AfterSales Training

Air Cooled Engine Repair
Types: 964 & 993

P10-L

Porsche AfterSales Training

Student Name: ____

Training Center Location: ____

Instructor Name: ____

Date: _________________

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Part Number - PNA P10 L01 Edition -6/04

Engine Number Identification

Digit: **1 2 3 4 5 6 7 8**

Example: 6 5 V 0 0 1 3 6

Engine Type: (6 = 6 Cyl. Engine)

Engine Version:

Model Year:

Serial Number:

911 Engine Type Designations Model Year 1984-98

Model Year	Engine Type	Displ. Liters	Engine Power kW / HP	Installed In
1984	930.20	3.2	170/231	911 Carrera - RoW
	930.21	3.2	152/207	911 Carrera - USA/Canada/Japan
	930.66	3.3	221/300	911 Turbo - Worldwide
1985	930.20	3.2	170/231	911 Carrera - RoW
	930.21	3.2	152/207	FRG/USA/Canada/Japan (with catalytic converter)
	930.26	3.2	170/231	Sweden /Switzerland /Australia
	930.66	3.3	221/300	911 Turbo - Worldwide
1986	930.20	3.2	170/231	911 Carrera - RoW
	930.21	3.2	152/207	911 Carrera USA/Canada/Japan
	930.26	3.2	170/231	911 Carrera Sweden./Switzerland/Australia
	930.66	3.3	221/300	ROW/Canada
	930.68	3.3	208/282	911 Turbo - USA (with catalytic convverter)
1987	930.20	3.2	170/231	911 Carrera - RoW
	930.25	3.2	160/217	USA / Japan
	930.26	3.2	170/231	Sweden
	930.66	3.3	221/300	RoW/Canada
	930.68	3.3	210/282	USA (with catalytic converter)
1988	930.20	3.2	170/231	911 Carrera - RoW
	930.25	3.2	160/217	USA/Japan/Canada/Australia/RoW (with catalytic conv.)
	930.26	3.2	170/231	Sweden
	930.66	3.3	221/300	Turbo RoW
	930.68	3.3	210/282	Turbo USA/Canada
1989	930.20	3.2	170/231	911 Carrera - RoW
	930.25	3.2	160/217	USA/Canada/Japan/Australia/RoW (with catalytic conv.)
	930.66	3.3	221/300	911 Turbo - RoW
	930.68	3.3	210/282	911 Turbo - USA
	M 64.01	3.6	184/250	911 Carrera 4 (964) - Worldwide
1990	M 64.01	3.6	184/250	911 Carrera (964) 2/4 with manual transmission - Worldwide
	M 64.02	3.6	184/250	911 Carrera (964) 2 with tiptronic transmission - Worldwide
1991	M64.01	3.6	184/250	911 Carrera (964) 2/4
	M64.02	3.6	184/250	911 Carrera (964) 2
	M30.69	3.3	235/320	911 Turbo (964)

Engine Type Designations

Model Year	Engine Type	Displ. Liters	Engine Power kW / HP	Installed In
1992	M64.01	3.6	184/250	911 Carrera (964) 2/4
	M64.02	3.6	184/250	911 Carrera (964) 2
	M64.03	3.6	191/260	911 Carrera (964) RS
	M30.69	3.3	235/320	911 Turbo (964)
1993	M64.01	3.6	184/250	911 Carrera (964) 2/4
	M64.02	3.6	184/250	911 Carrera (964) 2
	M64.03	3.6	191/260	911 Carrera (964) RS
	M64.50	3.6	265/360	911 Turbo (964)
1994	M64.01	3.6	184/250	911 Carrera (964) 2/4 USA
	M64.02	3.6	184/250	911 Carrera (964) 2 USA
	M64.05	3.6	200/272	911 Carrera (964) RoW
	M64.06	3.6	200/272	911 Carrera (964) RoW & Taiwan with Tiptronic
	M64.50	3.6	265/355	911 Turbo USA/CDN
1995	M64.05	3.6	200/272	911 Carrera (964) RoW
	M64.06	3.6	200/272	911 Carrera (964) RoW
	M64.20	3.7	220/300	911 Carrera (993) RS RoW
	M64.07	3.6	200/272	911 Carrera (993) USA
	M64.08	3.6	200/272	911 Carrera (993) USA
1996	M64.21	3.6	210/285	911 Carrera (993) /C4 /C4S RoW
	M64.22	3.6	210/285	911 Carrera (993) RoW Tiptronic
	M64.23	3.6	210/285	911 Carrera (993) /C4/C4S USA
	M64.24	3.6	210/285	911 Carrera (993) USA Tiptronic
	M64.60	3.6	300/408	911 Turbo (993) RoW and USA/CDN
1997	M64.21	3.6	210/285	911 Carrera (993) /C4 /C4S RoW
	M64.22	3.6	210/285	911 Carrera (993) RoW Tiptronic
	M64.23	3.6	210/285	911 Carrera (993) /