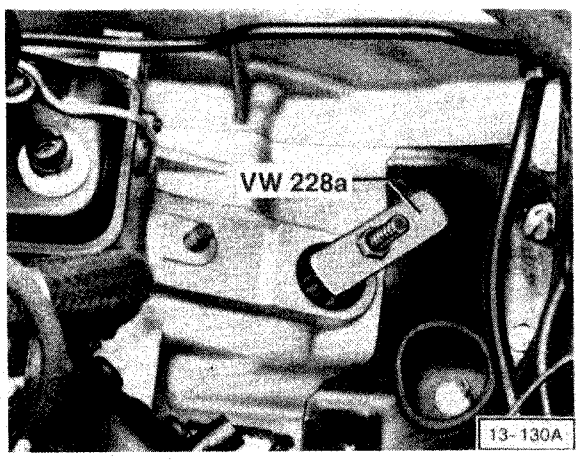


Fig. 3 Distributor drive, removing

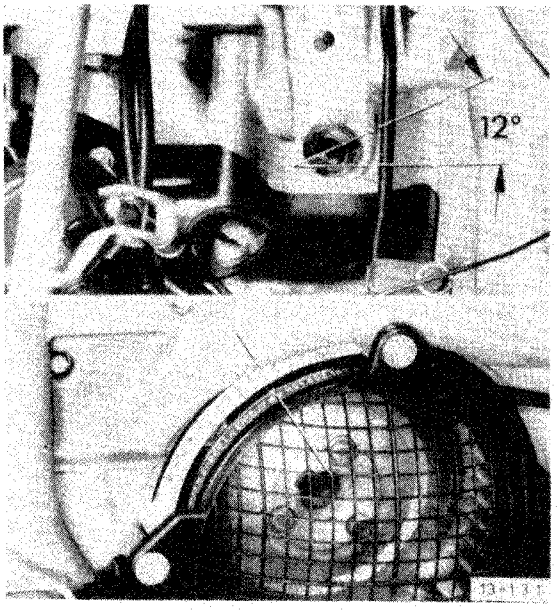


Fig. 4 Distributor drive, installing

— set crankshaft to TDC on cylinder No. 1
— install drive shaft so that offset slot is at an angle of about 12° to engine centerline (small segment to coil side)

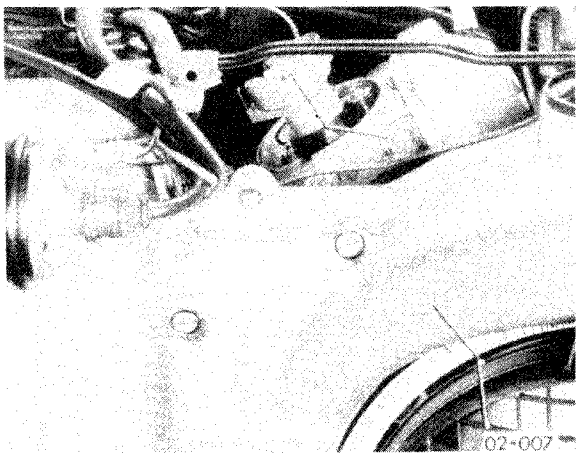


Fig. 5 Distributor, installing

— set cylinder No. 1 to TDC
— turn rotor until mark on rotor is in line with mark on distributor housing (cylinder No. 1)

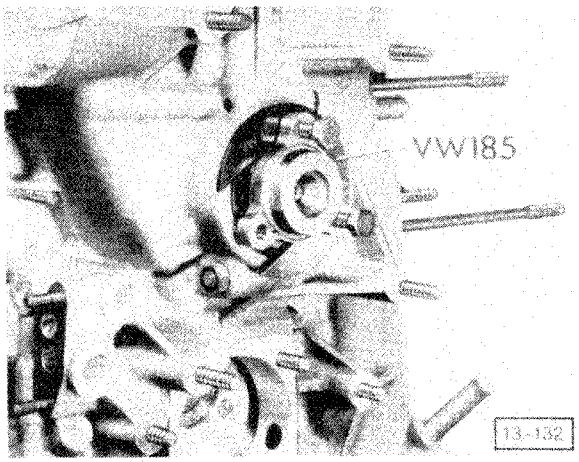


Fig. 6 Cooling fan hub, removing

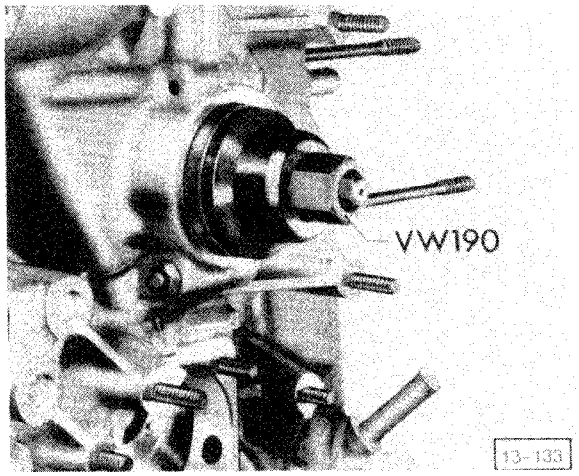


Fig. 7 Crankshaft oil seal, cooling fan side, installing

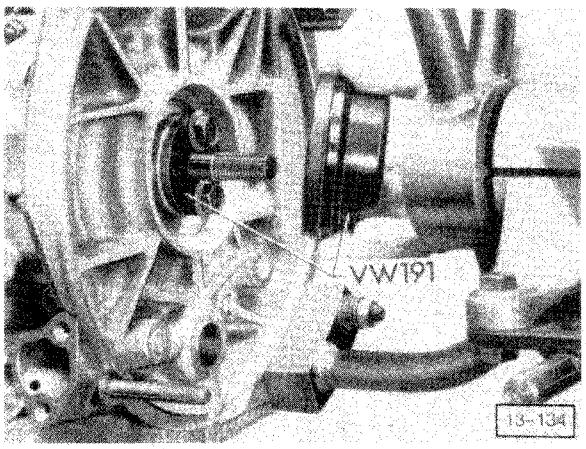


Fig. 8 Crankshaft oil seal, flywheel side, installing

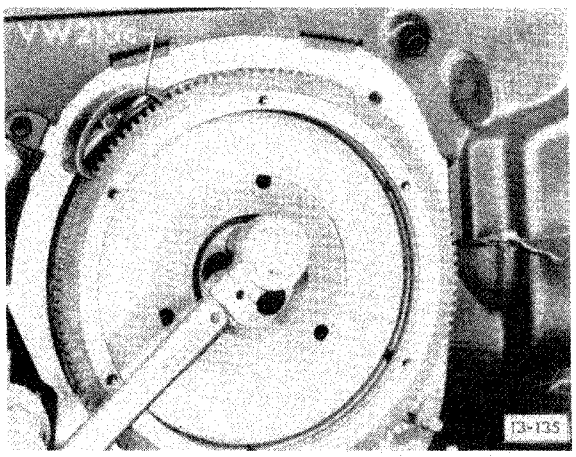


Fig. 9 Flywheel, removing/installing

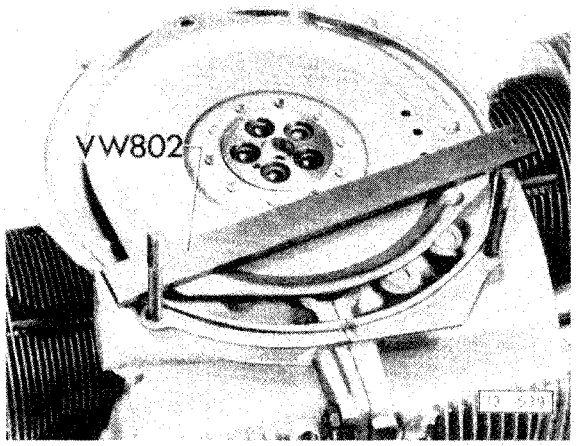


Fig. 10 Torque converter drive plate, removing

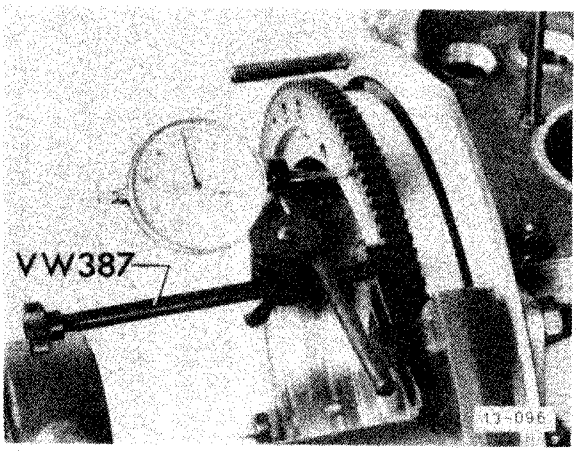


Fig. 11 Crankshaft end play, checking/adjusting

— check crankshaft end play and adjust if necessary
  • new: 0.07-0.13 mm (0.003-0.005 in.)
  • wear limit: 0.15 mm (0.006 in.)

if **NO**, proceed as follows:

— install flywheel with **2** shims but **without** O-ring and crankshaft oil seal
— mount dial indicator with bracket on crankcase
— move crankshaft in and out and measure movement (crankshaft end play)
— determine thickness of **3rd** shim

Example

dial indicator reading	0.44 mm (0.017 in.)
specified end play	– 0.10 mm (0.004 in.)
thickness of **3rd** shim	0.34 mm (0.013 in.)

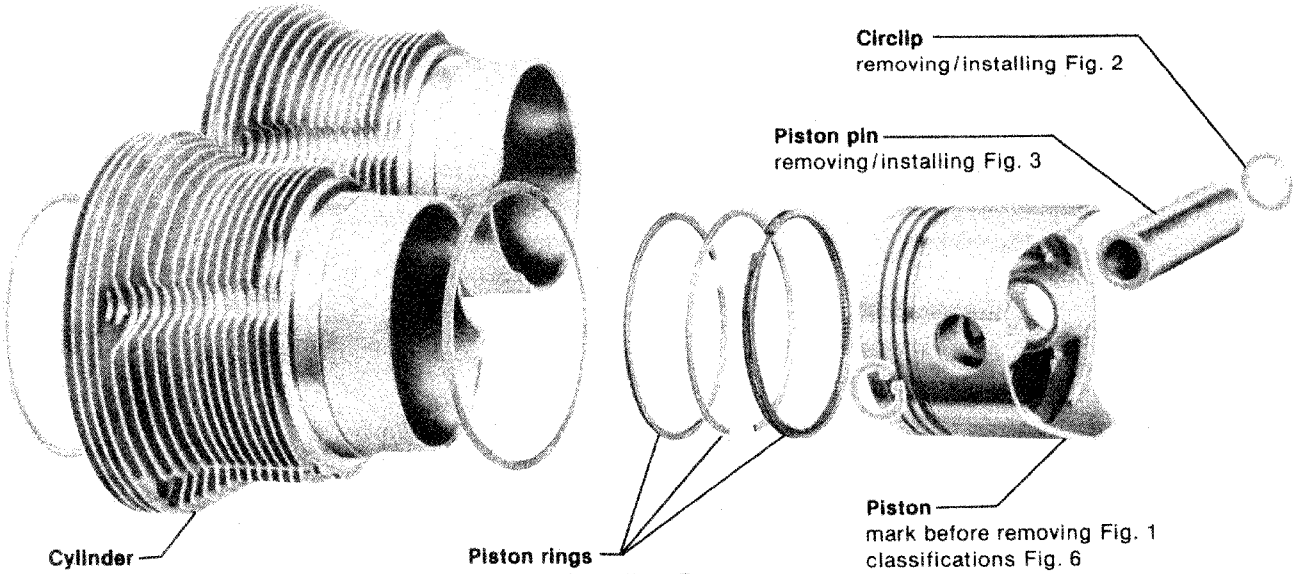
Note

Thickness of shim is etched on shim. Always recheck with micrometer

> **CAUTION**
>
> Always intall **three** shims to obtain correct crankshaft end play

— remove flywheel
— install O-ring, crankshaft oil seal and felt ring
— install all three shims

— install flywheel
— tighten bolts to 110 Nm (80 ft lb)
— recheck crankshaft end play



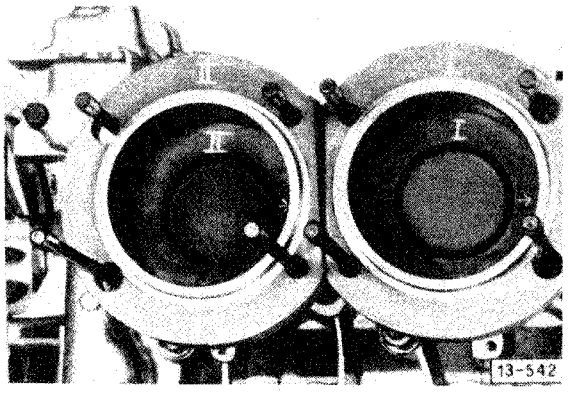


Fig. 1 Pistons/cylinders, marking

- arrow points to flywheel

Note

Before removing, mark matching numbers on pistons and cylinders

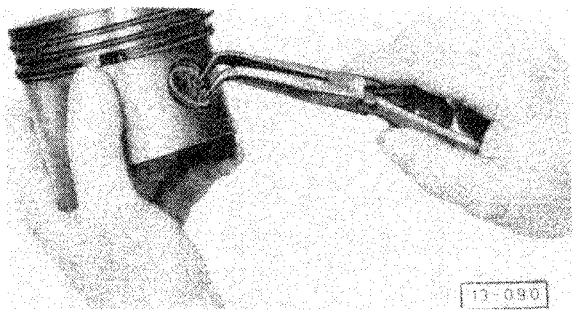


Fig. 2 Circlip, removing/installing

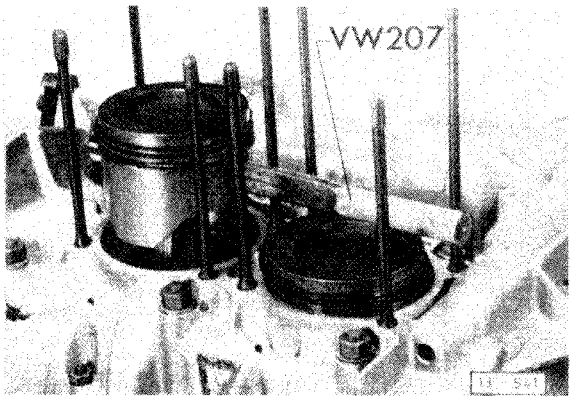


Fig. 3 Piston pin, removing/installing

- if pin is too tight in piston, heat piston to approx. 60°C (140°F)

Fig. 4 Piston rings, removing/installing

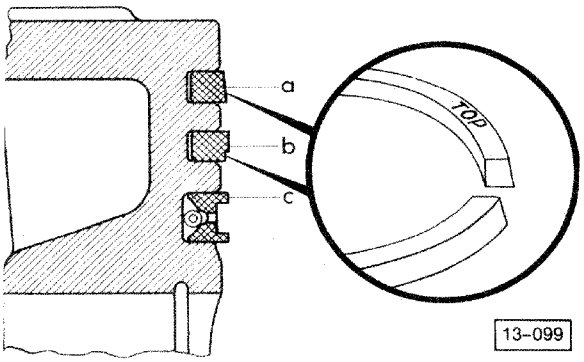


Fig. 5 Piston rings, positioning

- **TOP** mark on piston rings must face top of piston
  a = top ring
  b = middle ring
  c = oil scraper ring

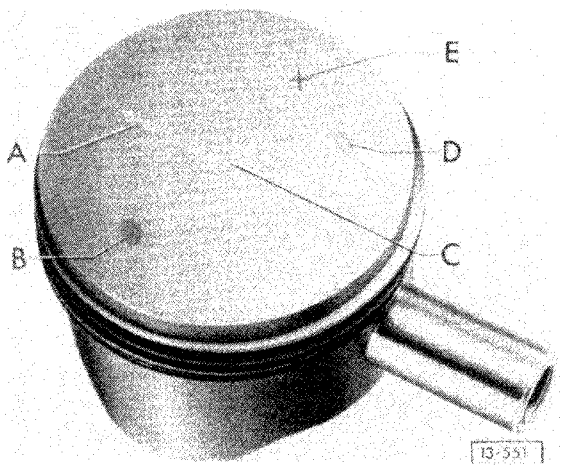


Fig. 6 Piston, classifications

A = arrow must point toward flywheel when installing
B and **C** = piston diameter in mm (blue or pink paint dot indicates matching size)
D and **E** = weight group
– (brown) = 474 – 482 grams
+ (gray) = 482 – 490 grams

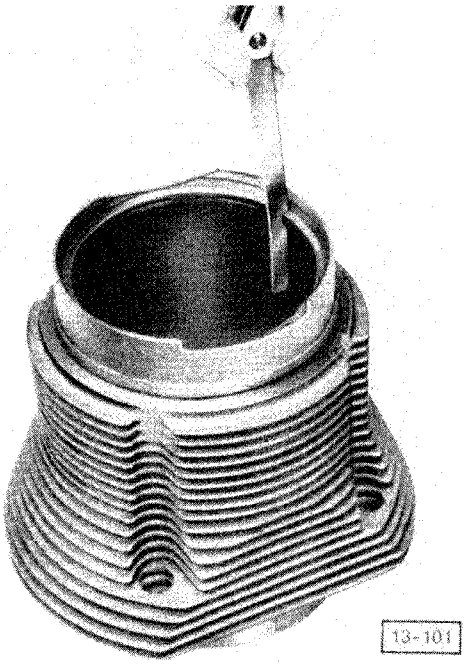


Fig. 7 Piston ring end gap, checking

— push ring into cylinder about 4-5 mm (approx. 3/16 in.)

	ring end gap	wear limit
upper/middle ring:	0.40-0.65 mm (0.016-0.026 in.)	0.90 mm (0.035 in.)
oil scraper ring:	0.25-0.40 mm (0.010-0.016 in.)	0.95 mm (0.037 in.)

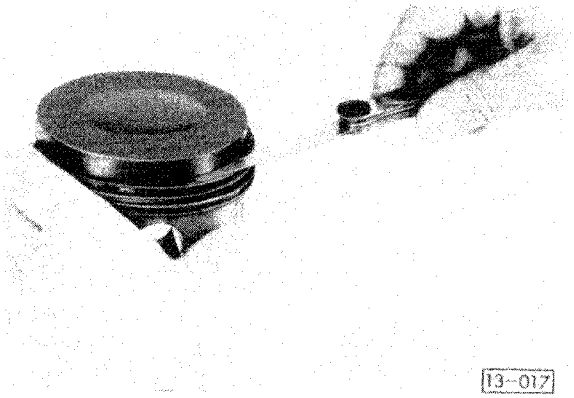


Fig. 8 Piston ring side clearance, checking

	clearance	wear limit
upper/middle ring:	0.04-0.07 mm (0.002-0.003 in.)	0.12 mm (0.005 in.)
oil scraper ring:	0.02-0.05 mm (0.001-0.002 in.)	0.10 mm (0.004 in.)

CAUTION

If measurement of piston/cylinder shows that clearance is close to 0.2 mm (0.008 in.), piston/cylinder should be replaced by set of same size group (standard or oversize).
Weight difference of pistons must not exceed 10 grams.
If cylinder of damaged piston shows no wear, install new piston of appropriate matching size.
Cylinders/pistons must be of same size group.

Cylinder bore/Piston diameter

	Cylinder bore (mm)	Piston dia. (mm)
Standard (94.0 mm)		
blue	93.992-94.008	93.97
pink	94.002-94.018	93.98
1st oversize (94.5 mm)		
blue	94.492-94.508	94.47
pink	94.502-94.518	94.48
2nd oversize (95.0 mm)		
blue	94.992-95.008	94.97
pink	95.002-95.018	94.98

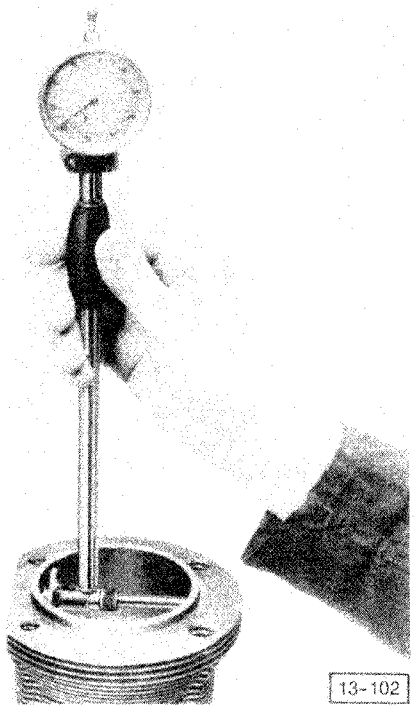


Fig. 9 Cylinder, checking for wear

— measure 10-16 mm (3/8-5/8 in.) from top

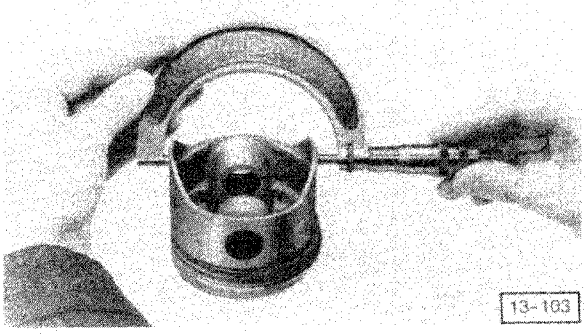


Fig. 10 Piston, checking diameter/wear

— measure at bottom of skirt approx. 16 mm (3/8 in.) from edge (diameter stamped in top of piston)
- clearance new: 0.02-0.05 mm (0.001-0.002 in.)
- wear limit: 0.2 mm (0.008 in.)

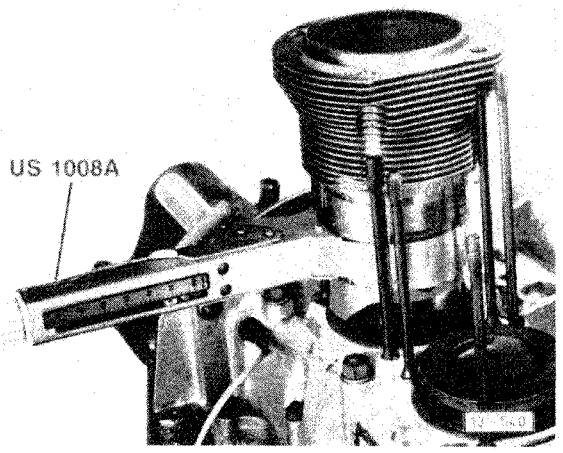
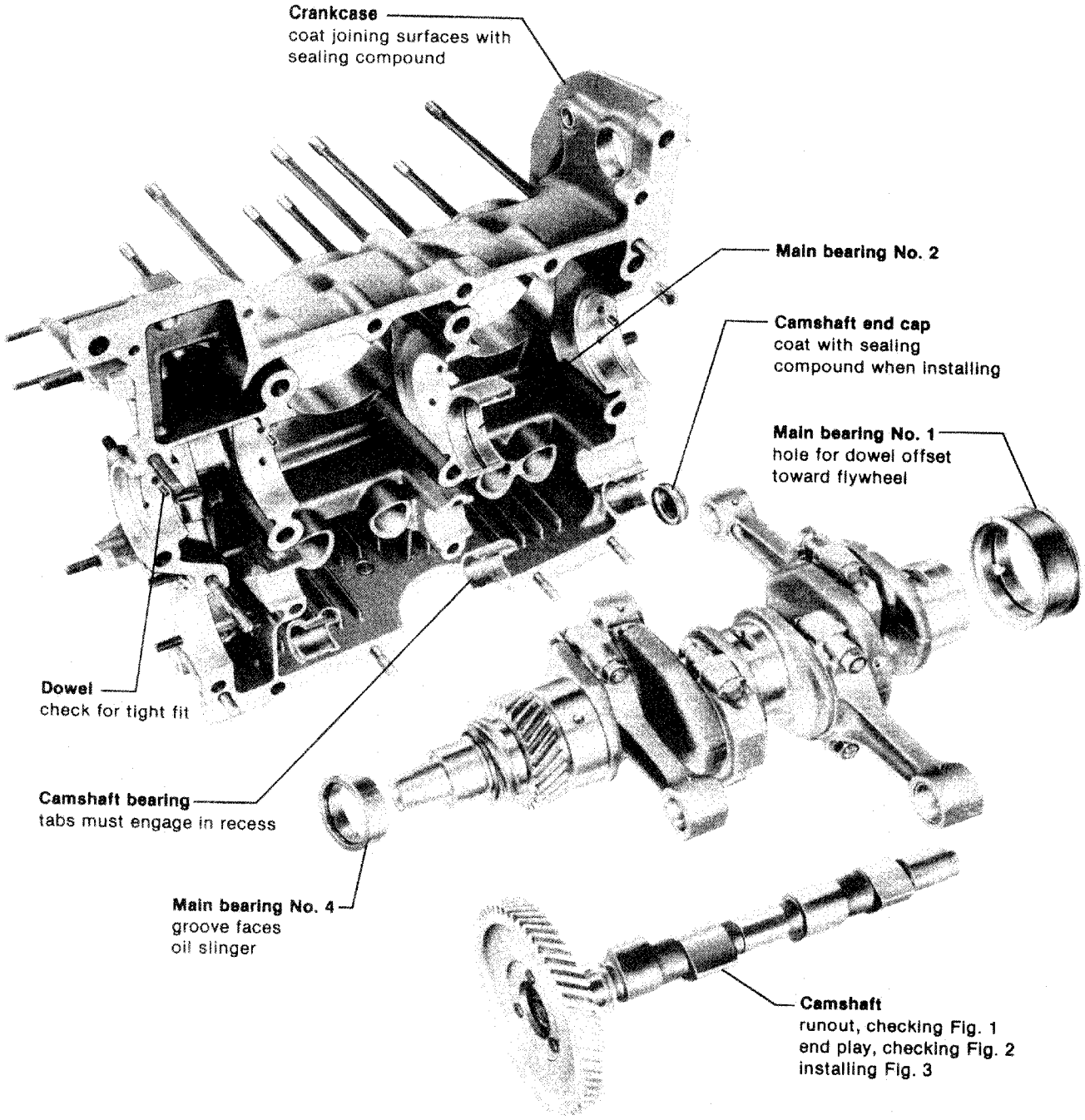


Fig. 11 Cylinder, installing

- piston ring end gaps must be offset 120°


Crankcase
coat joining surfaces with
sealing compound
Main bearing No. 2
Camshaft end cap
coat with sealing
compound when installing
Main bearing No. 1
hole for dowel offset
toward flywheel
Dowel
check for tight fit
Camshaft bearing
tabs must engage in recess
Main bearing No. 4
groove faces
oil slinger
Camshaft
runout, checking Fig. 1
end play, checking Fig. 2
installing Fig. 3
13-545

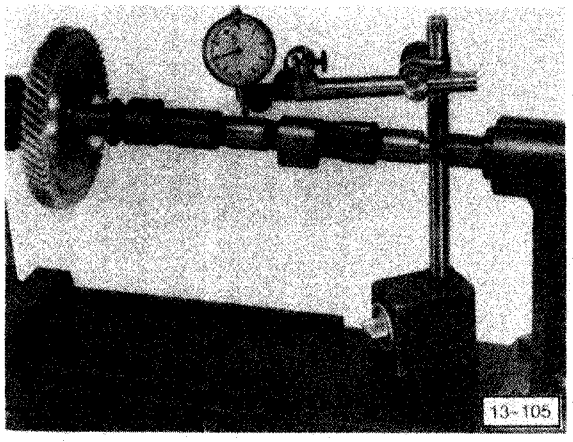


Fig. 1 Camshaft runout, checking

- wear limit 0.04 mm (0.0015 in.)

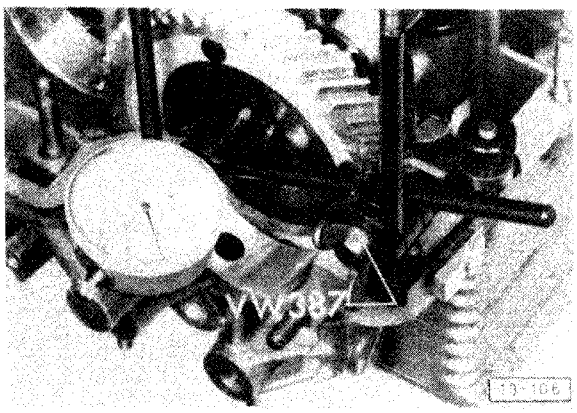


Fig. 2 Camshaft end play, checking

- wear limit 0.16 mm (0.006 in.)
- if out of specification, replace camshaft bearings

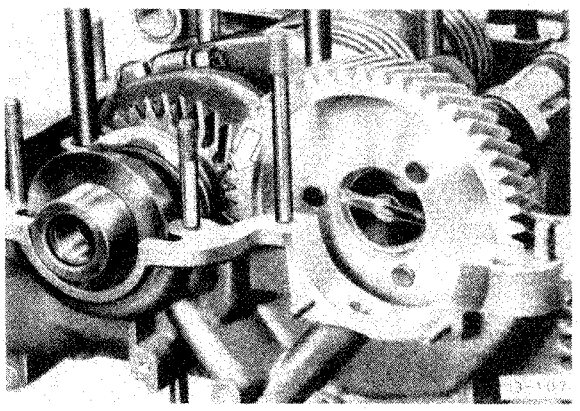


Fig. 3 Camshaft, installing

— mark on camshaft gear tooth must be between marks on crankshaft gear teeth
— check backlash of timing gears
- 0.0-0.05 mm (0-0.002 in.)
- backlash must be hardly noticeable

— turn crankshaft **backward**
- camshaft must not lift out of bearings
- if camshaft lifts out of bearings, install camshaft with smaller timing gear

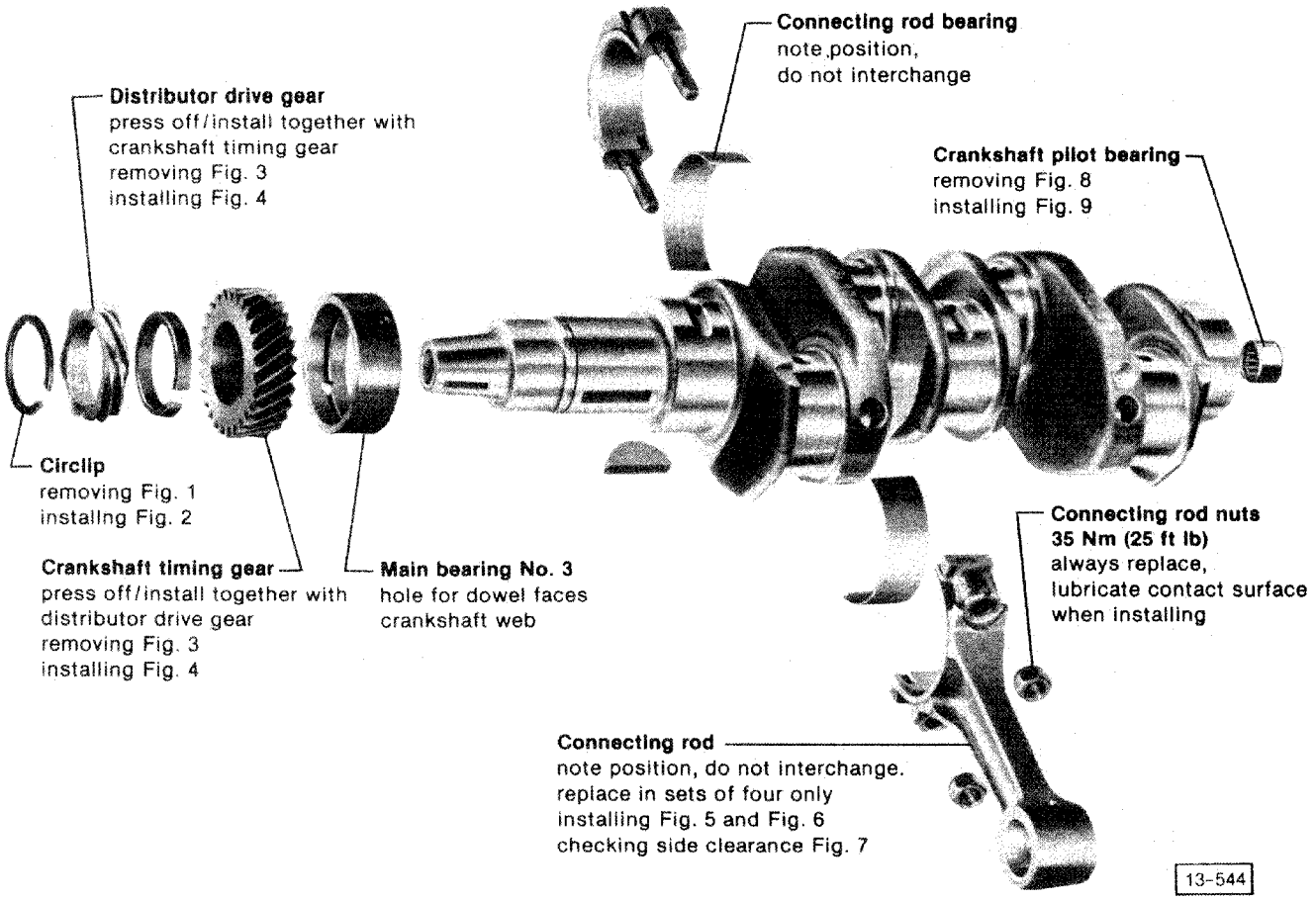
Note

To obtain specified backlash, camshafts with various size timing gears are available.
Markings are on **inner** face of timing gear.

Example
"−0.1", "+0.1", "+0.2", indicates in 1/100 mm how much pitch radius differs from standard pitch radius "0"

CAUTION

Mark 0 on **outer** face of camshaft timing gear is timing mark and must not be confused with markings on **inner** face. Crankshaft timing gear is available in one size only



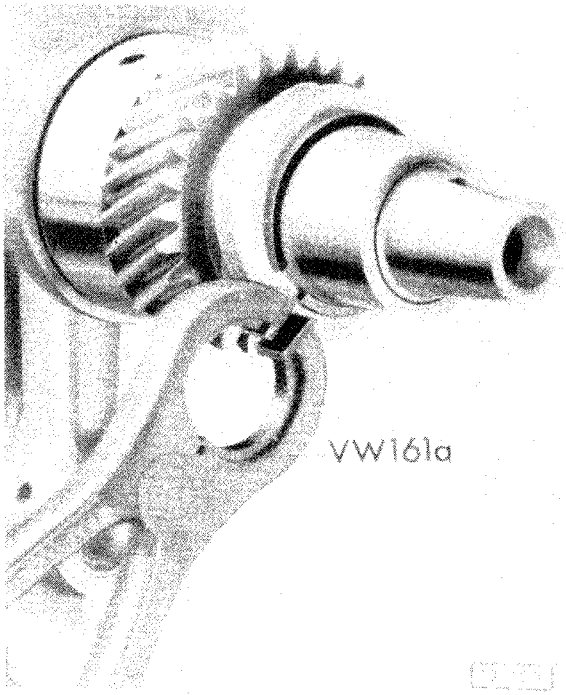


Fig. 1 Circlip, removing

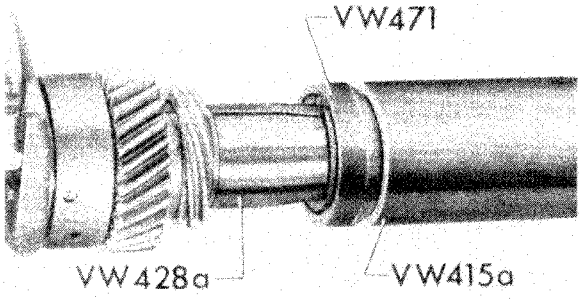


Fig. 2 Circlip, installing

13-109

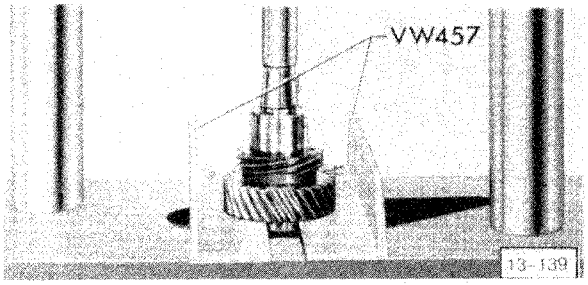


Fig. 3 Distributor drive gear/crankshaft timing gear, removing

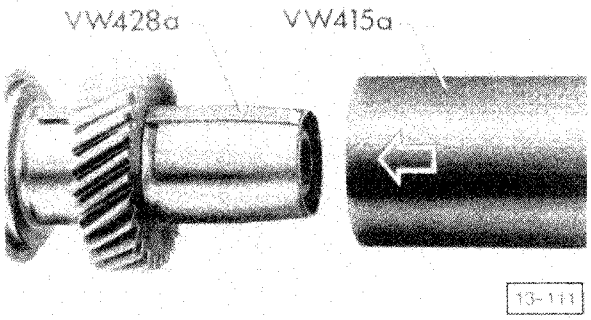


Fig. 4 **Distributor drive gear/crankshaft timing gear, installing**

— heat gears to approx. 80 °C (175 °F) before installing

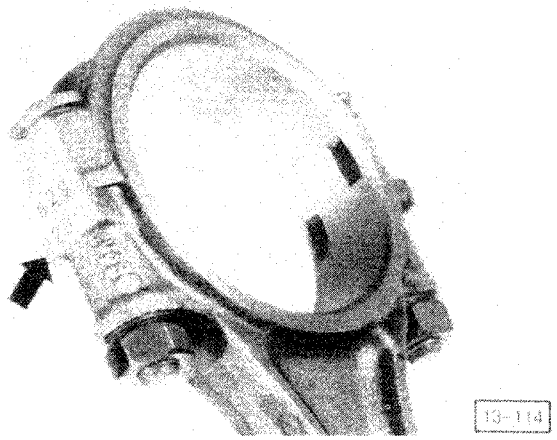


Fig. 5 **Connecting rod, installing**

— numbers (arrow) on rod and cap must be on same side

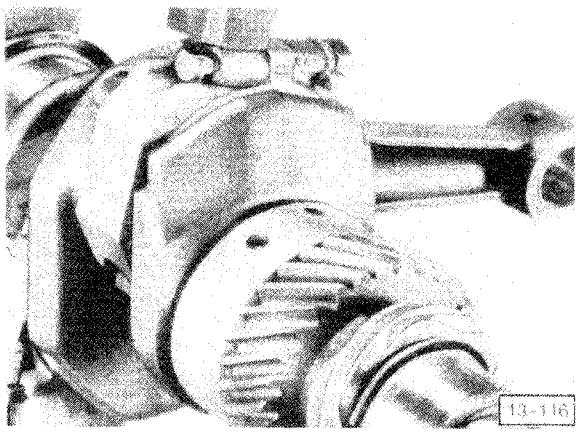


Fig. 6 **Connecting rod, installing**

— lightly tap both sides of connecting rod with hammer to eliminate slight pinching of bearing shells when installing connecting rod

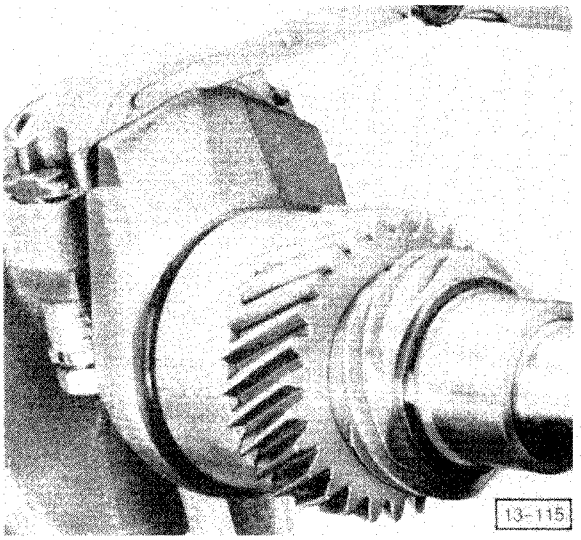


Fig. 7 **Connecting rod, checking side clearance**

• wear limit 0.7 mm (0.028 in.)

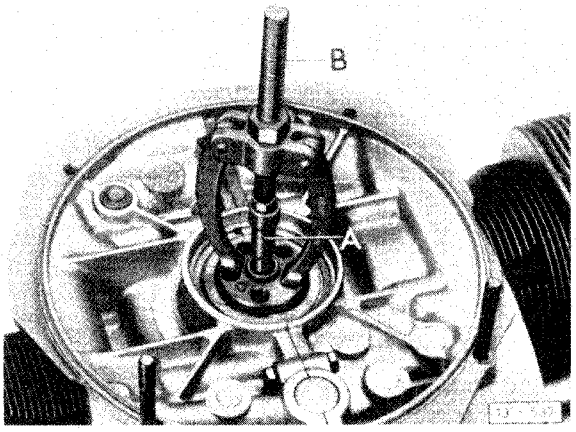


Fig. 8 **Crankshaft pilot bearing, removing**

A = US 8028
B = US 1039 & US 1039/3

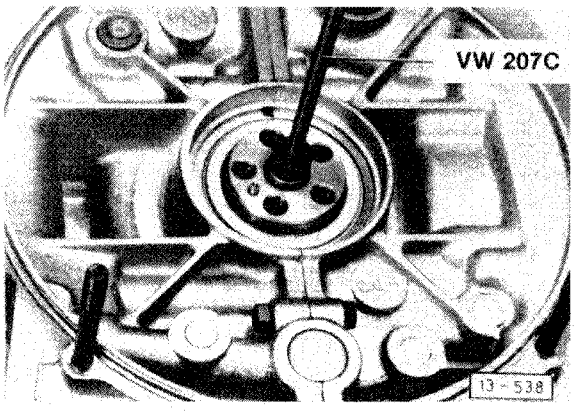


Fig. 9 **Crankshaft pilot bearing, installing**

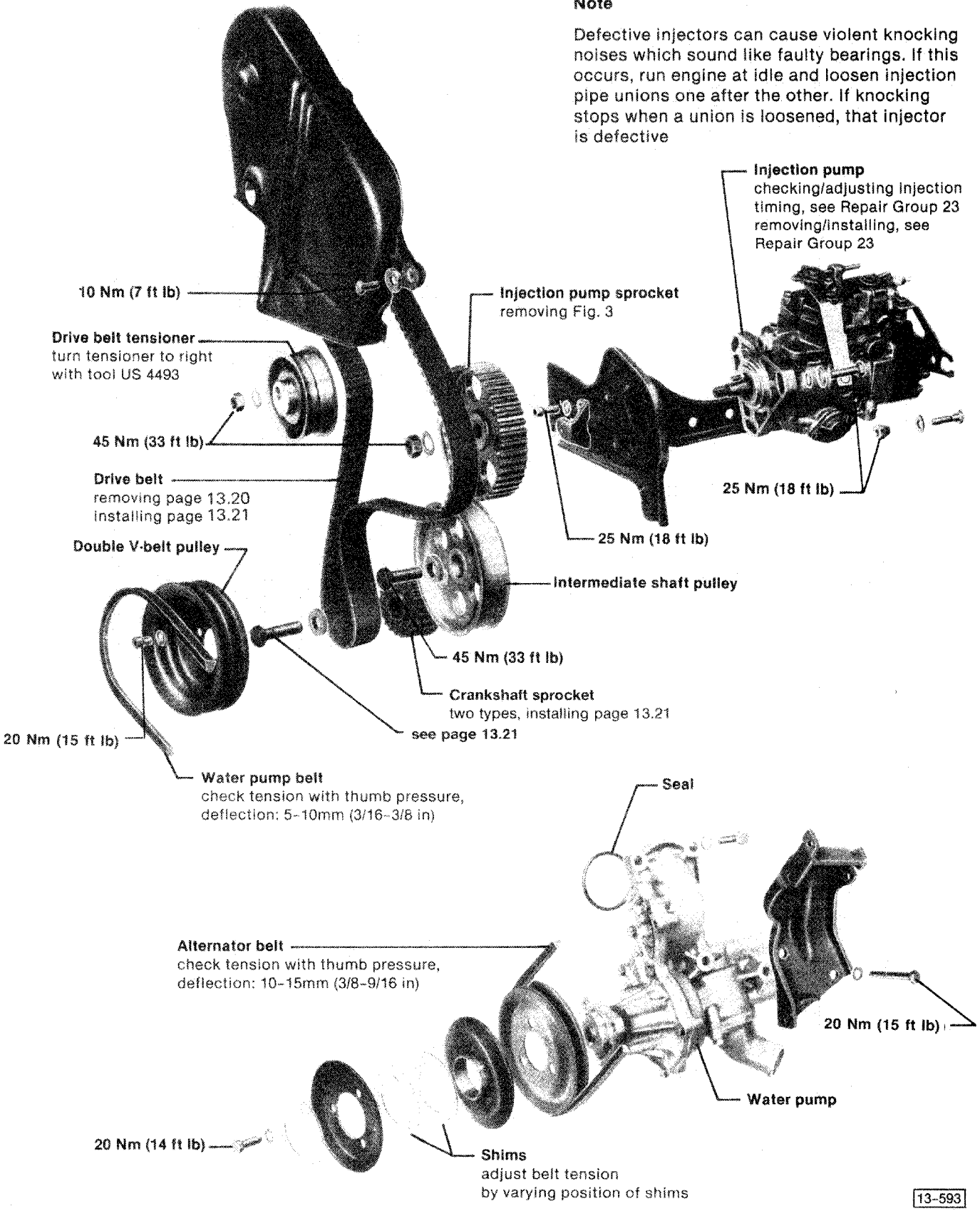
— lubricate with MoS_2 grease when installing

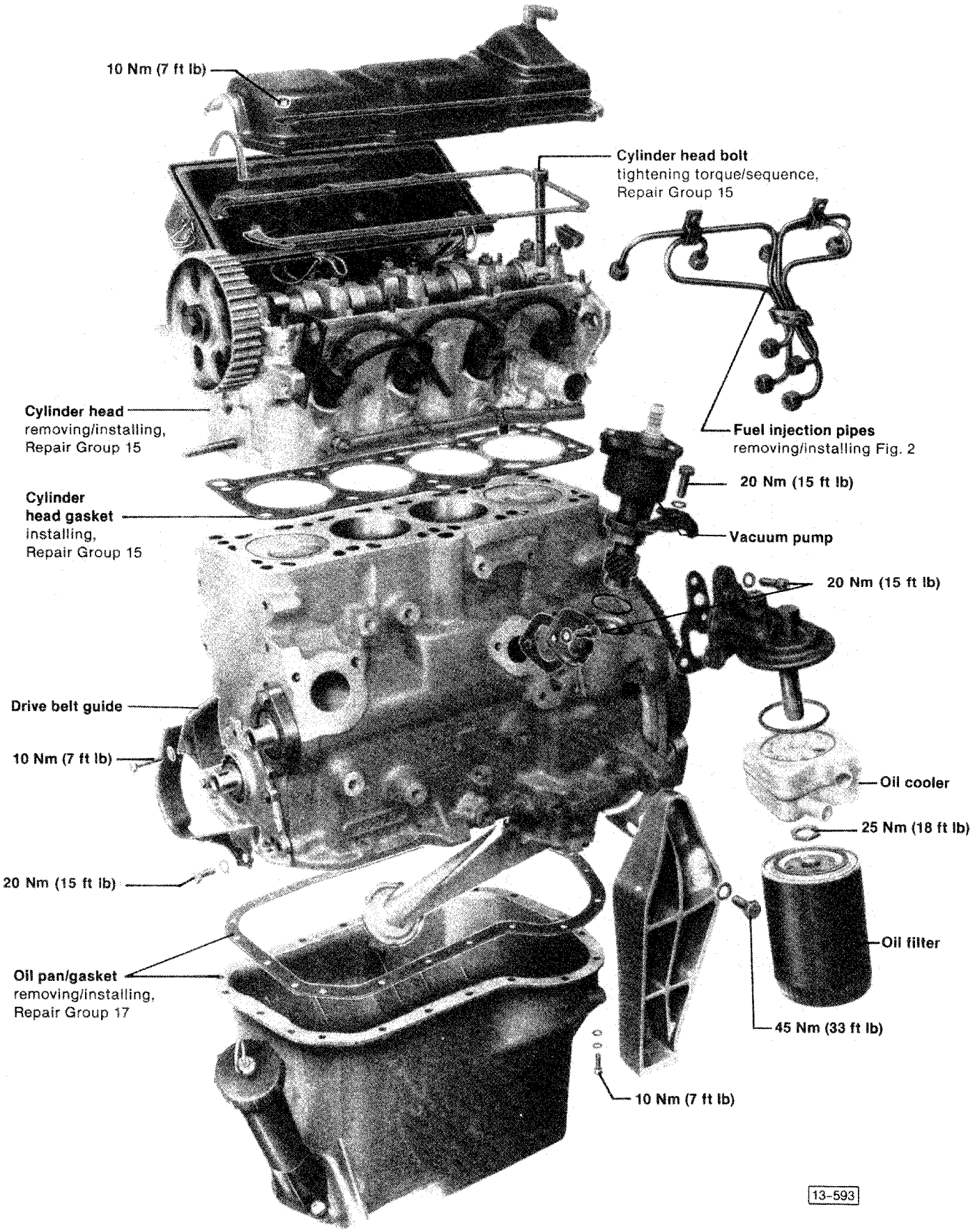
• markings on bearing cage must be visible when installed

Engine
mounting in engine stand Fig. 1

Note

Defective injectors can cause violent knocking noises which sound like faulty bearings. If this occurs, run engine at idle and loosen injection pipe unions one after the other. If knocking stops when a union is loosened, that injector is defective




10 Nm (7 ft lb)
Cylinder head bolt
tightening torque/sequence,
Repair Group 15
Cylinder head
removing/installing,
Repair Group 15
Fuel injection pipes
removing/installing Fig. 2
20 Nm (15 ft lb)
Cylinder
head gasket
installing,
Repair Group 15
Vacuum pump
20 Nm (15 ft lb)
Drive belt guide
10 Nm (7 ft lb)
Oil cooler
25 Nm (18 ft lb)
20 Nm (15 ft lb)
Oil filter
Oil pan/gasket
removing/installing,
Repair Group 17
45 Nm (33 ft lb)
10 Nm (7 ft lb)
13-593

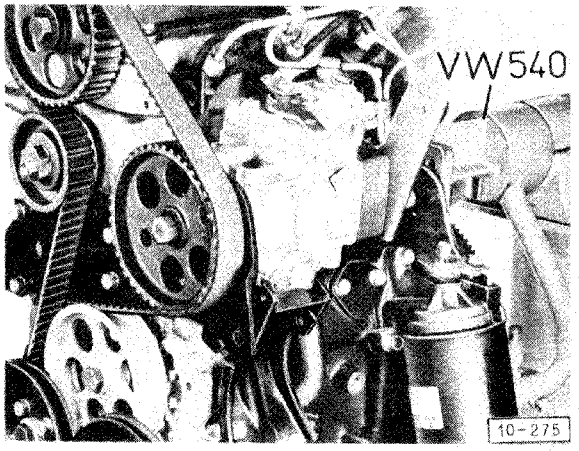


Fig. 1 Engine, mounting in engine stand

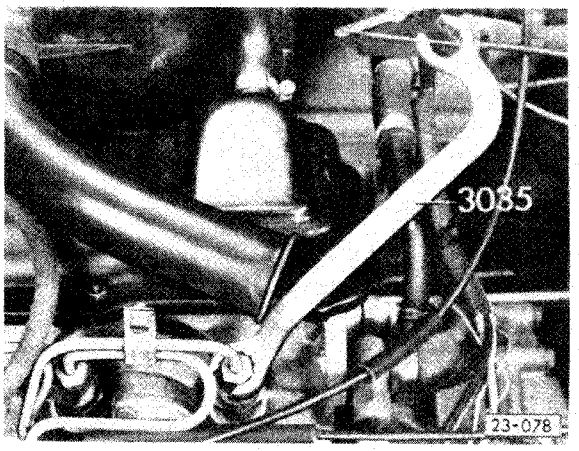


Fig. 2 Fuel injection pipes, removing/installing

—remove with tool 3035
—tighten to 25 Nm (18 ft lb)

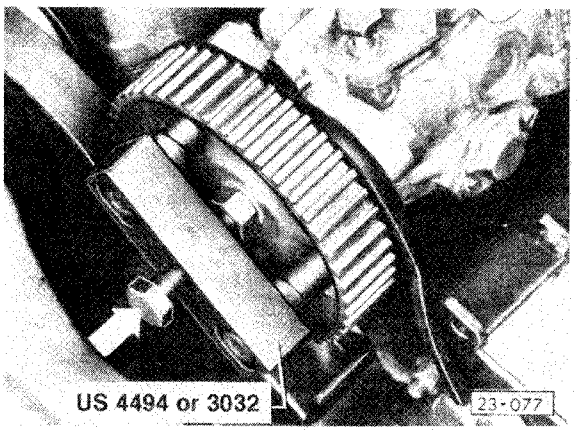


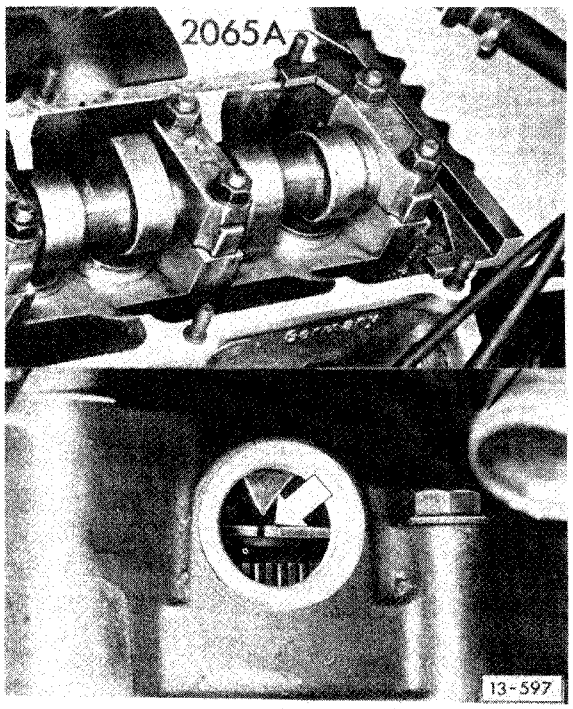
Fig. 3 Injection pump sprocket, removing

—loosen sprocket retaining nut slightly
—carefully apply tension with puller
—hit puller spindle head (arrow) with light hammer taps until sprocket loosens from injection pump shaft
—remove puller and nut
—remove sprocket by hand

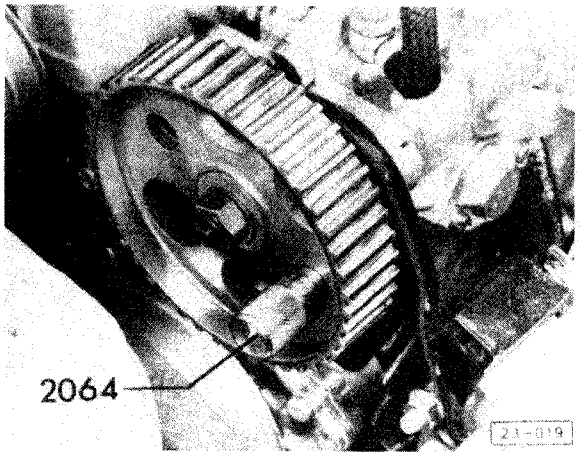
Drive belt, removing

Work sequence

—remove bolt cover and valve cover



—turn engine to TDC arrow on cylinder No. 1 and fix camshaft in position with tool 2065A
—align tool as follows:
- turn camshaft until one end of tool touches cylinder head
- measure gap at other end of tool with feeler gauge
- take half of measurement and insert feeler of this thickness between tool and cylinder head
- turn camshaft so that tool rests on feeler
- insert second feeler of same thickness between other end of tool and cylinder head



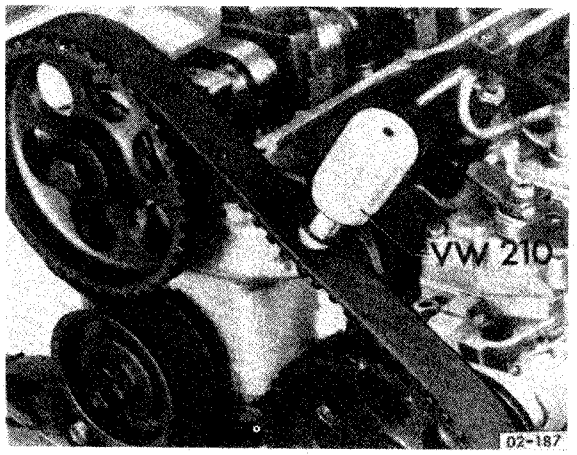
—lock injection pump sprocket in position with pin 2064
—check that marks on sprocket, bracket and pump body are aligned (engine at TDC)
—loosen tensioner

—remove V-belt pulley from crankshaft
—remove drive belt

Drive belt, installing

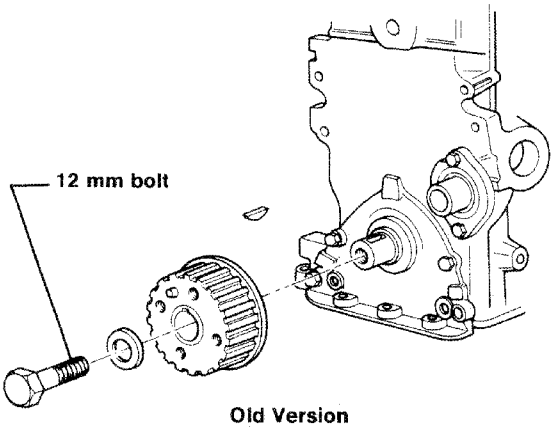
Work sequence

—check that TDC mark on clutch pressure plate is aligned with reference mark
—loosen camshaft sprocket bolt 1/2 turn and loosen gear from camshaft by tapping with rubber hammer
—install drive belt and remove pin 2064 from injection pump sprocket
—tension belt by turning tensioner to right

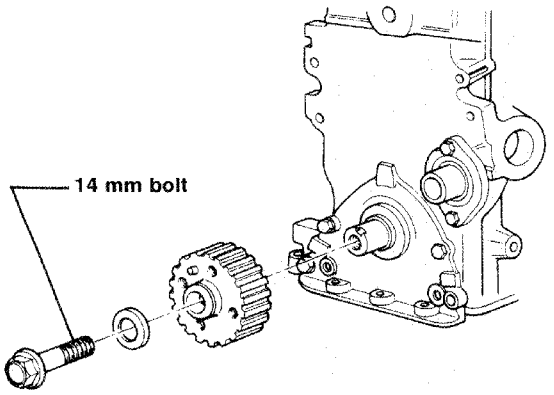


—check that on VW 210, scale reads 12–13
  • check belt tension between camshaft sprocket and injection pump sprocket
—tighten camshaft sprocket bolt to 45 Nm (33 ft lb)
—remove tool from camshaft
—turn crankshaft 2 turns in direction of engine rotation (clockwise)
—strike belt once with rubber hammer between camshaft sprocket and injection pump sprocket
—check belt tension again
—check injection pump timing, see Repair Group 23

Drive belt sprocket bolt, tightening



Old Version
150 Nm (108 ft lb)
with locking compound



New Version
200 Nm (148 ft lb)
lubricate threads before installing

Shown above are the two versions of drive belt sprocket used on Diesel Vanagon. Ensure that the correct tightening torque specification is used when repairing these engines.

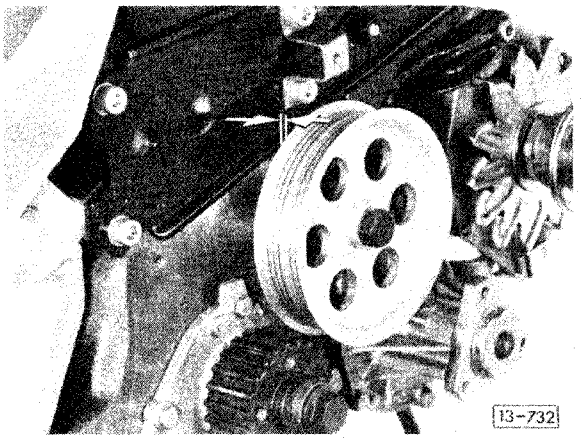
Fully closed drive belt cover

Beginning in February 1984, the Diesel engine has been produced with a fully closed drive belt cover.

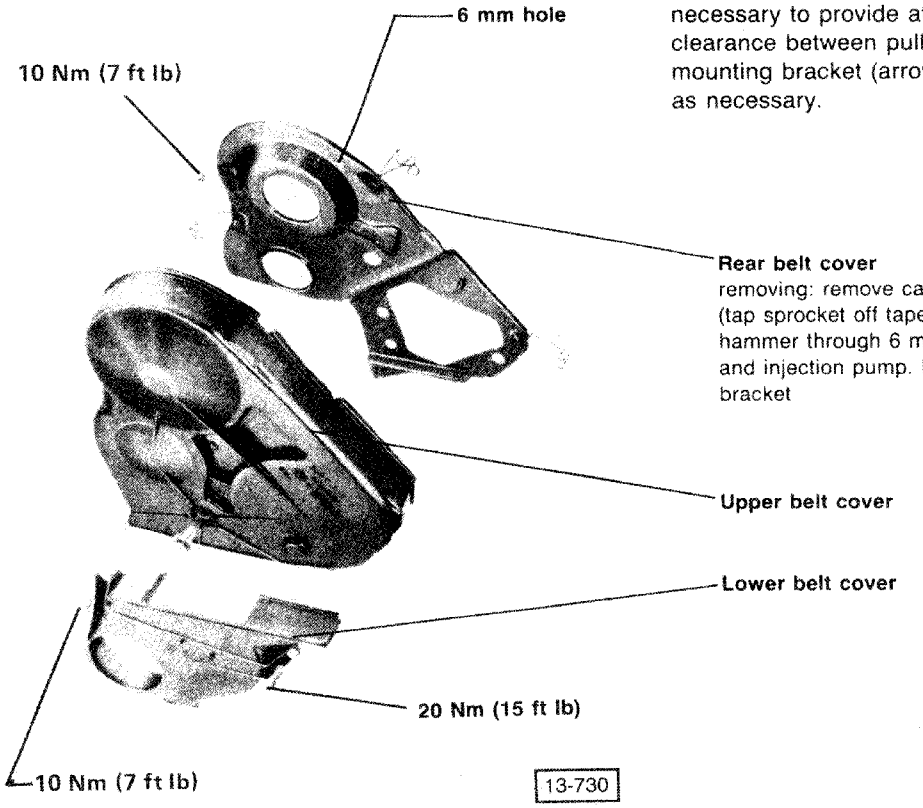
Additional new parts include a revised injection pump mounting bracket and intermediate shaft pulley. The pulley now mounts closer to the engine block.

Note

Only the new version pulleys will be supplied as service parts.

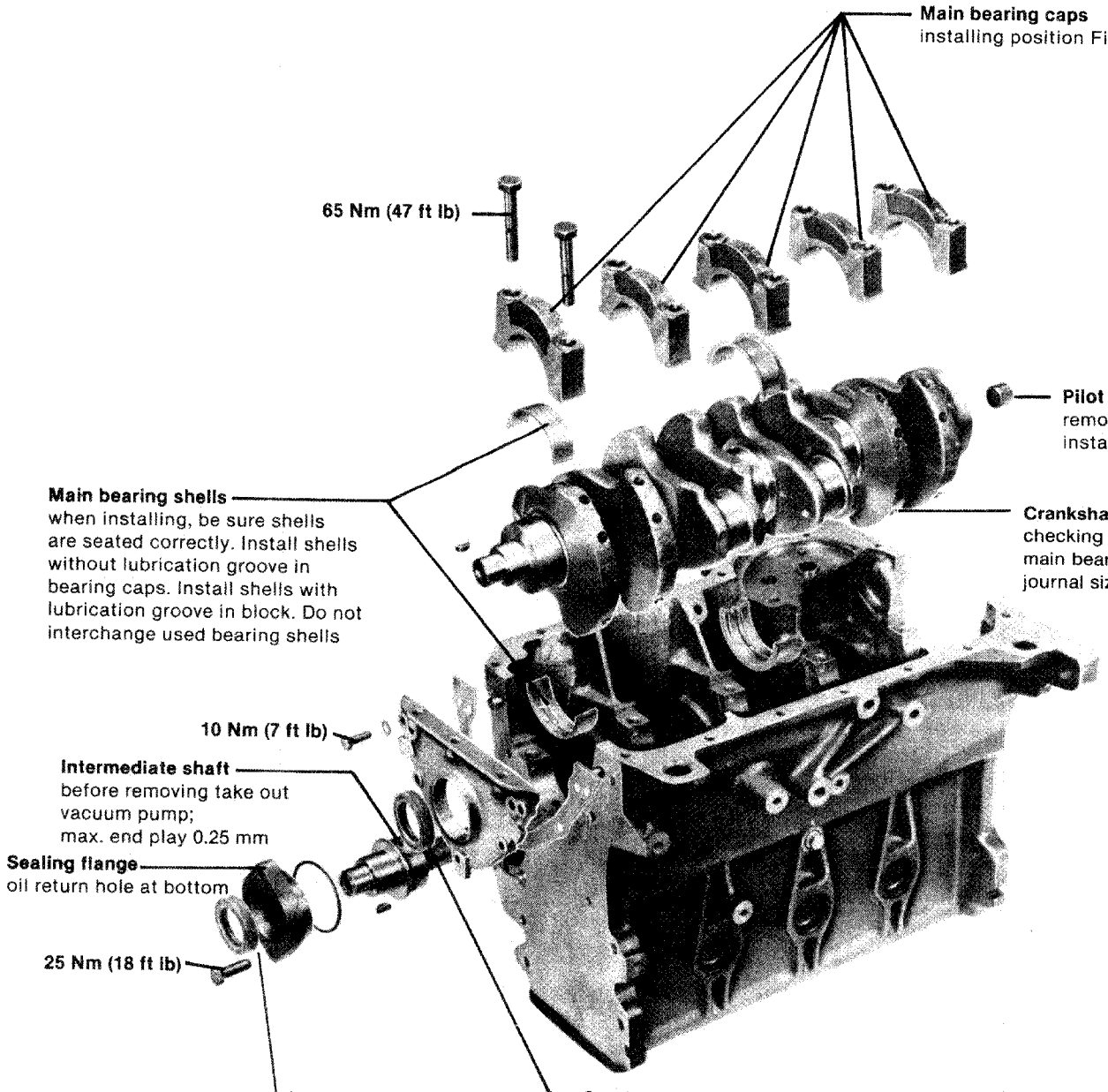


When installing the new version pulley in earlier engines (without fully closed belt cover) it is necessary to provide at least 0.5 mm (0.020 in.) clearance between pulley and injection pump mounting bracket (arrows). Rework pump bracket as necessary.



Note

Defective injectors can cause violent knocking noises which sound like faulty bearings. If this occurs, run engine at idle and loosen injection pipe unions one after the other. If knocking stops when a union is loosened, that injector is defective



13-594

WARNING

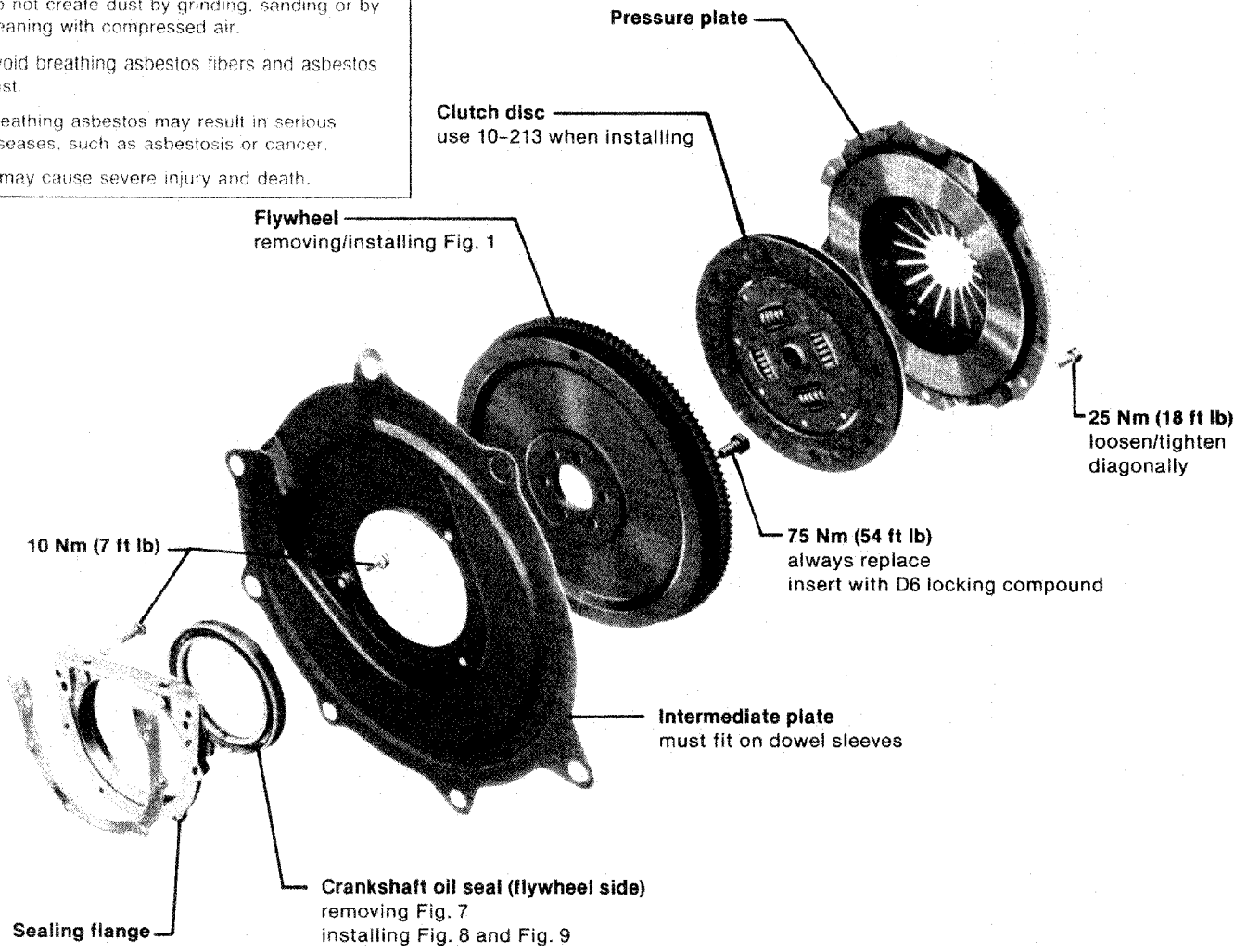
Friction materials such as brake and clutch linings, or brake pads may contain asbestos fibers.

Do not create dust by grinding, sanding or by cleaning with compressed air.

Avoid breathing asbestos fibers and asbestos dust.

Breathing asbestos may result in serious diseases, such as asbestosis or cancer.

It may cause severe injury and death.



Crankshaft journal sizes (mm)

Stage	Main bearing journals	Max. out of round	Connecting rod journals	Max. out of round
Standard	53.96-53.98	0.03	47.76-47.78	0.03
1st undersize	53.71-53.73	0.03	47.51-47.53	0.03
2nd undersize	53.46-53.48	0.03	47.26-47.28	0.03
3rd undersize	53.21-53.23	0.03	47.01-47.03	0.03

Note

3 undersizes of bearing shells available in graduations of 0.25 mm

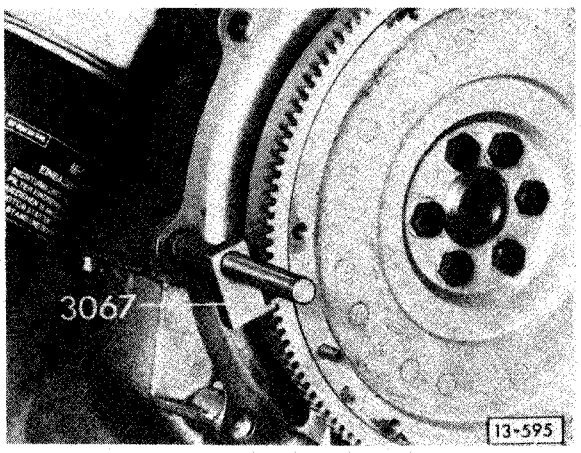


Fig. 1 Flywheel, removing/installing

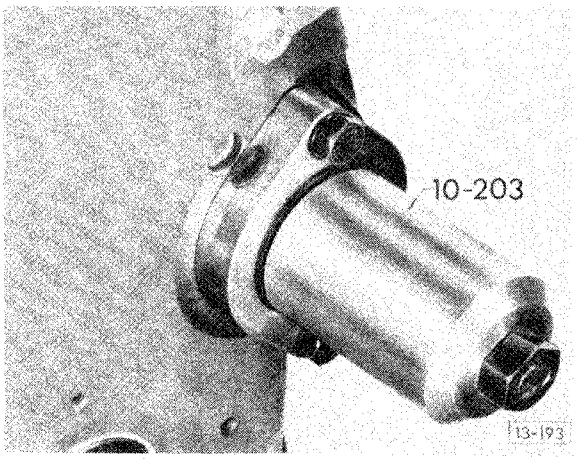


Fig. 2 Intermediate shaft oil seal, installing

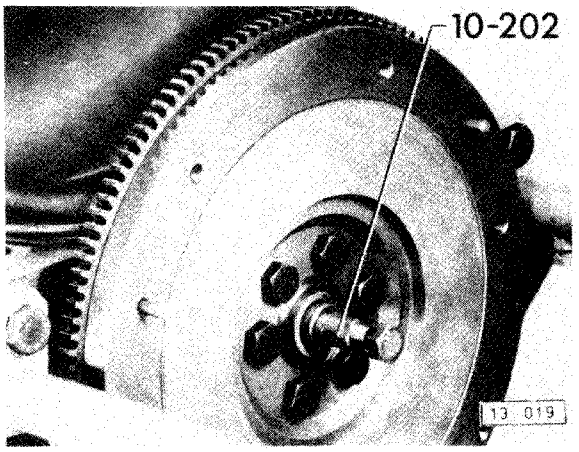


Fig. 3 Pilot bearing, removing

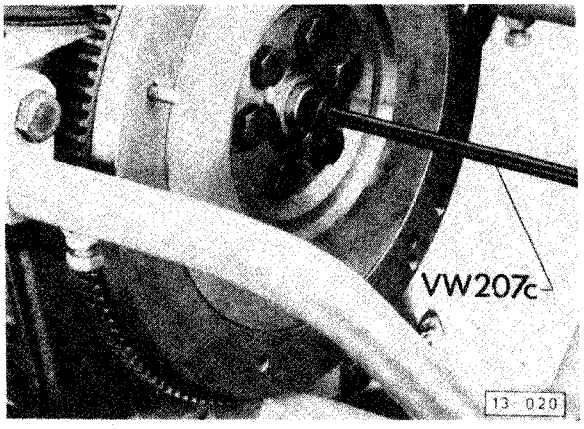


Fig. 4 Pilot bearing, installing

- lettered side faces out
- installation depth = 1.5 mm (0.060 in)

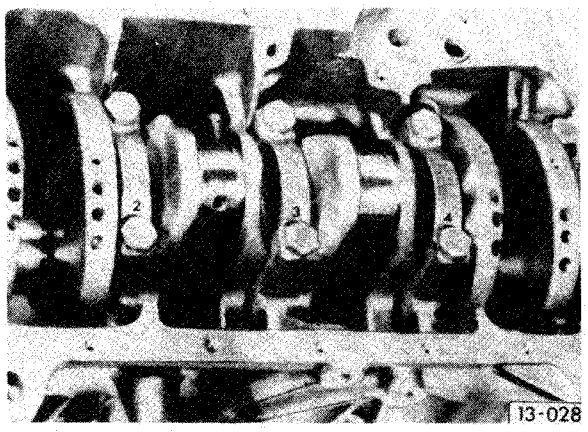


Fig. 5 Main bearing cap, positions

- bearing No. 1 on drive belt side
- bearing No. 5 on flywheel side

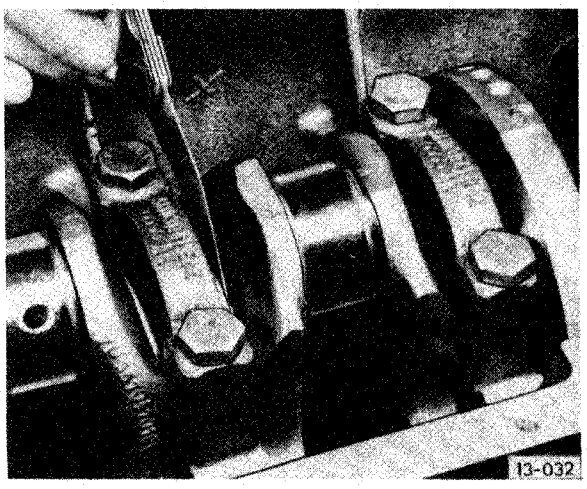


Fig. 6 Crankshaft end play, checking

—check with feeler gauge on main bearing No. 3

- new part = 0.07-0.17 mm (0.003-0.007 in.)
- wear limit = 0.37 mm (0.015 in.)

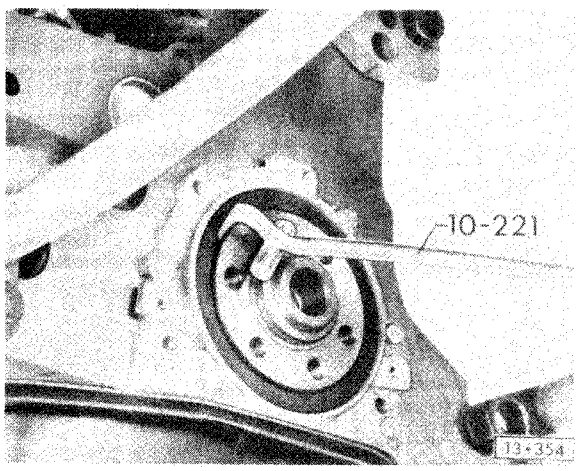


Fig. 7 Crankshaft oil seal (flywheel side), removing

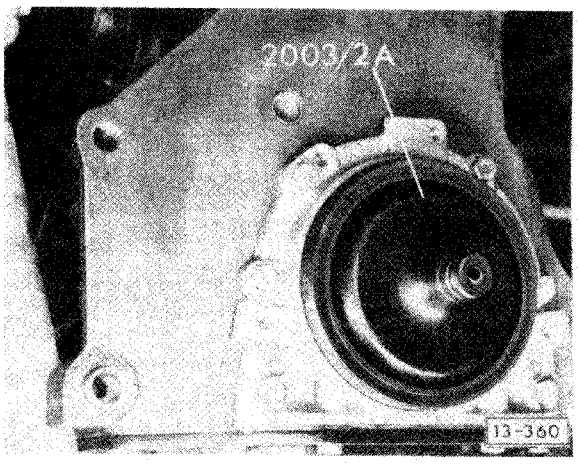


Fig. 8 Crankshaft oil seal (flywheel side), installing

—center with sleeve first

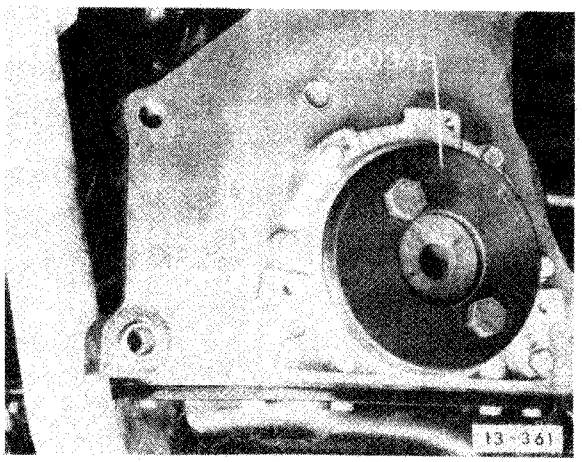


Fig. 9 Crankshaft oil seal (flywheel side), installing

—press in seal until fully seated

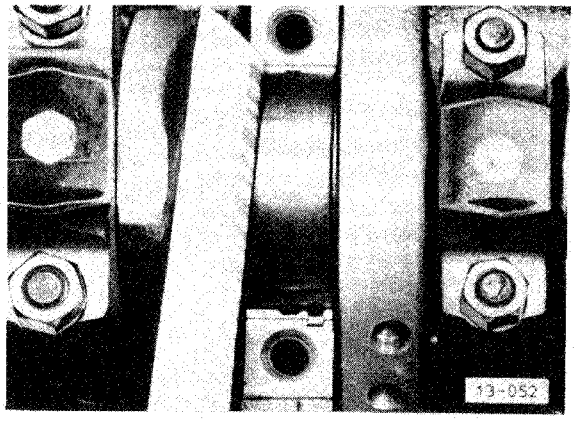


Fig. 10 Main bearing clearance, checking

—remove bearing caps
—clean shells and journals
—measure clearance with Plastigage
- new part: 0.03–0.08 mm (0.001–0.003 in.)
- wear limit: 0.17 mm (0.007 in.)

CAUTION

Do not turn crankshaft

Crankshaft oil seal (pulley side), removing/installing

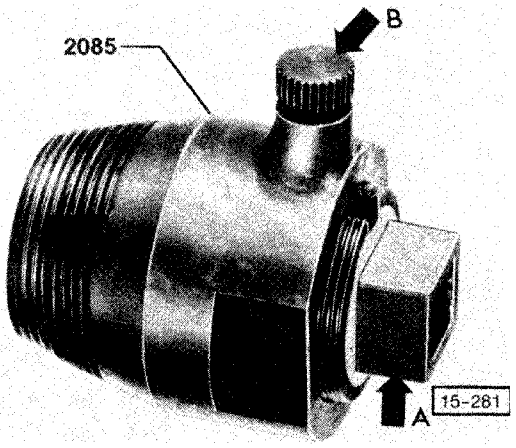
Note

Puller 2002 may also be used

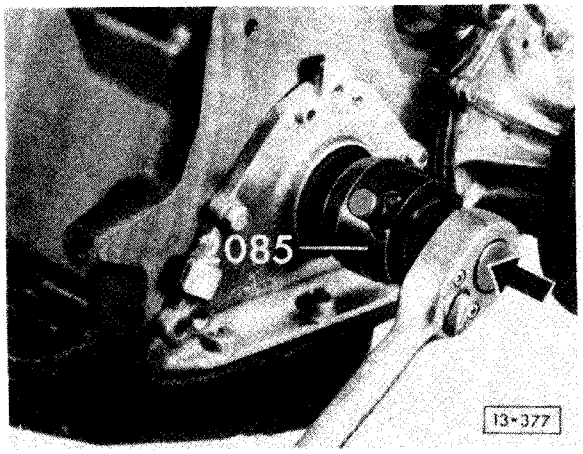
Work sequence

Removing

—remove drive belt cover and drive belt
—remove drive belt sprocket on crankshaft
—remove woodruff key from crankshaft



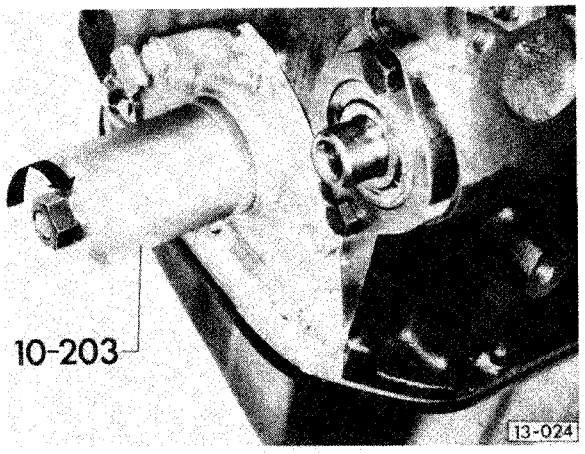
—unscrew inner part (arrow A) of oil seal extractor 2085 2 turns (approx. 3mm/1/8 in.) out of outer part
—lock in position with knurled screw (arrow B)
—to guide extractor, screw sprocket bolt into crankshaft until it projects about 20 mm (3/4 in.)
—lubricate threads on tapered end of seal extractor



—position seal extractor and screw it into oil seal as far as possible by pushing firmly in direction of arrow
—loosen knurled screw and turn inner part in against crankshaft until oil seal is pulled out
—clamp extractor in vise and remove oil seal with pliers

Installing

—coat seal lips with oil

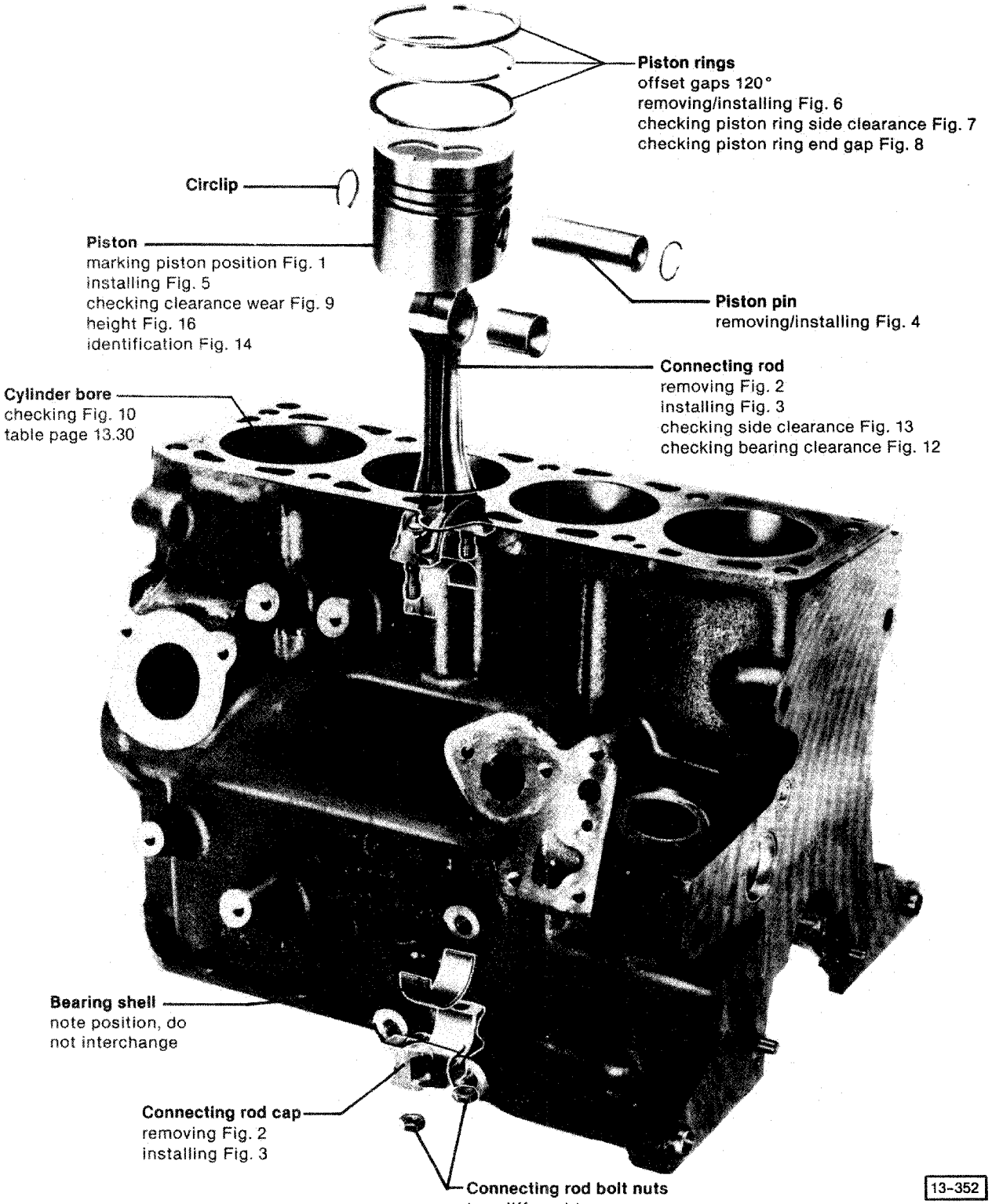


—press in seal to a depth of 2 mm (0.080 in.) below outer edge of cover
• use washer from sprocket bolt between bolt head and tool

Note

When installing new pistons or short block, check piston height to determine head gasket thickness, see Fig. 15 and Fig. 16

Defective injectors can cause violent knocking noises which sound like faulty bearings. If this occurs, run engine at idle and loosen injection pipe unions one after the other. If knocking stops when a union is loosened, that injector is defective



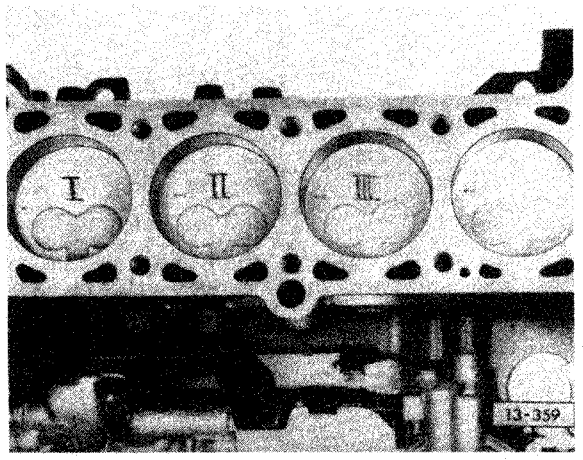


Fig. 1 Pistons, marking

—mark number on piston to match cylinder number. Arrows point toward drive belt side

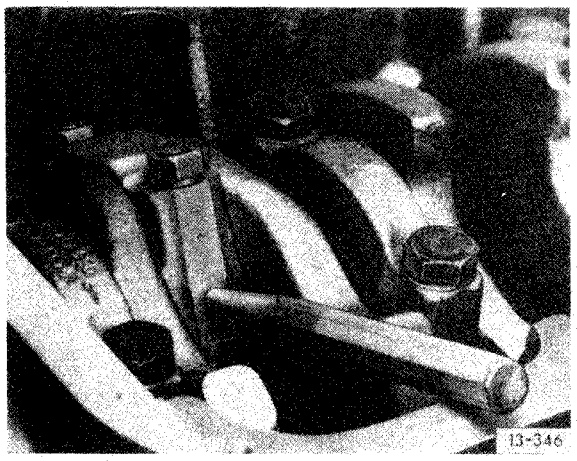


Fig. 2 Connecting rod, removing

—mark rod and cap before removing

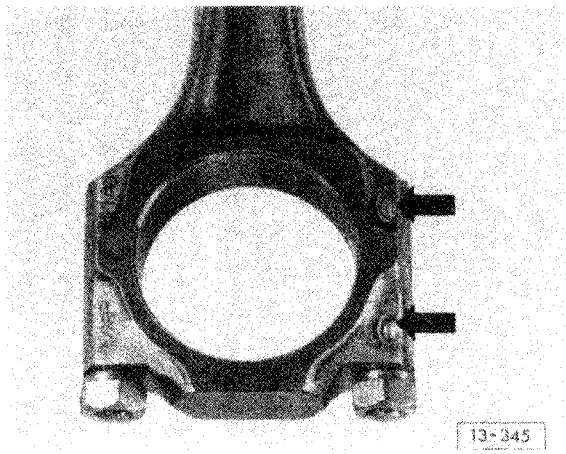


Fig. 3 Connecting rod, installing

—casting marks and retaining lug for bearing shell face toward intermediate shaft (arrows)

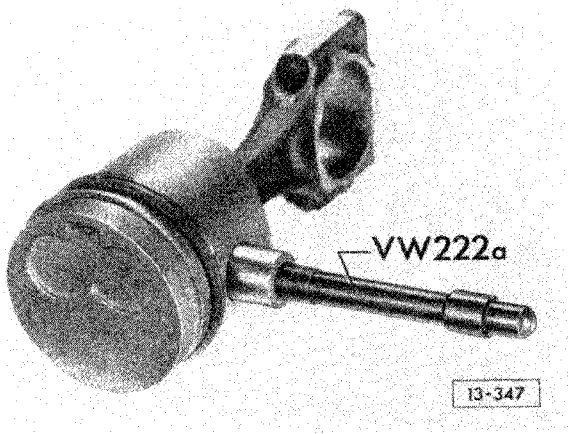


Fig. 4 Piston pin, removing/installing

—remove circlips
—if too tight, heat piston to approximately 60 °C (140 °F)

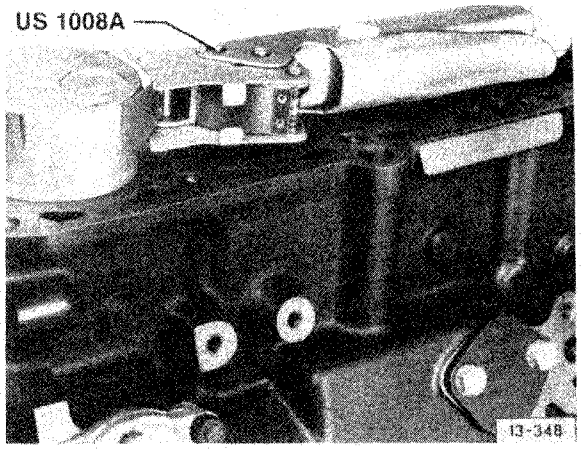


Fig. 5 Pistons, installing

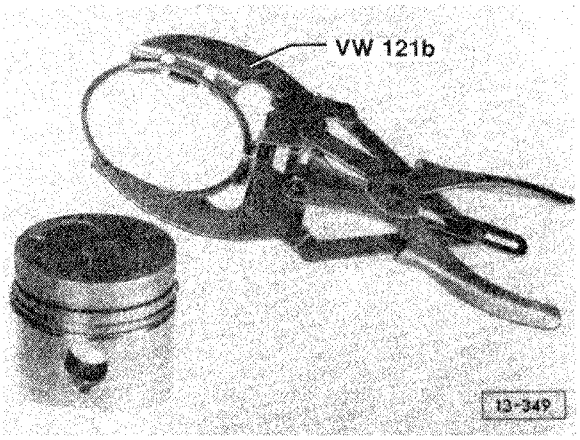


Fig. 6 Piston rings, removing/installing

—"Top" marks on piston rings must face toward piston crown

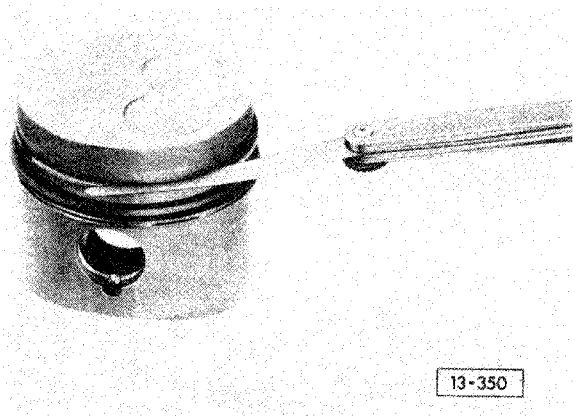


Fig. 7 Piston ring side clearance, checking

	Clearance	Wear limit
Upper ring	0.06–0.09 mm (0.002–0.004 in.)	0.2 mm (0.008 in.)
Lower ring	0.05–0.08 mm (0.002–0.003 in.)	0.2 mm (0.008 in.)
Oil scraper ring	0.03–0.06 mm (0.001–0.002 in.)	0.15 mm (0.006 in.)

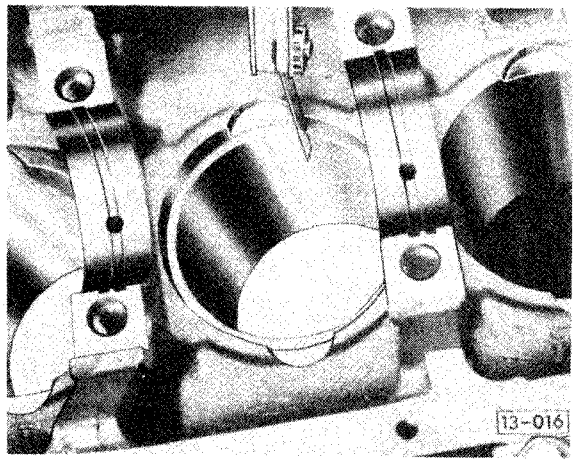


Fig. 8 Piston ring end gap, checking

—push ring down squarely into cylinder until it is about 15 mm (9/16 in.) from top edge

	Ring gap	Wear limit
Upper and lower rings	0.3–0.5 (0.012–0.020 in.)	1 mm (0.039 in.)
Oil scraper ring	0.25–0.40 mm (0.010–0.016 in.)	1 mm (0.039 in.)

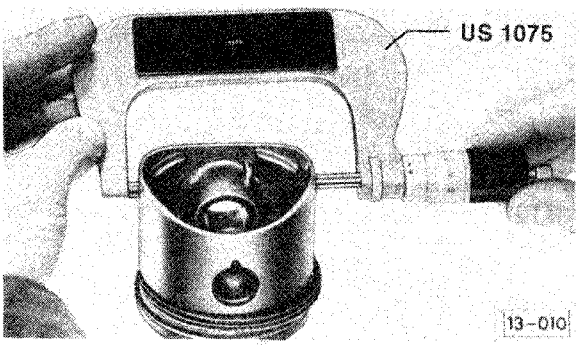


Fig. 9 Piston, checking for wear

—measure about 15 mm (9/16 in.) from lower edge

Piston diameter

	Piston dia. (mm)	Cylinder bore (mm)
Standard	76.48	76.51
	76.49	76.52
	76.50	76.53
1st oversize	76.73	76.76
	76.74	76.77
	76.75	76.78
2nd oversize	76.98	77.01
	76.99	77.02
	77.00	77.03
3rd oversize	77.48	77.51
	77.49	77.52
	77.50	77.53

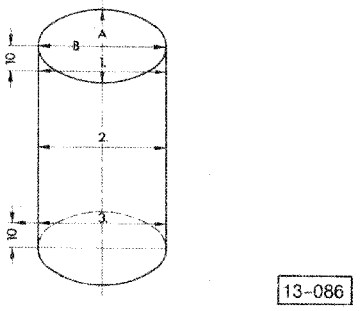


Fig. 10 Cylinder clearance, checking

—measure at points 1, 2 and 3 first in direction A then direction B
1 = 10 mm (3/8 in.) from top
2 = middle of cylinder wall
3 = 10 mm (3/8 in.) from bottom

- piston to cylinder clearance
  new part: 0.03 mm (0.0011 in.)
  wear limit: 0.07 mm (0.0027 in.)

Note

Do not measure when block is mounted in repair stand as measurements may be incorrect due to distortion

Cylinder bore

	Bore (mm)	Piston dia. (mm)
Standard	76.51	76.48
	76.52	76.49
	76.53	76.50
1st oversize	76.76	76.73
	76.77	76.74
	76.78	76.75
2nd oversize	77.01	76.98
	77.02	76.99
	77.03	77.00
3rd oversize	77.51	77.48
	77.52	77.49
	77.53	77.50

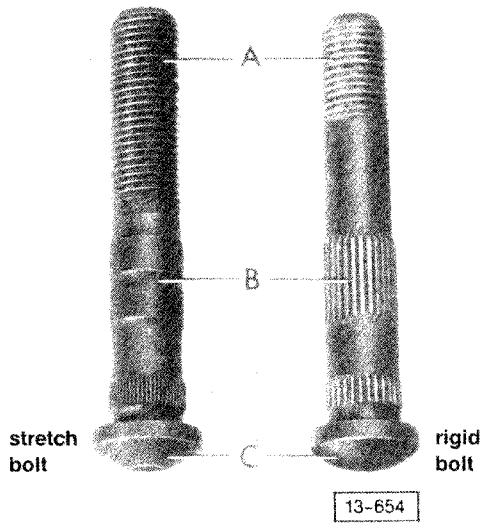


Fig. 11 Connecting rod bolts, identification/ tightening procedure

stretch		rigid
25mm (1.0 in.)	**A** = thread length	15 mm (9/16 in.)
smooth	**B** = center part	serrated
conical	**C** = bolt head	half round

Tightening procedure

stretch bolt:
— lubricate contact face of nut
— tighten to 30 Nm (22 ft lb)
— then tighten nut ¼ turn (90°) more

rigid bolt:
— lubricate contact face of nut
— tighten to 45 Nm (33 ft lb)

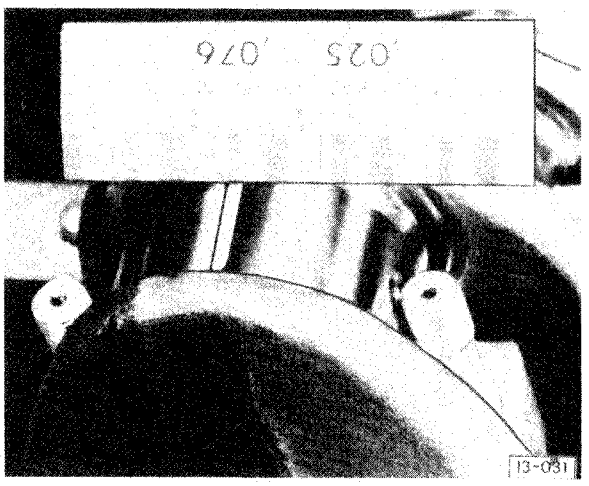


Fig. 12 Connecting rod bearing clearance, checking

— remove connecting rod cap
— clean bearing shell and crankshaft journal
— place Plastigage® across journal
— install cap and tighten nuts
- if rigid bolts, tighten nuts to 45 Nm (33 ft lb)
- if stretch bolts, tighten nuts to 30 Nm (22 ft lb) (to avoid stretching bolts, do **not** turn stretch bolt nuts extra quarter turn when measuring bearing clearance)

CAUTION
Do not turn crankshaft

— remove connecting rod cap
— compare width of strip with measuring scale; figure on scale gives bearing clearance
- new part: 0.028–0.088 mm (0.0011–0.0034 in.)
- wear limit: 0.12 mm (0.0047 in.)

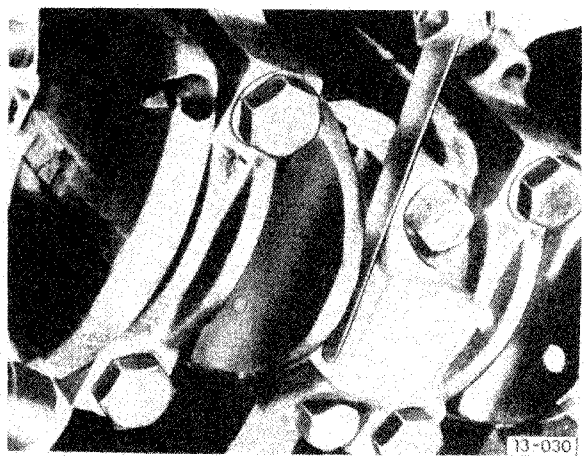


Fig. 13 Connecting rod side clearance, checking
wear limit: 0.37 mm (0.014 in)

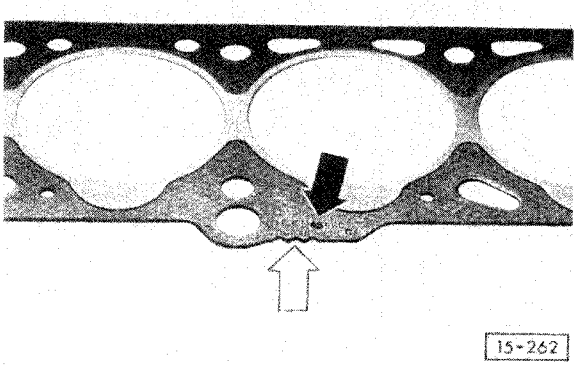


Fig. 15 Cylinder head gasket, identification

white arrow = identification notches
black arrow = part number

Note

Always select gasket thickness according to piston height above top of cylinder block

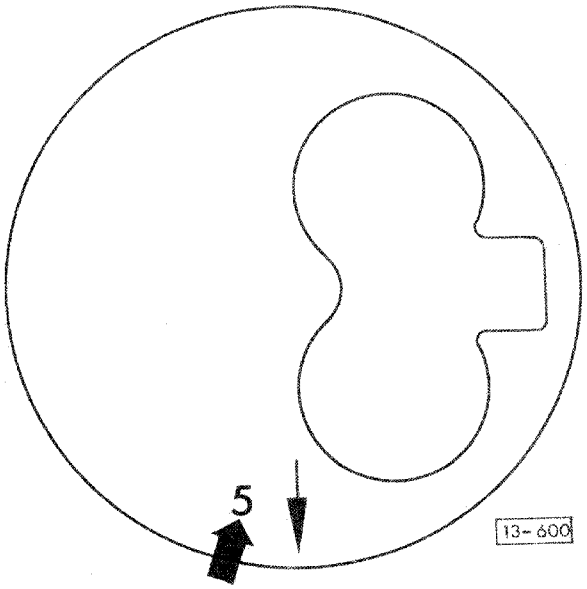


Fig. 14 Piston identification

- pistons are marked with figure 5 next to installation direction
- arrow must point to drive belt side

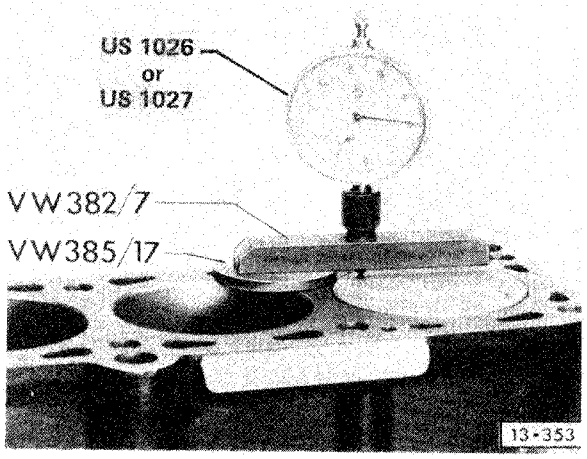


Fig. 16 Piston height, checking

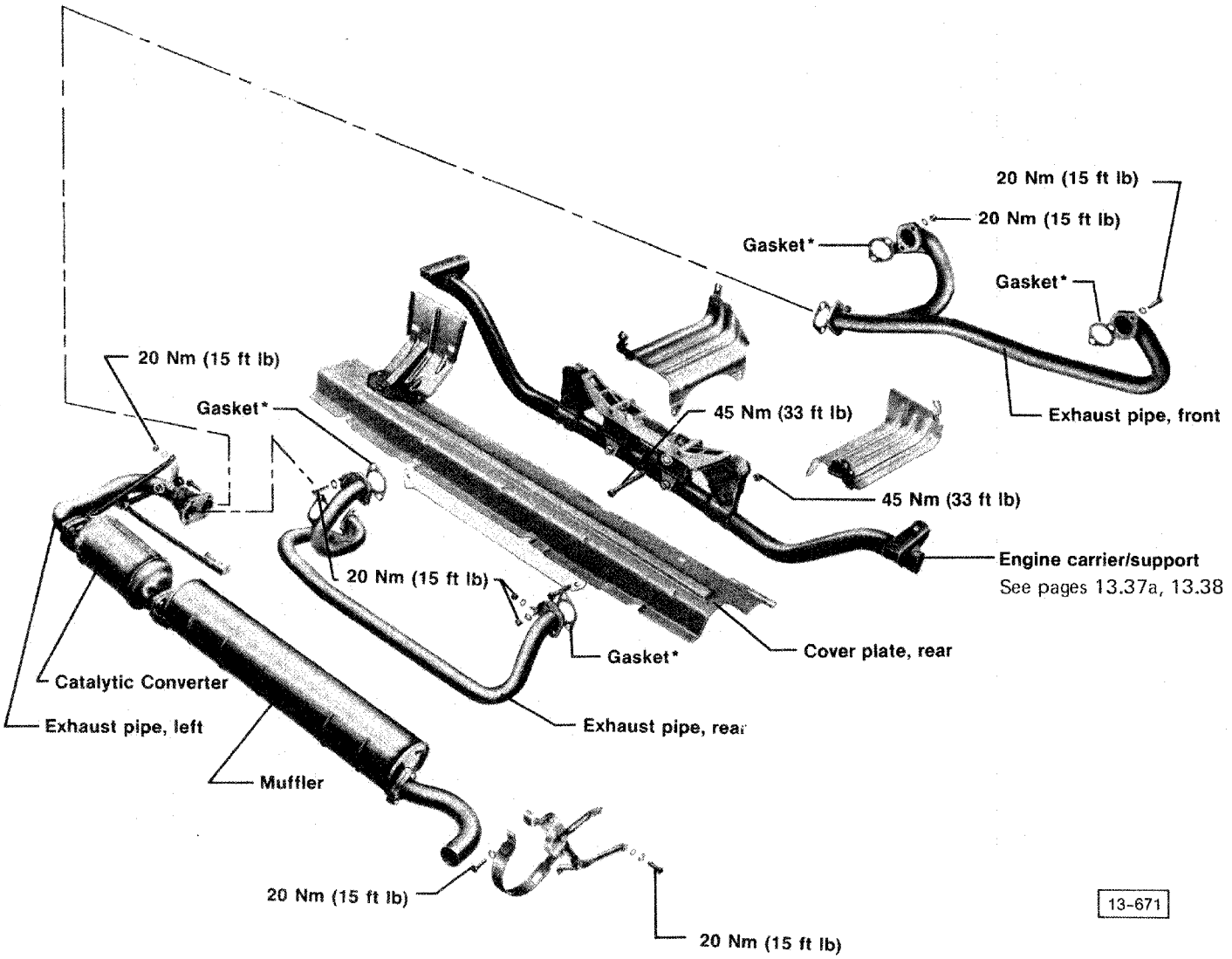
Piston height of **ALL** cylinders must be measured when installing new pistons or short block.

Head gasket is selected based on cylinder with **HIGHEST** piston height.

Thickness of gasket (mm/in.)	Piston height (mm/in.)	Identification notches in head gasket	Part No.
0.63-0.82 (0.025-0 032)	1.4 (0.055)	1	068 103 383 L
0.83-0.92 (0.033-0.036)	1.5 (0.059)	2	068 103 383 M
0.93-1.02 (0.037-0.040)	1.6 (0.063)	3	068 103 383 N

Note

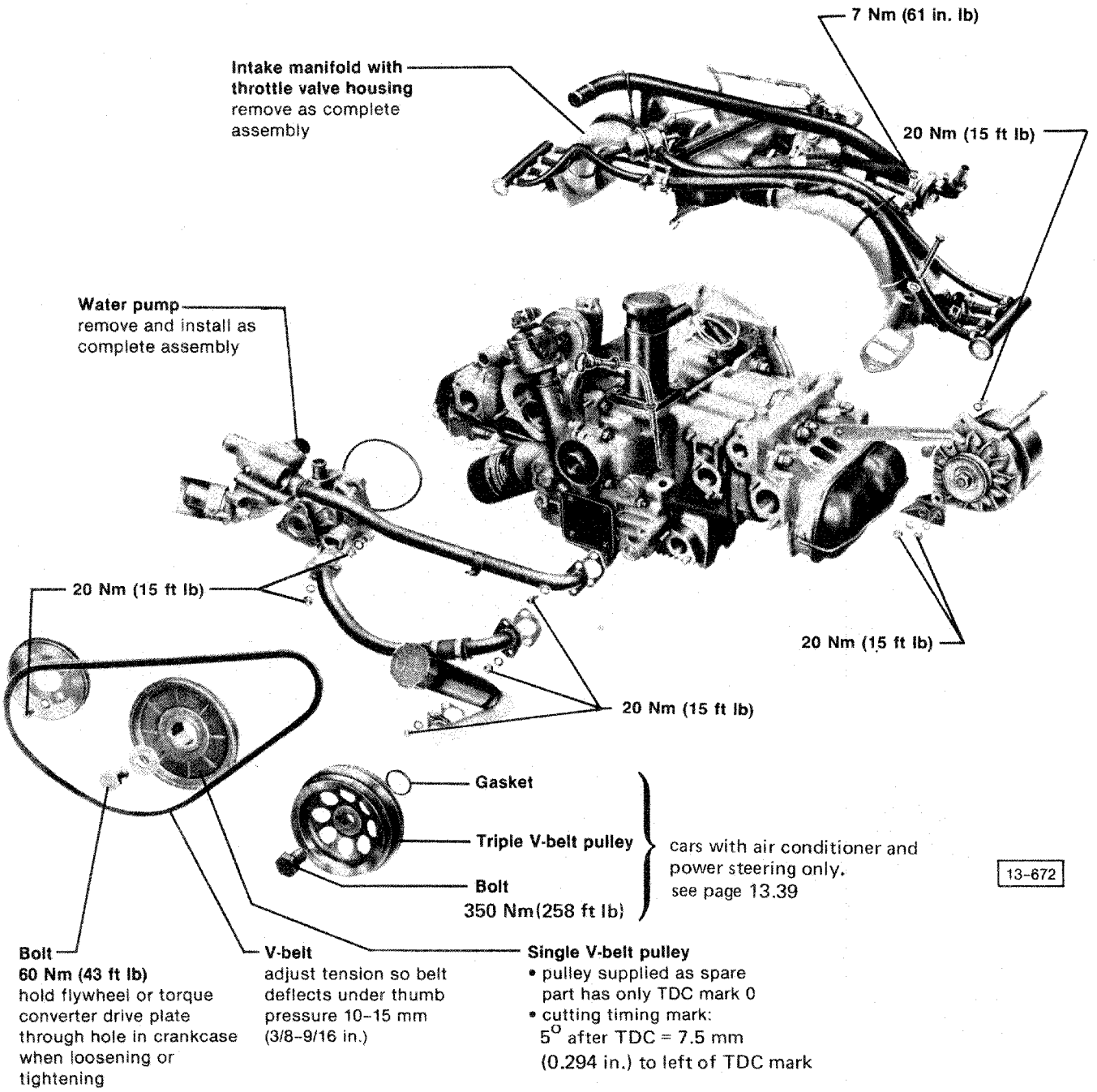
Arrows on carrier must point to front of vehicle when reinstalling. Remove carrier as complete assembly

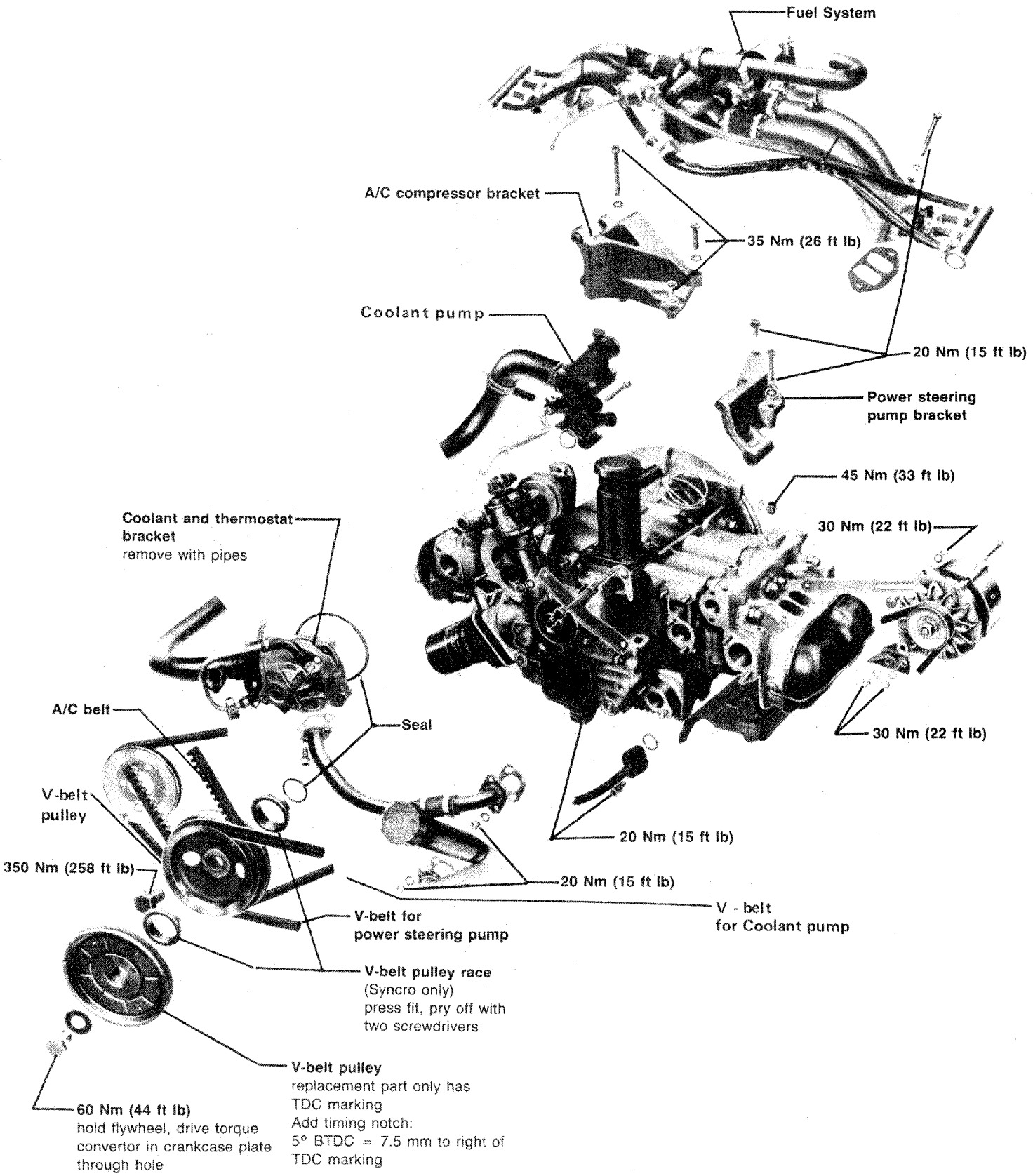


*metal surface faces cyl. head

Note

Tighten all hoses with hose clamps





13.34 Engine, disassembling/assembling

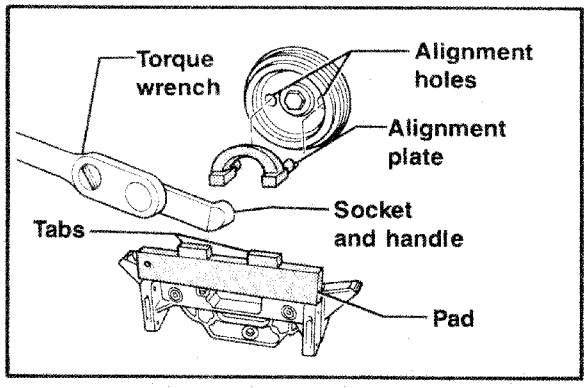
Water-cooled - from 1986

Removal of three groove pulley

Retainer tool 3149 is required to hold crankshaft from rotating while removing/installing the three groove pulley.

It consists of three separate pieces:
- alignment plate
- pad
- socket and handle

Work sequence



— loosen power steering pump, if applicable, remove V-belt from crankshaft pulley
— loosen A/C compressor, if applicable, remove V-belt from crankshaft pulley
— loosen alternator, remove V-belt from crankshaft pulley
— unscrew coolant expansion tank, lay to one side
— remove expansion tank bracket
— remove retaining screws and bolts from exhaust heat shield
— reposition heat shield down and under its original position

Note

When tool 3149 is used, it will **not** be necessary to remove muffler.

— rotate pulley so both **alignment holes** are horizontal
— insert **alignment plate** into pulley

— place pad across engine mounts with tabs pointing upward
— attach socket and handle
— remove crankshaft pulley bolt and pulley
— installation of three groove pulley is in reverse order

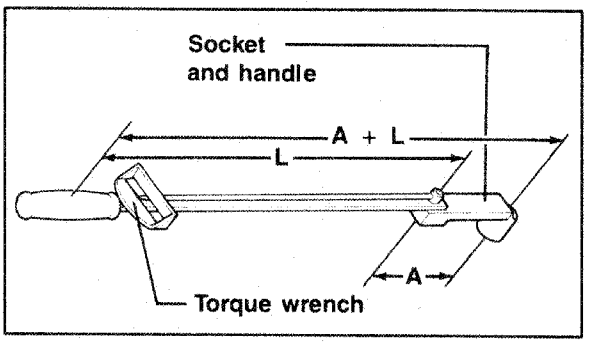
CAUTION

Tightening torque applies **only** when socket and handle is used in alignment with torque wrench.

Correct torque wrench setting **must be calculated** to achieve 350 Nm (258 ft lb) at crankshaft pulley bolt.

— torque crankshaft pulley bolt to 350 Nm (258 ft lb)

How to compute torque when using adapter



$TA = \frac{TW \times (L + A)}{L}$ where:

TA = Torque at end of adapter
TW = Torque wrench scale reading
L = Lever length of torque wrench
A = Lever length of adapter

Example:
TA = Unknown
TW = 100 lb.-ft.
L = 15 inches
A = 7.5 inches

Now use the formula as follows:

$TA = \frac{TW \times (L + A)}{L}$

$TA = \frac{100 \times (15 + 7.5)}{15}$

$TA = \frac{100 \times (22.5)}{15}$

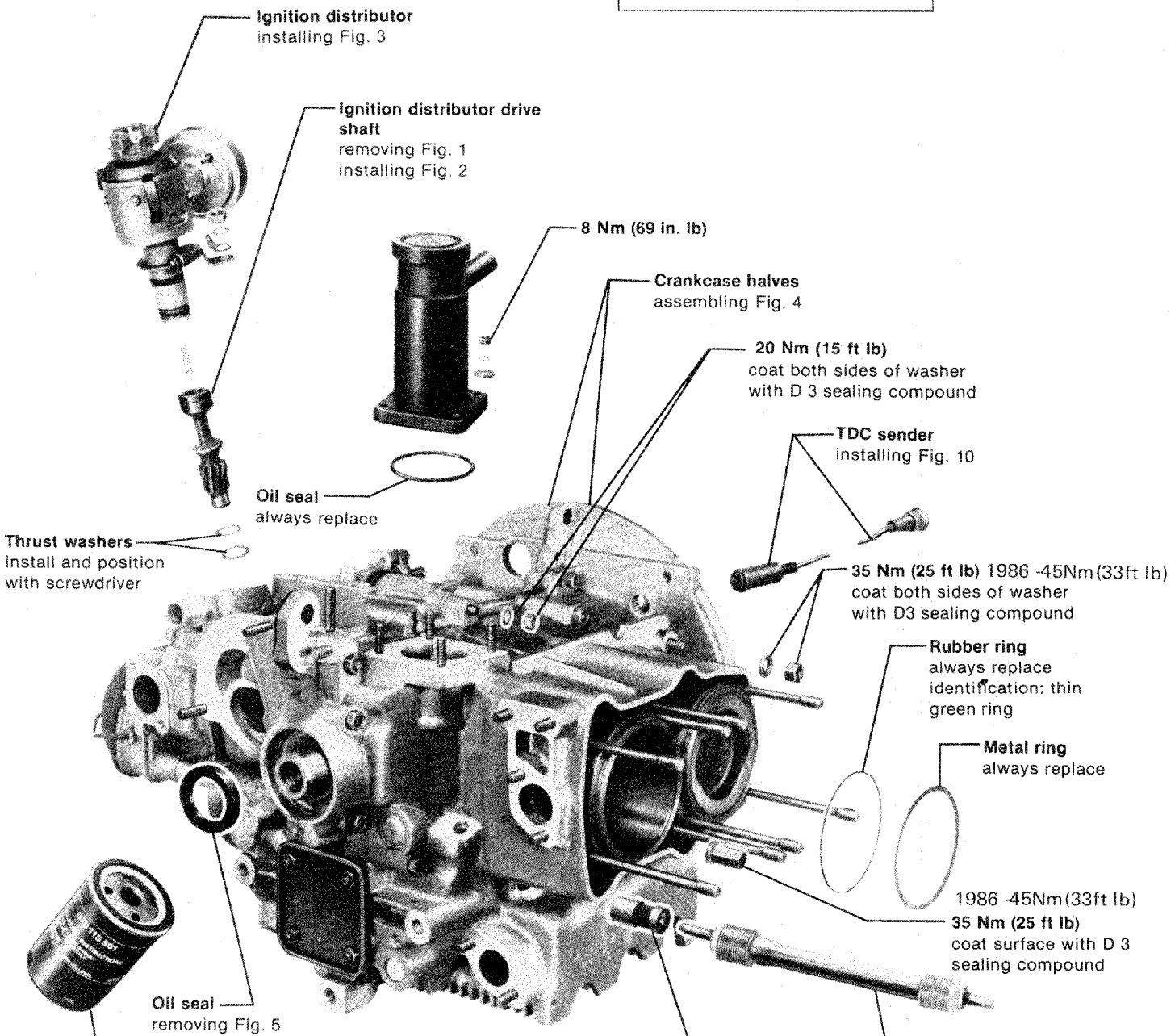
$TA = \frac{2250.0}{15}$

TA = 150 ft.-lb.

— adjust all belts to specification
— top off coolant level in expansion tank

CAUTION

When assembling crankcase halves, see Fig. 4

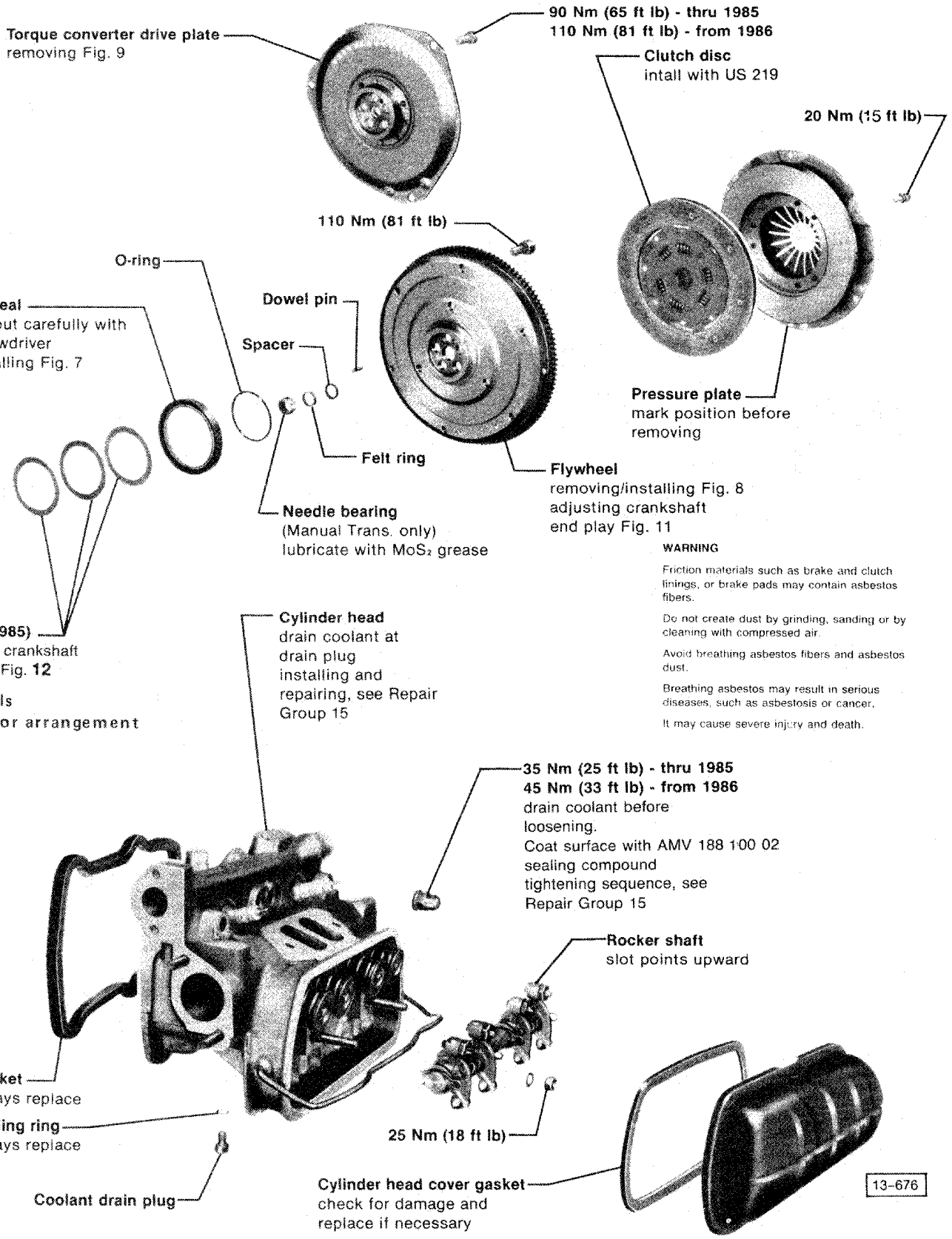


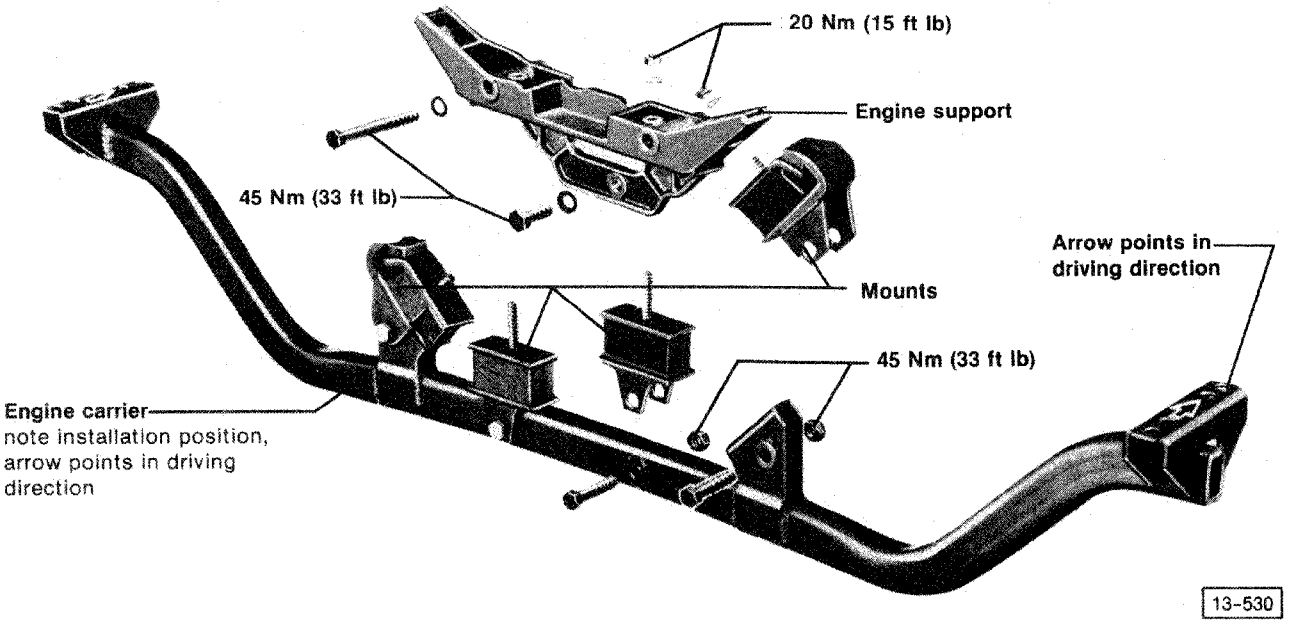
Oil filter
note instructions on filter or box.
Remove with US 4462

Note:
from 1986 -oil cooler added
-see Group 17, pg. 17.7

Hydraulic valve lifter
do not interchange positions.
Store vertical, base downward
repairing, see Repair Group 15

Pushrod tube
seam faces up.
Always replace pushrod tube seals.
Tube can be replaced with cyl. head installed, see Repair Group 15
Preloading and repairing, see Repair Group 15

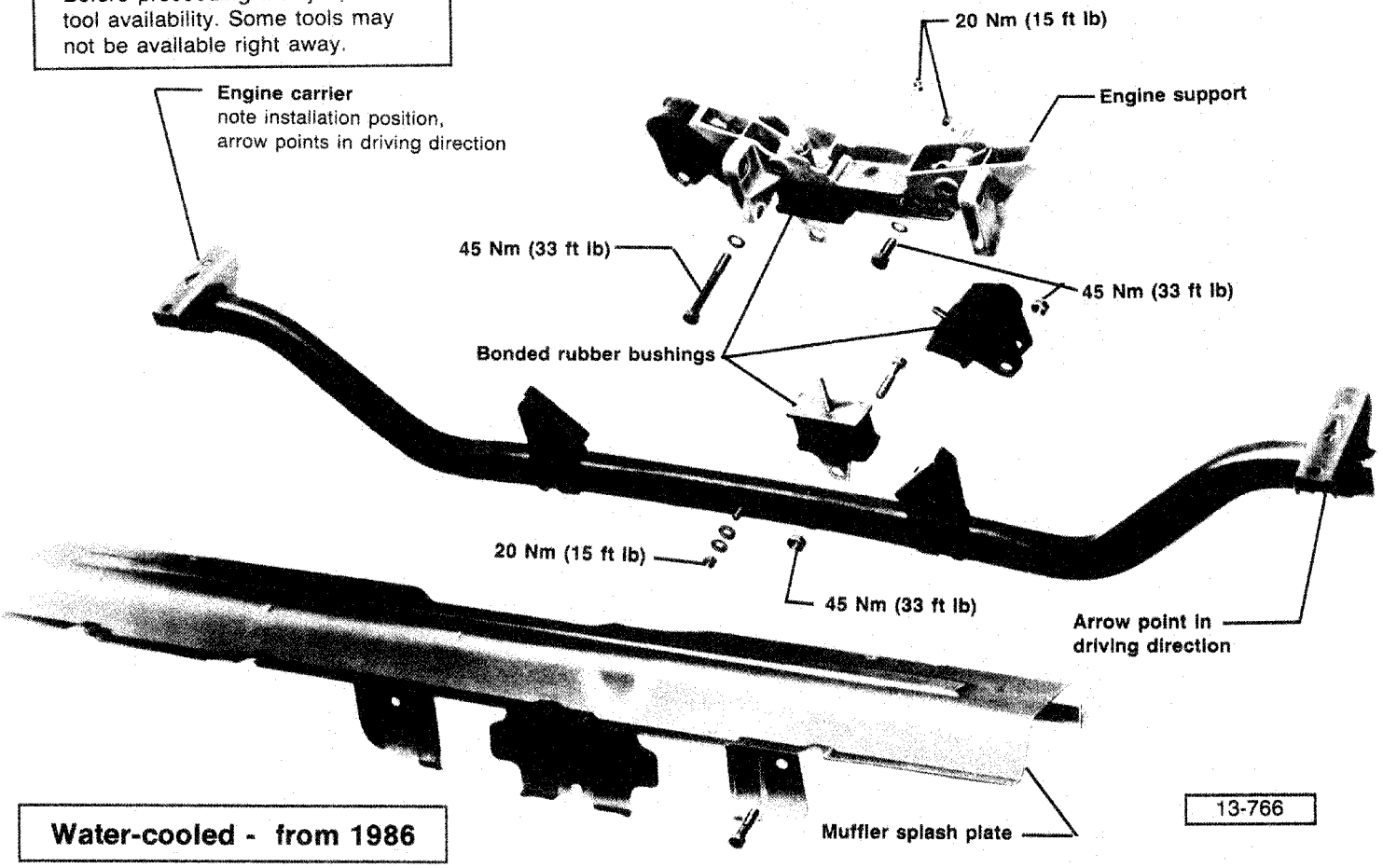

Torque converter drive plate
removing Fig. 9
90 Nm (65 ft lb) - thru 1985
110 Nm (81 ft lb) - from 1986
Clutch disc
intall with US 219
20 Nm (15 ft lb)
110 Nm (81 ft lb)
O-ring
Oil seal
pry out carefully with screwdriver installing Fig. 7
Dowel pin
Spacer
Felt ring
Needle bearing
(Manual Trans. only)
lubricate with MoS2 grease
Pressure plate
mark position before removing
Flywheel
removing/installing Fig. 8
adjusting crankshaft end play Fig. 11
WARNING
Friction materials such as brake and clutch linings, or brake pads may contain asbestos fibers.
Do not create dust by grinding, sanding or by cleaning with compressed air.
Avoid breathing asbestos fibers and asbestos dust.
Breathing asbestos may result in serious diseases, such as asbestosis or cancer.
It may cause severe injury and death.
Shims (thru 1985)
used to adjust crankshaft end play, see Fig. 12
1986 Models
See 13.40 for arrangement
Fig. 13
Cylinder head
drain coolant at drain plug
installing and repairing, see Repair Group 15
35 Nm (25 ft lb) - thru 1985
45 Nm (33 ft lb) - from 1986
drain coolant before loosening.
Coat surface with AMV 188 100 02 sealing compound
tightening sequence, see Repair Group 15
Rocker shaft
slot points upward
Gasket
always replace
Sealing ring
always replace
Coolant drain plug
25 Nm (18 ft lb)
Cylinder head cover gasket
check for damage and replace if necessary
13-676


20 Nm (15 ft lb)
Engine support
45 Nm (33 ft lb)
Arrow points in driving direction
Mounts
45 Nm (33 ft lb)
Engine carrier
note installation position, arrow points in driving direction
13-530

CAUTION

Before proceeding with job, check tool availability. Some tools may not be available right away.

Engine mount/mount bracket can be removed/installed with engine in vehicle.



Water-cooled - from 1986

Engine, disassembling/assembling —All-water-cooled

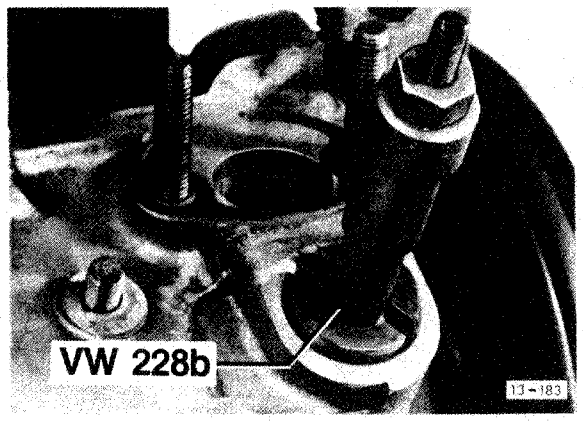


Fig. 1 Ignition distributor drive shaft, removing

— use puller as shown

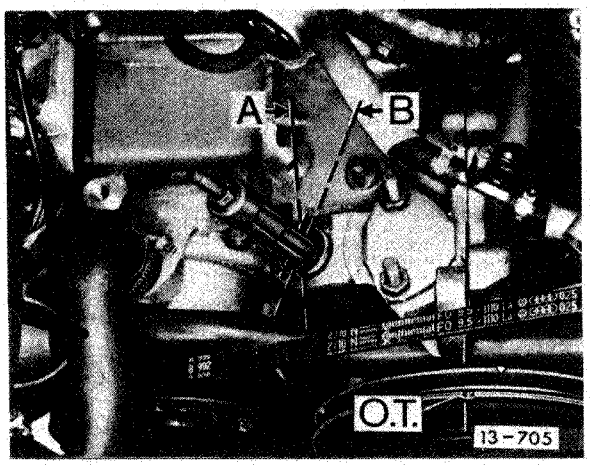


Fig. 2 Ignition distributor drive shaft, installing

— set crankshaft to TDC on cyl. No. 1
— install drive shaft so that offset slot faces bolt (arrow)
— small segment faces water pump

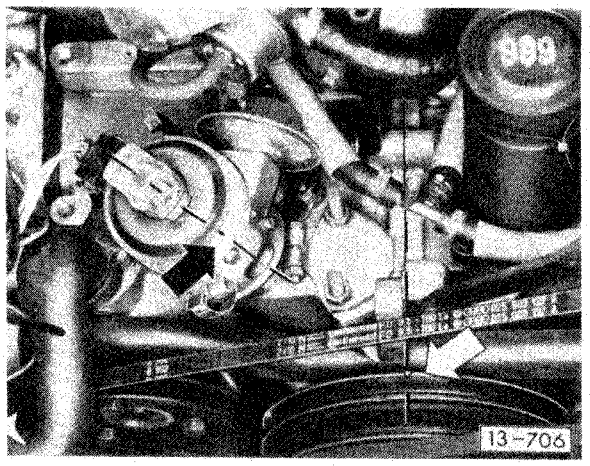


Fig. 3 Ignition distributor, installing

— set cylinder No. 1 to TDC
— turn rotor until mark on rotor is in line with mark on distributor housing (cyl. No. 1)

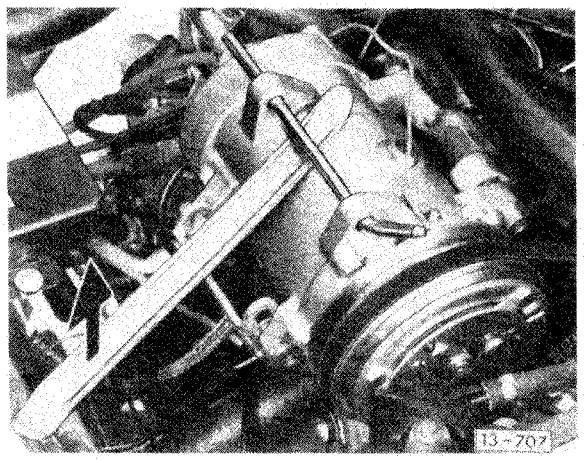


Fig. 4 A/C compressor V-belt, tightening (if applicable)

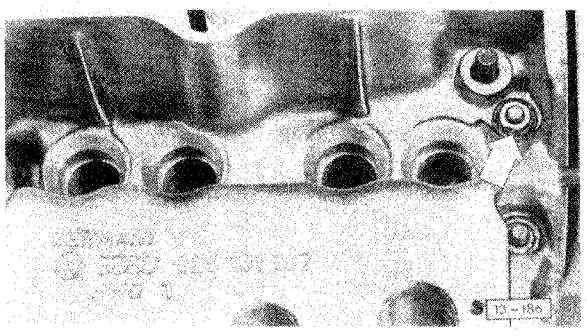


Fig. 5 Crankcase halves, assembling

Note

AMV 188 000 02 sealant is now being used when assembling crankcase halves as of December 12, 1983; engine no. - DH 017 006

When repairing engines, use only AMV 188 000 02 sealant instead of D 3 sealant.

— clean surfaces of crankcase to be joined
  • if D 3 sealant (brownish color) was used on the crankcase previously, the old sealant must be completely removed
  • if the engine was sealed previously with AMV 188 000 02 sealant, only excess material over the edge of the housing should be removed
— apply a thin layer of AMV 188 000 02 sealant to degreased crankcase surfaces to be joined
  • the newly applied sealant dissolves the old sealant and hardens on contact with metal and in absence of air after assembly
— first tighten **M 8** nut (arrow)
— then tighten all **M 10** nuts
— tighten remaining **M 8** nuts

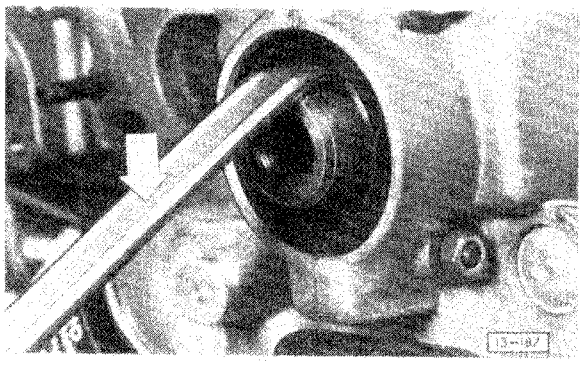


Fig. 6 Crankshaft oil seal, removing

— pry out

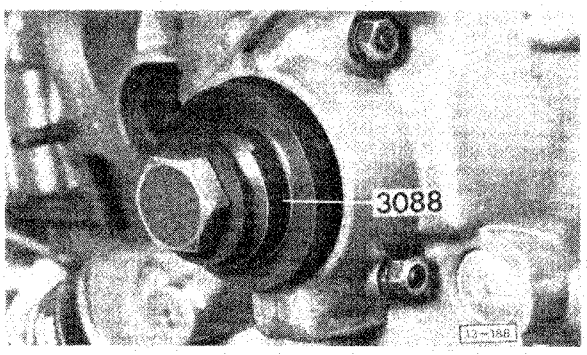


Fig. 7 Crankshaft oil seal, installing

Single pulley
— coat seal lips with oil and install seal with 3088 and pulley bolt without washer (3162 in Syncro)
— then tighten bolt **with washer** until stop

Triple pulley
— coat seal lips with oil and install with 3088 and pulley bolt **without washer** and tighten bolt until stop

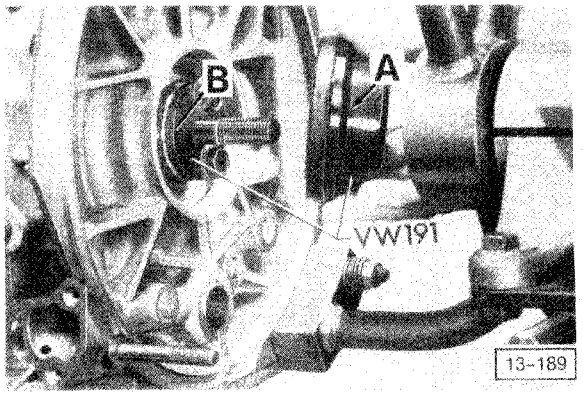


Fig. 8 Crankshaft oil seal (flywheel side), installing

— coat seal lips with oil and put on guide **A**
— screw base **B** into crankshaft and press in guide **A** with seal until seated

shims and disks between crankshaft bearing and oil seal must be installed in correct order. See Fig. 13.

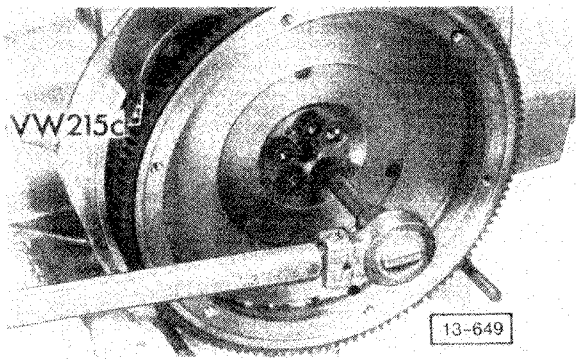


Fig. 9 Flywheel, removing

— lock flywheel with tool

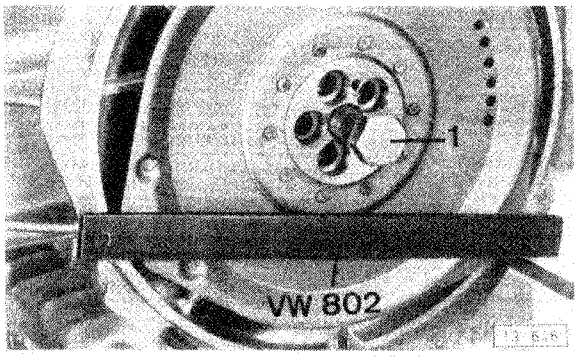


Fig. 10 Torque converter drive plate, removing

— lock plate with VW 802
— to remove, screw in bolt **1** (M 18 × 1.5 × 60). Thread length of bolt must be at least 45 mm (1.77 in.)

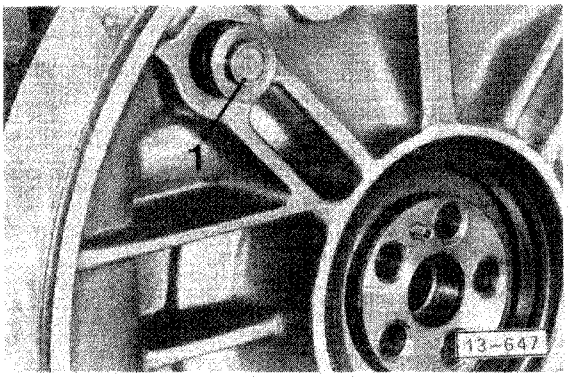


Fig. 11 TDC sender, installing

— use piston pin and plastic hammer to drive TDC sender in until stop
— do not damage inner ring **1**

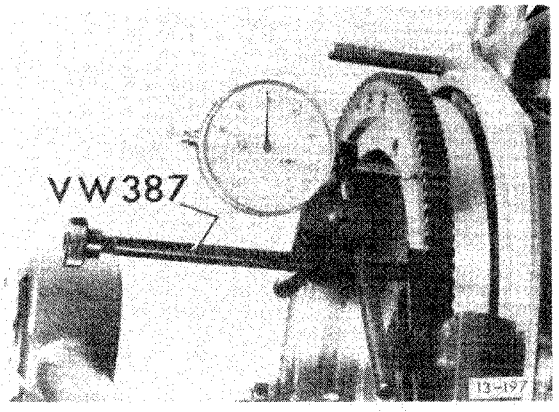


Fig. 12 Crankshaft end play, checking/adjusting

— check crankshaft end play
  • new: 0.07–0.13 mm (0.003–0.005 in.)
  • wear limit: 0.15 mm (0.006 in.)
— if out of specification proceed as follows:
— install flywheel with **2** shims but **without** O-ring and crankshaft oil seal
— mount dial indicator with bracket on crankcase
— move crankshaft in and out and measure movement (crankshaft end play)
— determine thickness of **3rd** shim

Example

dial indicator reading	0.44 mm (0.017 in.)
specified end play	– 0.10 mm (0.004in.)
thickness of **3rd** shim	0.34 mm (0.013 in.)

Shims C on 1986 and 1987 vechicles see Fig. 13

go to next page

Note

Thickness of shim is etched on shim. Always recheck with micrometer

> **CAUTION**
>
> Always install **three** shims to obtain correct crankshaft end play

— remove flywheel
— install O-ring, crankshaft oil seal and felt ring
— install all three shims

— install flywheel
— tighten bolts to 110 Nm (80 ft lb)
— recheck crankshaft end play

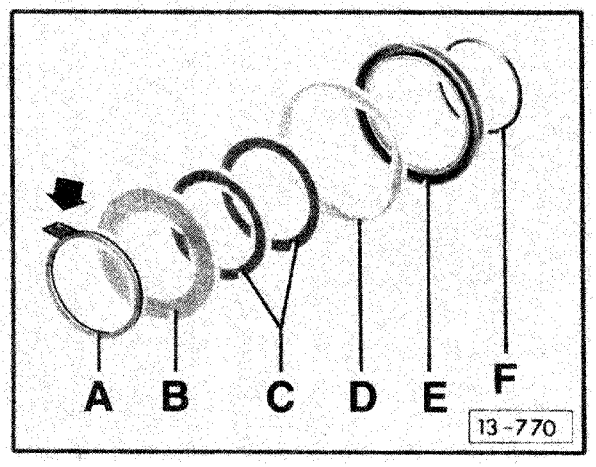
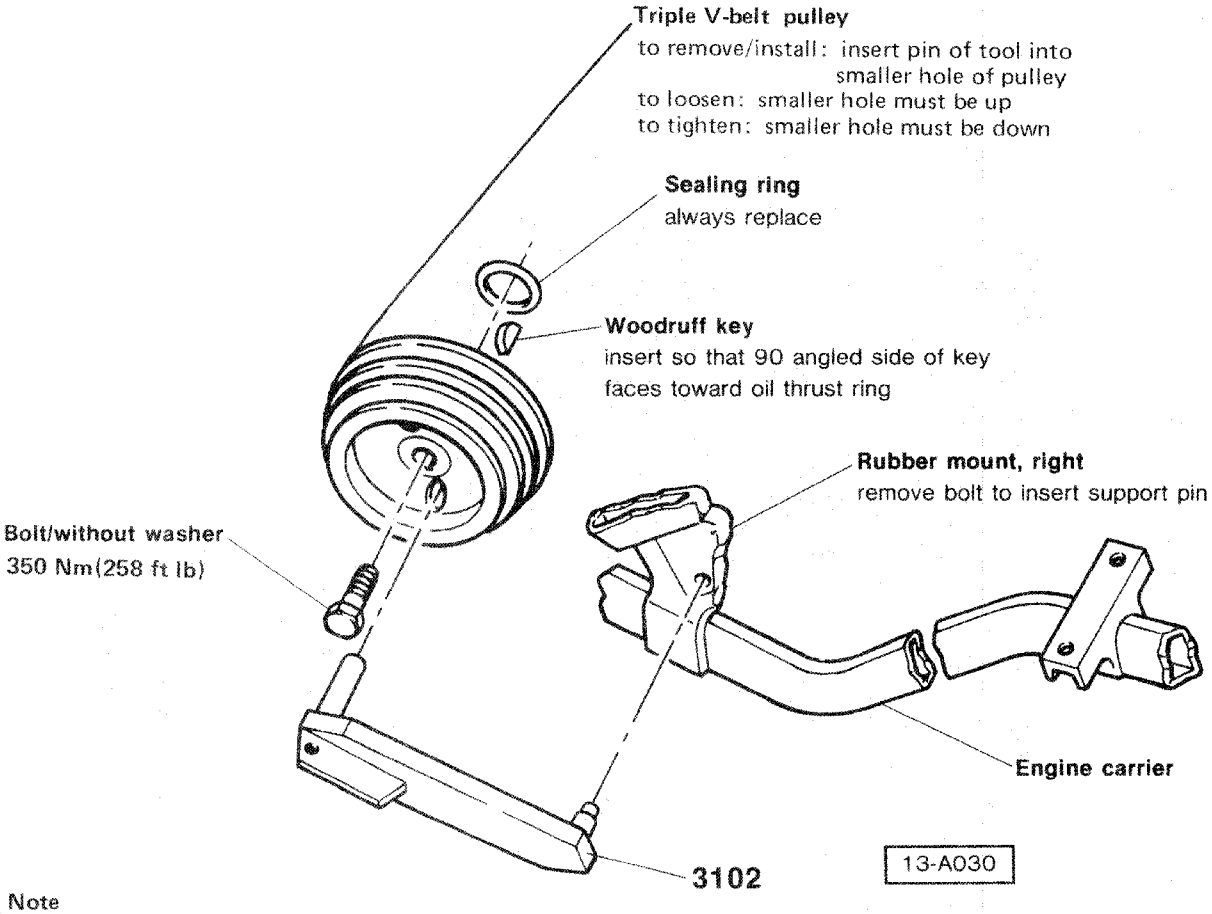


Fig. 13 **Shim arrangement (from 1986)**
A = Thrust washer
• lip points toward crankshaft bearing
B = 0.81 mm shim
C = 0.75 mm shims
D = 0.94 mm
E = Oil seal
• pry out with screwdriver
F = O-ring
• always replace

Apply light film of oil on **both** sides of thrust washer **A**.
Install with lip (arrow) pointing **toward** crankshaft bearing
— press shim **B** to **A**
— install flywheel **without** O-rings, **E**, **F**
— mount dial indicator with bracket on crankcase
Proceed to determine thickness of shim **C** (see fig. 12)
— remove flywheel
— install shims **C**, **D**, and oil seal **E**
— install flywheel with **F**
— tighten bolts to 110 Nm (80 ft lb)
— recheck crankshaft end play

13.41 Crankshaft end play

Water-cooled from 1986



Note

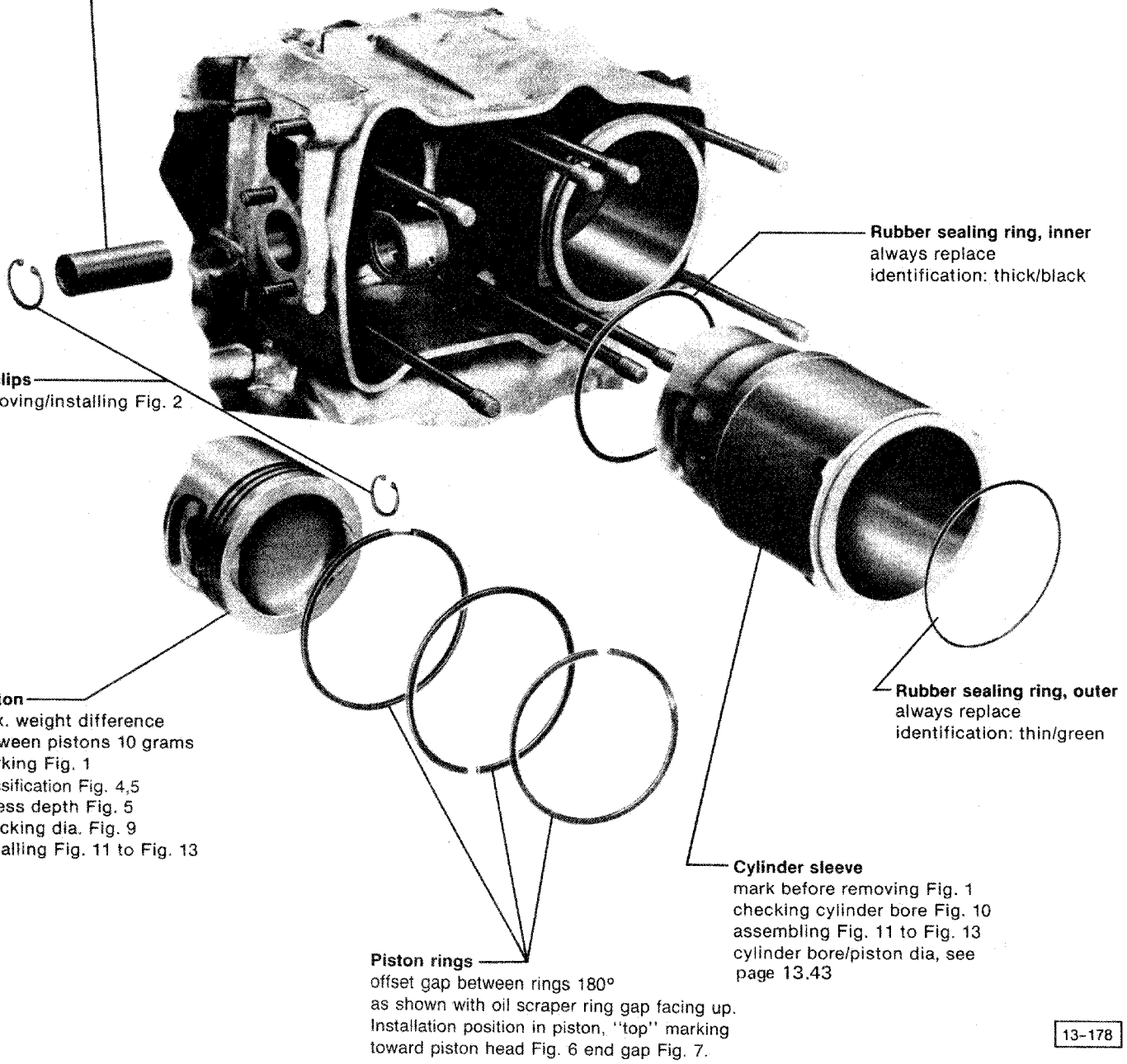
Triple V-belt pulleys supplied as spare parts have only TDC mark 0. Cut timing mark same as single V-belt pulley, see page 13.33

Note

Remove deposits (scale) from cylinders/crankcase and cylinder head

Note

Before proceeding with repairs, verify availability of all tools.



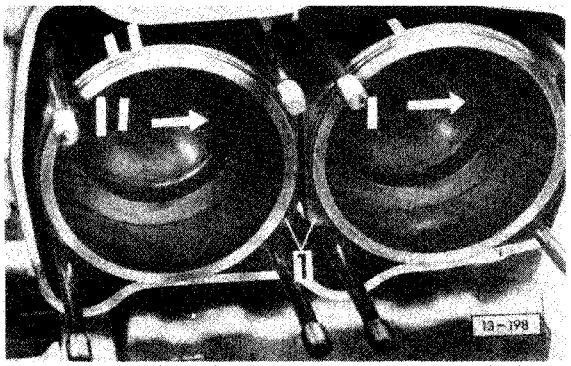


Fig. 1 Piston/cylinder sleeve, marking

- arrow points to flywheel
- before removing, mark matching numbers on pistons and cylinder sleeves
- cylinder boss **1** faces inward

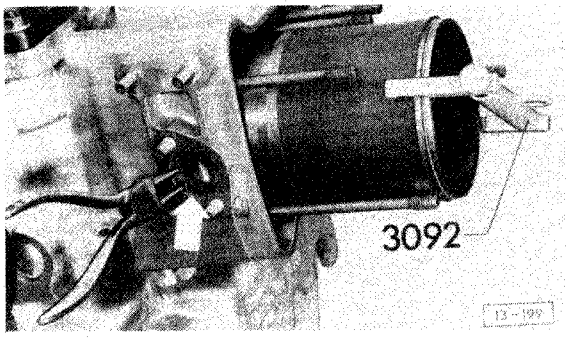


Fig. 2 Circlips, removing/installing
on V-belt side:

— with piston at TDC, pull out cylinder sleeve with 3092 until piston pin circlip visible (arrow)

at flywheel end:

— with first cylinder sleeve removed

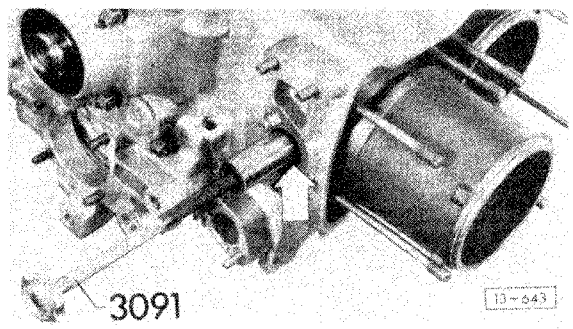


Fig. 3 Piston pins, removing

— remove pins as shown (arrow)

Note

If piston pin cannot be pulled out of piston, remove 3091 and remove burr in piston pin bore with reamer 3159.

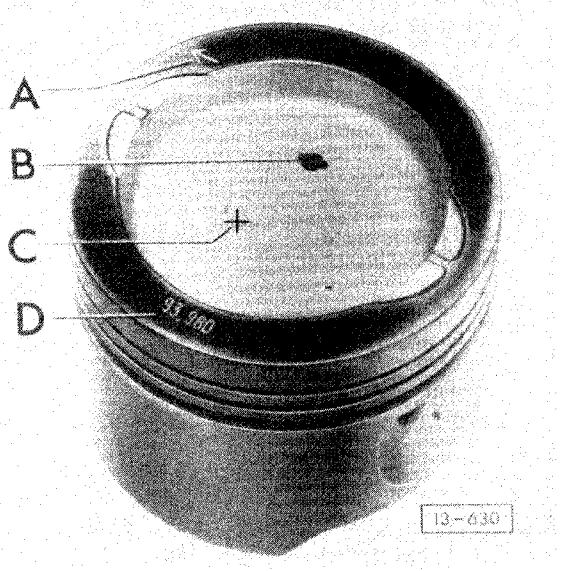


Fig. 4 Piston classifications

A = arrow (stamped on) must point toward flywheel when piston is installed
B = paint dot (blue) indicates matching size
C = weight group (+ or −) stamped on
− weight = 448-456 grams
+ weight = 457-464 grams
D = piston size in millimeters (see table on page 13.43)

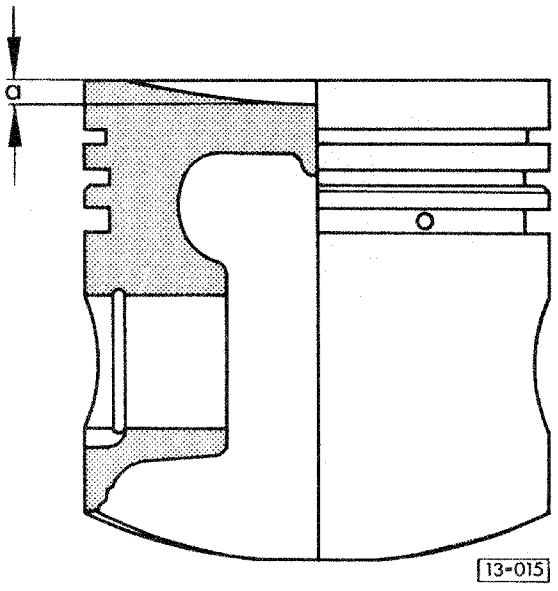


Fig. 5 Piston recess depth

- measurement **a** = 11.65 mm (0.458 in.)

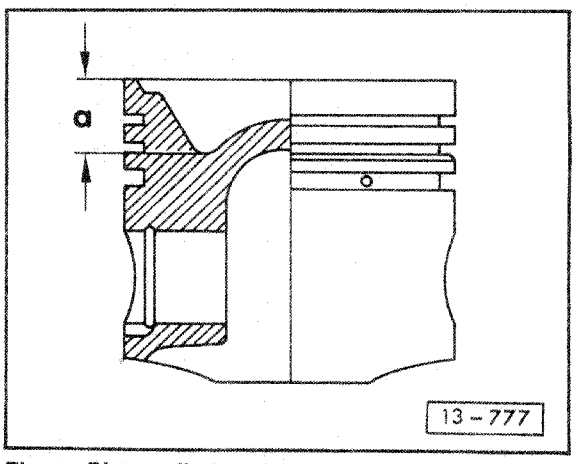


Fig. 6 Piston distinguishing characteristics - 2.1 L Digifant/Syncro only

engine code	dimension 'a'
MV	15.5 mm

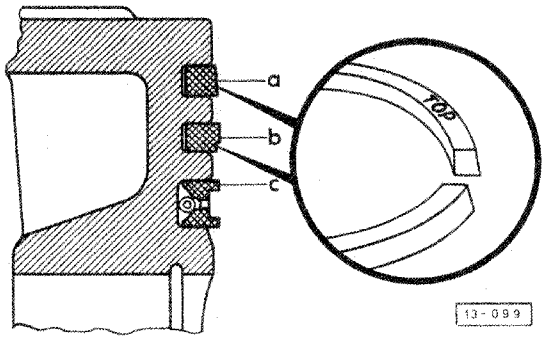


Fig. 7 Piston rings, installation position

- **TOP** mark on piston rings must face to top of piston

a = upper ring
b = lower ring
c = oil scraper ring

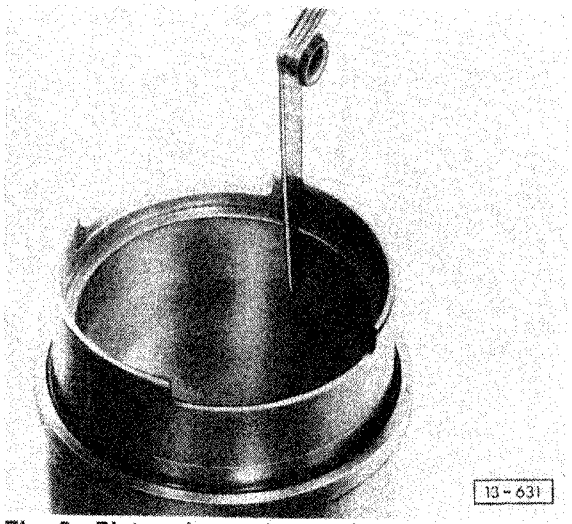


Fig. 8 Piston ring end gap, checking

— push ring in squarely from lower cylinder opening about 4-5 mm (3/16 in.)
— measure gap with feeler gauge

	ring end gap	wear limit
upper ring	= 0.30-0.45 mm (0.012-0.018 in.)	0.90 mm (0.035 in.)
lower ring	= 0.30-0.50 mm (0.012-0.020 in.)	0.90 mm (0.035 in.)
oil scraper ring	= 0.25-0.40 mm (0.010-0.016 in.)	0.95 mm (0.037 in.)

Fig. 9 Piston ring side clearance, checking

	clearance	wear limit
upper ring	= 0.05-0.08 mm (0.002-0.003 in.)	0.12 mm (0.005 in.)
lower ring	= 0.04-0.07 mm (0.002-0.003 in.)	0.10 mm (0.004 in.)
oil scraper ring	= 0.02-0.05 mm (0.001-0.002 in.)	0.10 mm (0.004 in.)

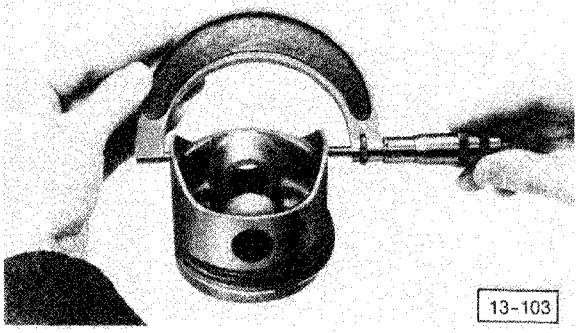


Fig. 10 Piston, checking diameter/wear

— measure at bottom of skirt approx. 15 mm (9/16 in.) from edge (diameter stamped in top of piston)

Fig. 11 Cylinder sleeve, checking for wear

— measure 10-16 mm (3/8-5/8 in.) from top
- piston to sleeve clearance is sleeve diameter minus piston diameter

new = 0.03-0.06 mm (0.001-0.002 in.)
wear limit = 0.2 mm (0.008 in.)

Cylinder sleeve bore/Piston diameter

size	color	cylinder diameter	matching piston diameter
standard	blue	94.005-94.016 mm	93.98 mm
1st oversize	pink	94.016-94.027 mm	93.99

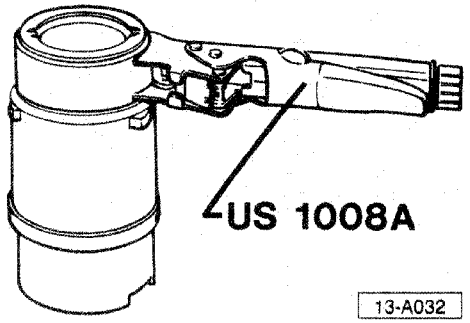


Fig. 12 Piston and cylinder sleeve, installing

— replace rubber sealing rings for cylinder sleeves:
- cylinder head end = thin ring (green)
- crankcase end = thick ring (black)

— install piston into cylinder sleeve (flywheel side first)
- arrow on piston points toward flywheel
- gap of oil scraper ring must be to top
- piston ring gaps offset by 180° (see explosion view)

— insert circlip for piston pin on flywheel side of piston

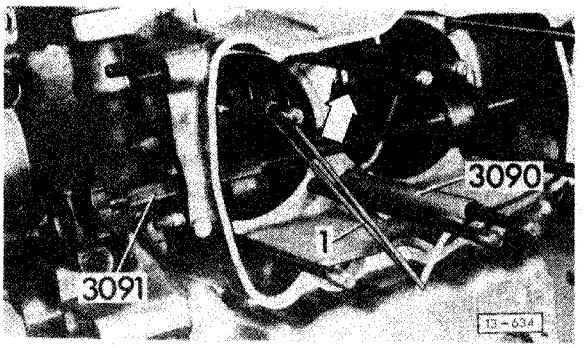


Fig. 13 Piston and cylinder sleeve, installing

— note markings on connecting rod support 3090
- R = right side of engine
- L = left side of engine

— push connecting rod support onto center stud so finger of tool supports connecting rod; then secure it with rubber band **1** to prevent it from slipping

— align connecting rod such that piston pin can be installed through hole in housing
- crankshaft must be at TDC
- lug on rod faces up

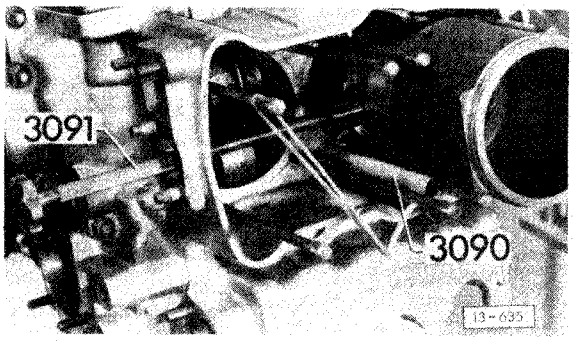


Fig. 14 Piston and cylinder sleeve, installing

— install piston pin with 3091 and insert circlip

CAUTION

When assembling crankcase halves, observe tightening sequence and tightening torque (see page 13.36 and page 13.39, Fig. 5)

Oil pickup line with filter screen
cleaning Fig. 4
replacing Fig. 5

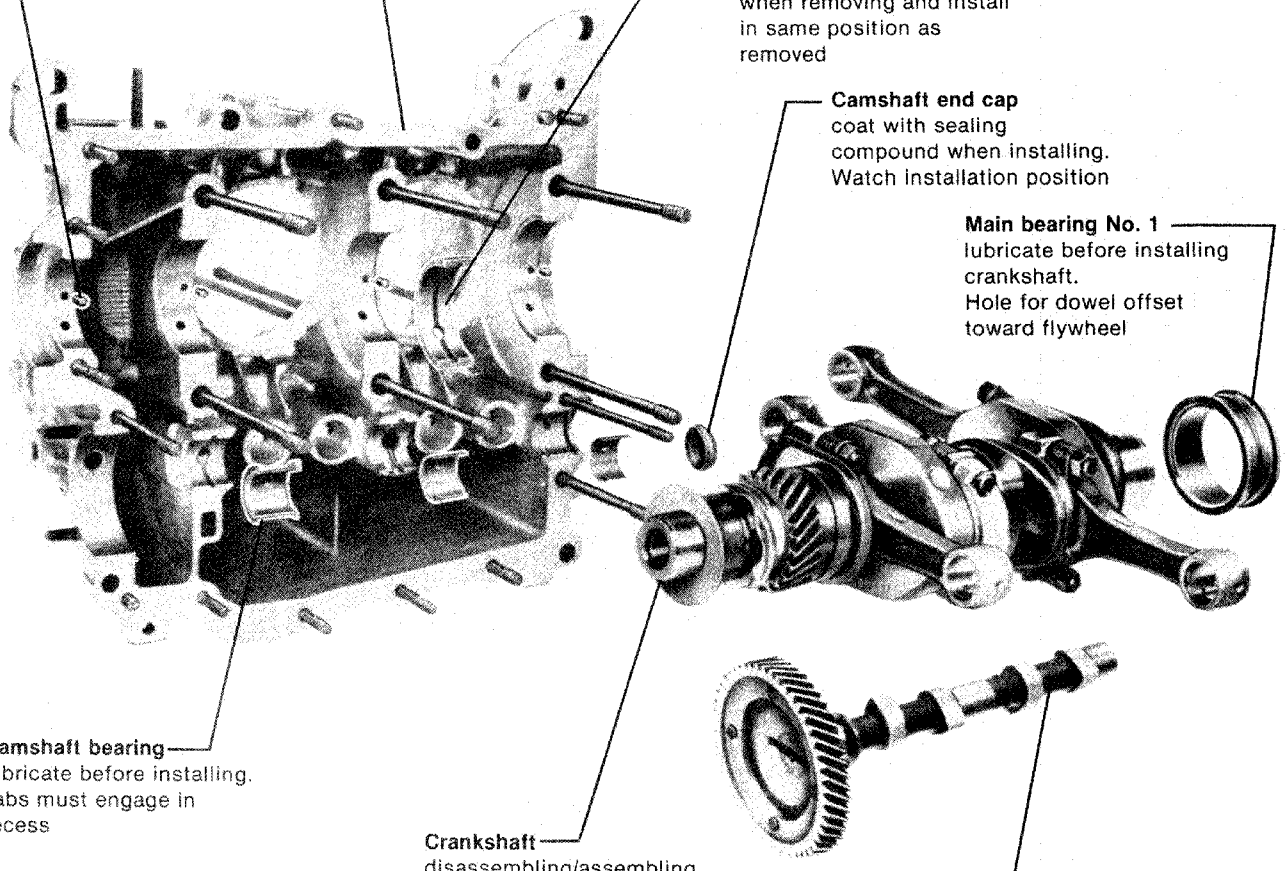
Crankcase
clean and blow through all oil channels with compressed air.
Coat joining surfaces with D3 sealing compound

Dowel
check for tight fit in case

Main bearing No. 2
lubricate before installing crankshaft.
Note installation position when removing and install in same position as removed

Camshaft end cap
coat with sealing compound when installing.
Watch installation position

Main bearing No. 1
lubricate before installing crankshaft.
Hole for dowel offset toward flywheel



Camshaft bearing
lubricate before installing.
Tabs must engage in recess

Crankshaft
disassembling/assembling, see page 13.46

Camshaft
runout, checking Fig. 1
end play, checking Fig. 2
installing Fig. 3

13-179

CAUTION

When assembling crankcase halves, observe tightening sequence and tightening torque.

Oil pickup line with filter screen. Fig. 4

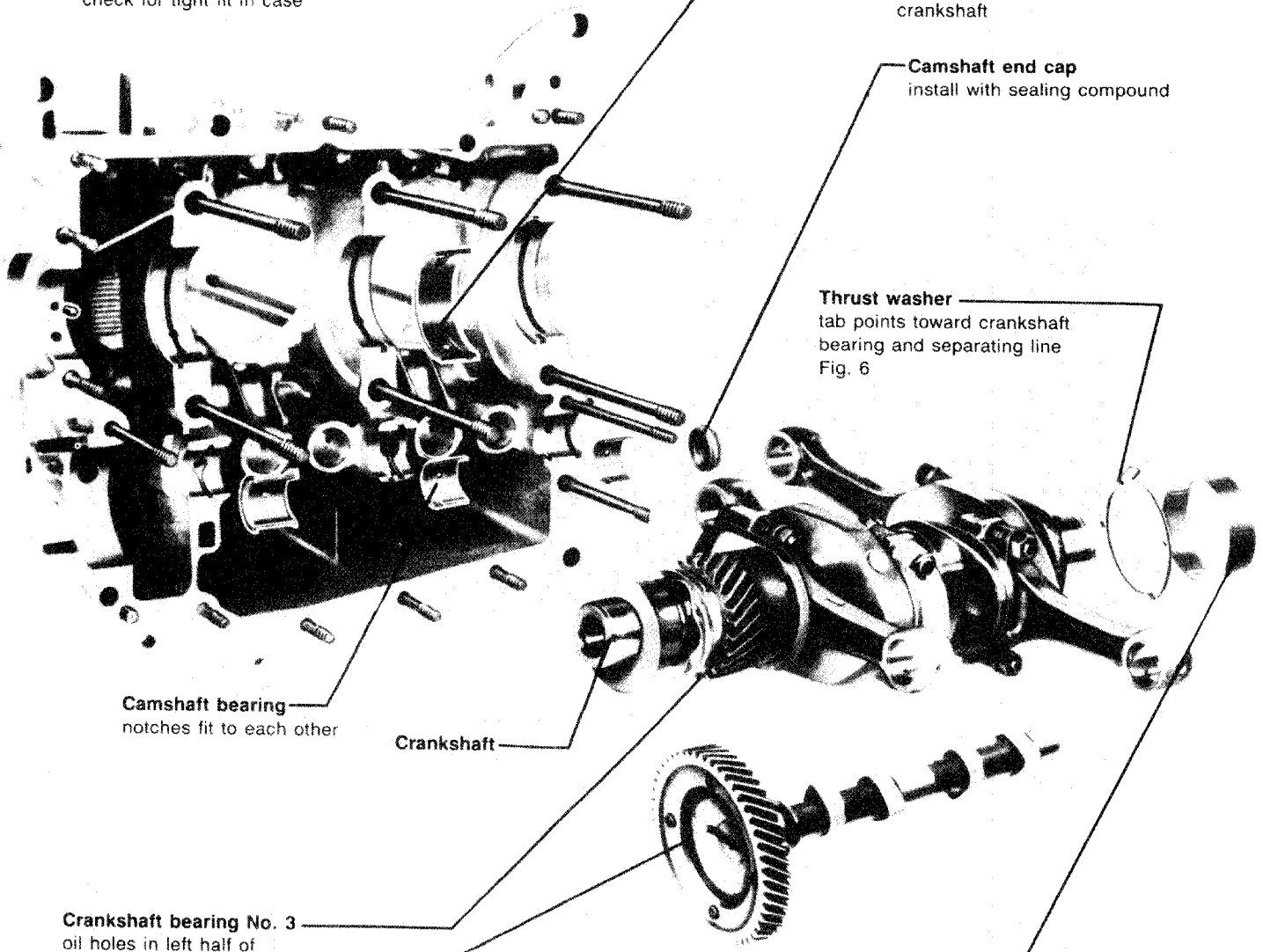
Crankcase
clean and blow through all oil channels with compressed air. Coat joining surfaces with AMV 188 100 02 sealing compound

Dowel
check for tight fit in case

Main bearing No. 1
color coded red/blue corresponding to crankshaft dimensions
lubricate before installing in crankshaft
tabs on bearing fit into recesses in crankshaft housing
oil holes in left side of crankshaft

Camshaft end cap
install with sealing compound

Thrust washer
tab points toward crankshaft bearing and separating line Fig. 6



Camshaft bearing
notches fit to each other

Crankshaft

Crankshaft bearing No. 3
oil holes in left half of crankshaft housing tabs engage in recess

13-771

Camshaft
face marked with blue runout Fig. 1

Main bearing No. 2
lubricate before installing
color coded blue or red corresponding to crankshaft dimensions

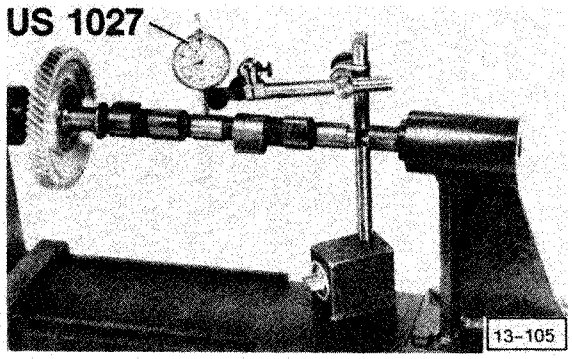


Fig. 1 Camshaft runout, checking

- wear limit 0.04 mm (0.0015 in.)

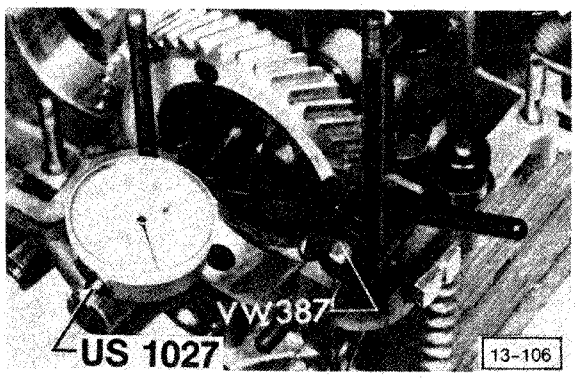


Fig. 2 Camshaft end play, checking

- wear limit 0.16 mm (0.006 in.)
- if out of specification, replace camshaft bearings

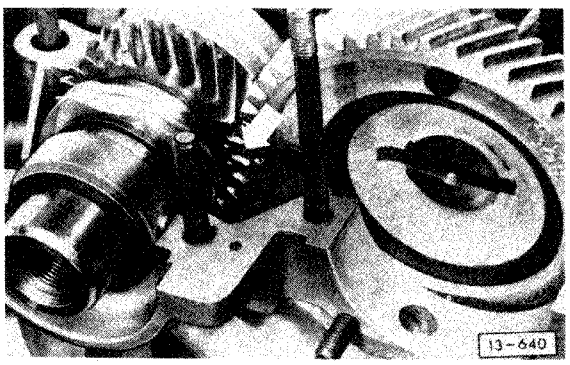


Fig. 3 Camshaft, installing

— mark on camshaft gear tooth must be between marks on crankshaft gear teeth (arrow)
— check backlash of timing gears
- 0.0-0.05 mm (0-0.002 in.)
- backlash must be hardly noticeable

— turn crankshaft **backward**
- camshaft must not lift out of bearings
- if camshaft lifts out of bearings, install camshaft with smaller timing gear

Note

To obtain specified backlash, camshafts with various size timing gears are available. Markings are on **inner** face of timing gear

Example
"−0.1", "+0.1", "+0.2", indicates in 1/100 mm how much pitch radius differs from standard pitch radius "0"

CAUTION

Mark **0** on **outer** face of camshaft timing gear is timing mark and must not be confused with markings on **inner** face. Crankshaft timing gear is available in one size only

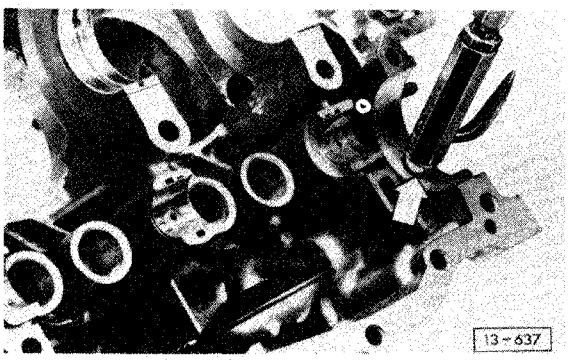


Fig. 4 Oil pickup line with filter screen, cleaning

— clean oil channels by blowing through with compressed air (arrow)

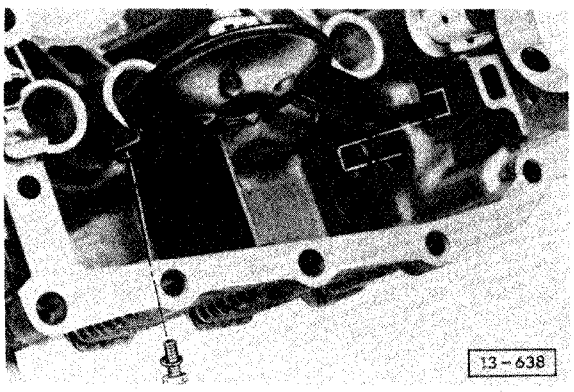


Fig. 5 Oil suction line with filter screen, replacing

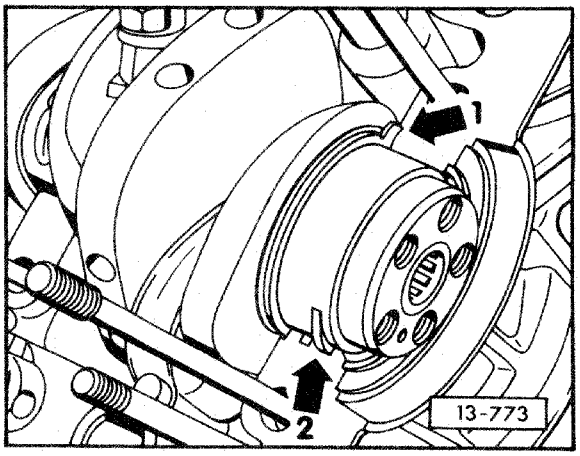
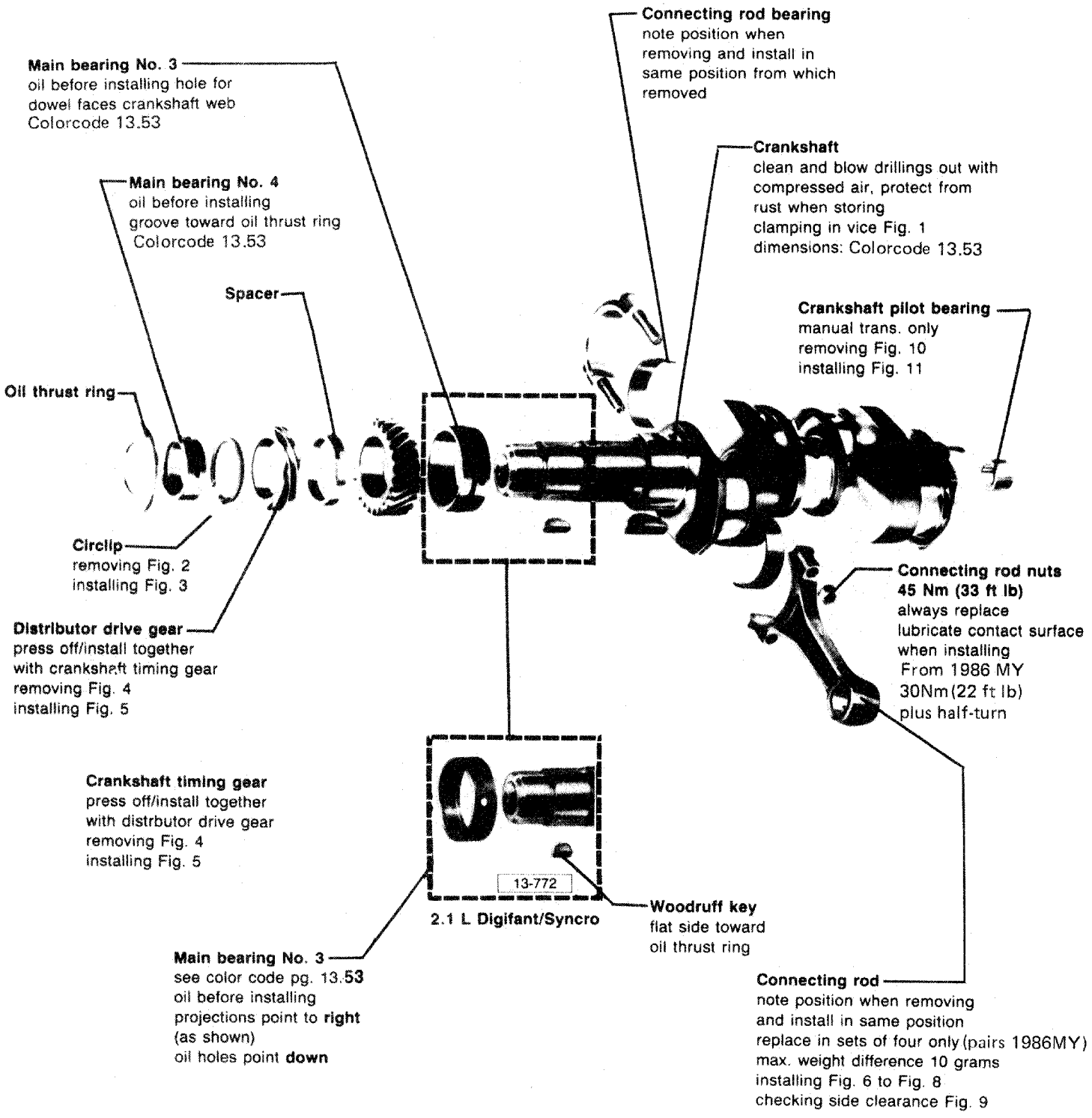
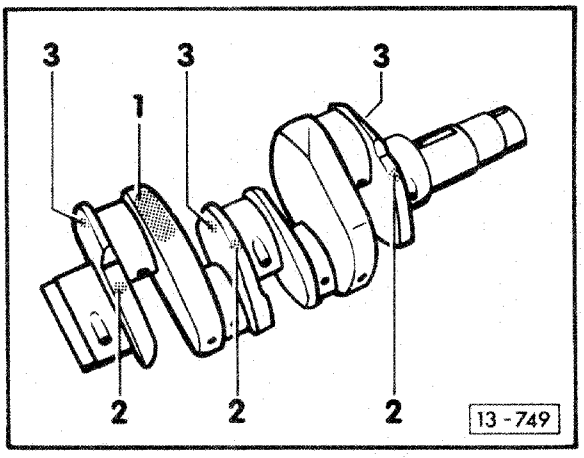


Fig. 6 Thrust washer and main bearing 1, installing

Arrow 1: projection on thrust washer points toward main bearing and separating line of crankcase.

Arrow 2: projection on main bearing fit into notches in crankcase. Oil holes are in left half of crankcase housing.


Connecting rod bearing
note position when removing and install in same position from which removed
Main bearing No. 3
oil before installing hole for dowel faces crankshaft web
Colorcode 13.53
Crankshaft
clean and blow drillings out with compressed air, protect from rust when storing
clamping in vice Fig. 1
dimensions: Colorcode 13.53
Main bearing No. 4
oil before installing
groove toward oil thrust ring
Colorcode 13.53
Spacer
Crankshaft pilot bearing
manual trans. only
removing Fig. 10
installing Fig. 11
Oil thrust ring
Circlip
removing Fig. 2
installing Fig. 3
Distributor drive gear
press off/install together with crankshaft timing gear
removing Fig. 4
installing Fig. 5
Connecting rod nuts
45 Nm (33 ft lb)
always replace
lubricate contact surface when installing
From 1986 MY
30Nm (22 ft lb)
plus half-turn
Crankshaft timing gear
press off/install together with distrbutor drive gear
removing Fig. 4
installing Fig. 5
13-772
2.1 L Digifant/Syncro
Woodruff key
flat side toward oil thrust ring
Main bearing No. 3
see color code pg. 13.53
oil before installing
projections point to right (as shown)
oil holes point down
Connecting rod
note position when removing and install in same position
replace in sets of four only (pairs 1986MY)
max. weight difference 10 grams
installing Fig. 6 to Fig. 8
checking side clearance Fig. 9
13-177



Crankshaft color code

1 = Color code **green** (2.1 L engine-Digifant/Syncro)
2 = Color code **blue** or **red** (crankshaft code/size)

Note

On some crankshafts the blue or red code can appear in position **three.**

Crankshaft journal sizes (mm)

	Bearing No. 1	Bearing No. 2	Bearing No. 3	Bearing No. 4	Connecting rod
Standard size (thru 1985)	59.980-59.990 (marked: blue dot)	54.971-54.990	54.980-54.990 (marked: blue dot)	39.984-40.00	54.983-54.996
2.1 L Digifant, Syncro	59.971-59.979 (marked: red dot)	54.980-54.990 (marked: blue dot) 54.971-54.979 (marked: red dot)	54.971-54.979 (marked: red dot)		

Note

If crankshaft has blue or red dot **only** main bearings with same color code can be used.

Code for main bearings, 1, 2, 3 = 001 (blue), 004 (red)

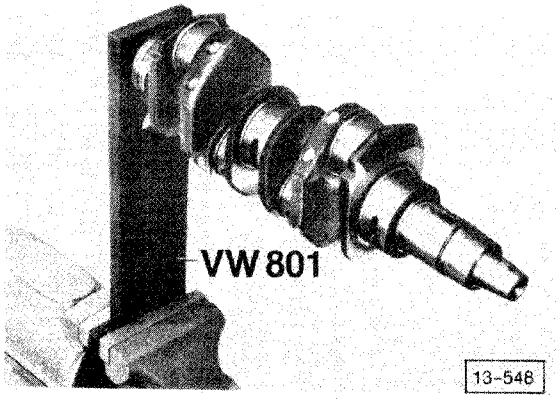


Fig. 1 Crankshaft, clamping in vise

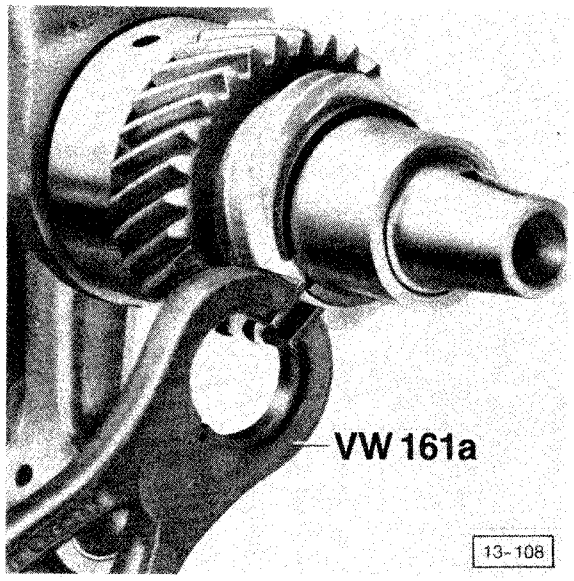


Fig. 2 Circlip, removing

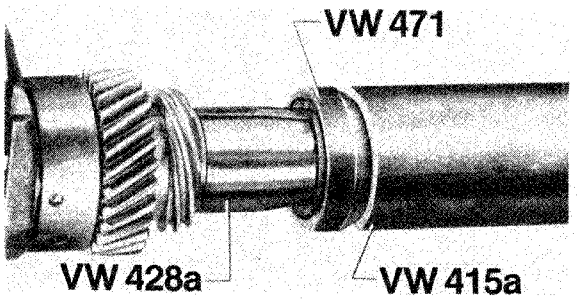


Fig. 3 Circlip, installing

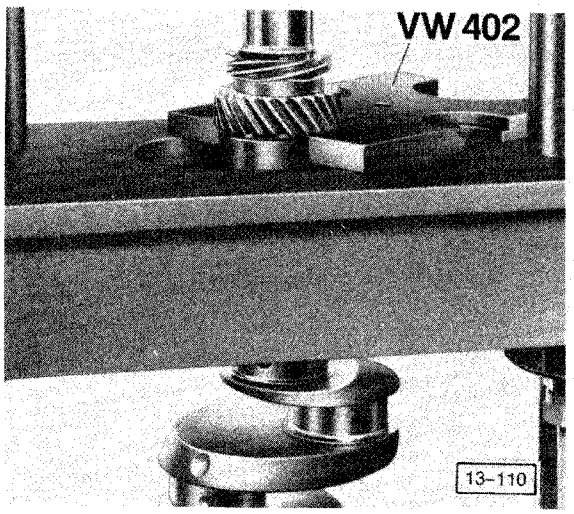


Fig. 4 Distributor drive gear/crankshaft timing gear, removing

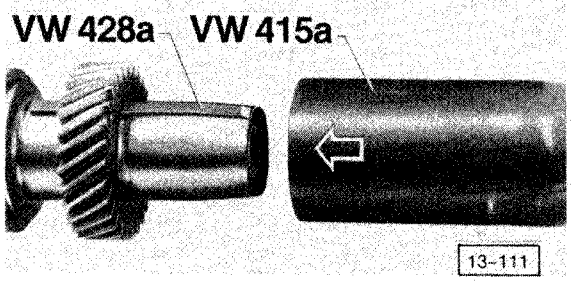


Fig. 5 Distributor drive gear/crankshaft timing gear, installing

— heat gears to approx. 80 °C (175 °F) before installing

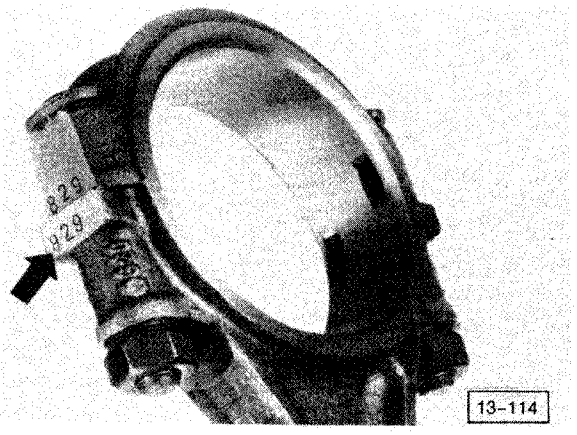


Fig. 6 Connecting rod, installing

— numbers (arrow) on rod and cap must match and be on same side

Connecting rod bolts, removal/installing
2.1L Digifant/Syncro

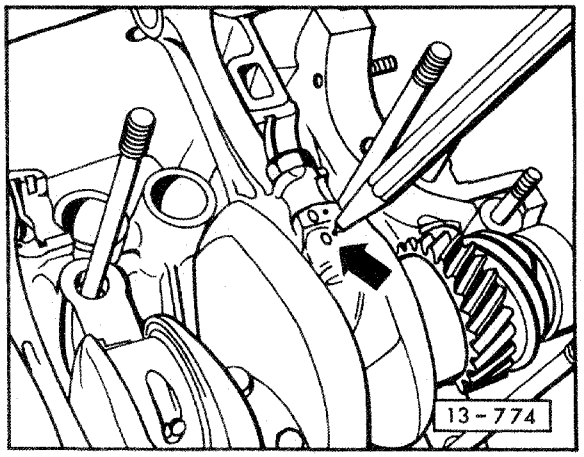


Fig. 7 Mark matching connecting rod/bearing cover with cylinder

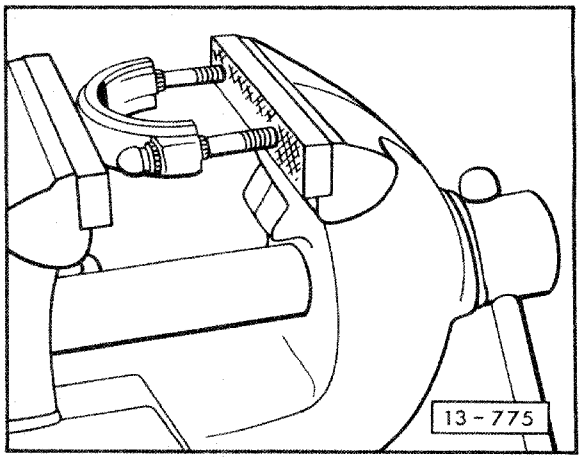


Fig. 8 Connecting rod bolts, removing

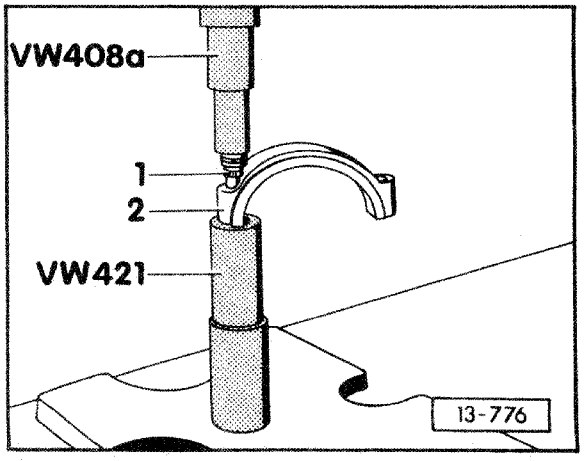


Fig. 9 Connecting rod bolts, installing

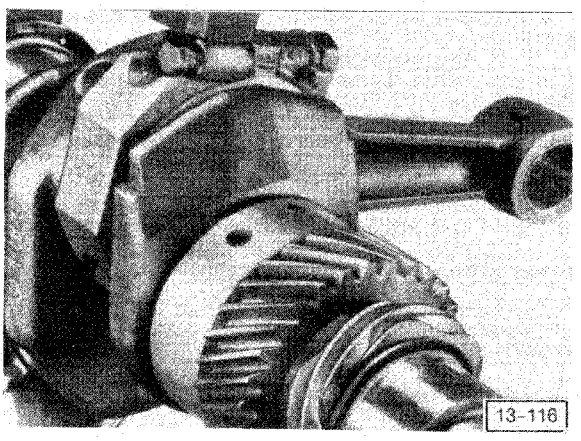


Fig. 10 Connecting rod, installing

— lightly tap both sides of connecting rod with hammer to eliminate slight pinching of bearing shells when installing connecting rod

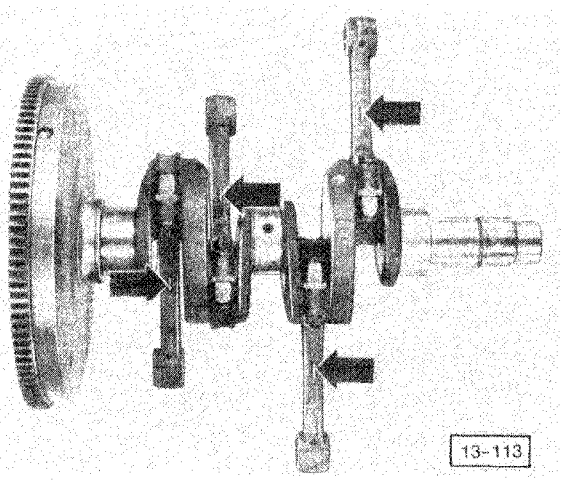


Fig. 11 Connecting rods, installation position

• forged mark on rods (arrows) must face up when rods are installed

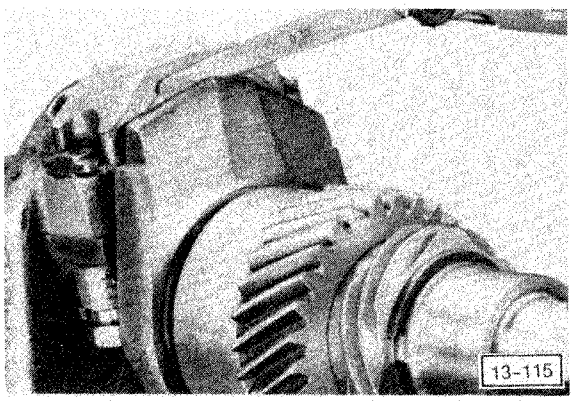


Fig. 12 Connecting rod, checking side clearance

• wear limit 0.7 mm (0.028 in.)

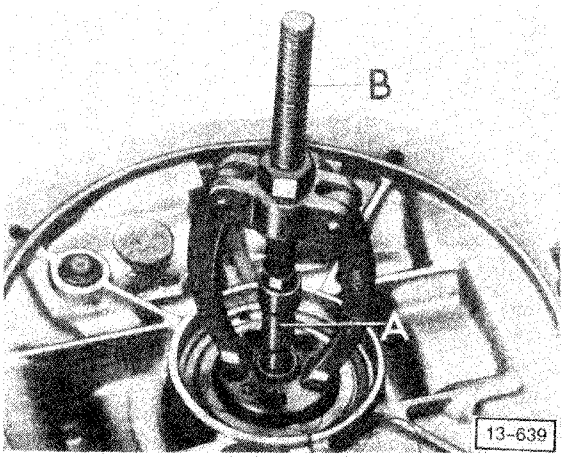


Fig. 13 Crankshaft pilot bearing, removing

A = US 8028
B = US 1039 & US 1039/3

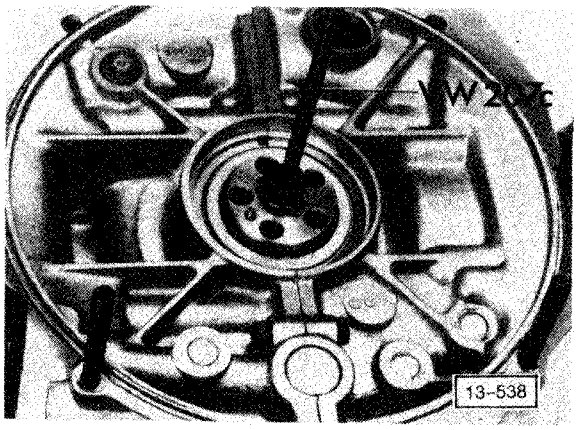


Fig. 14 Crankshaft pilot bearing, installing

— lubricate with MoS_2 grease when installing
- markings on bearing cage must face outward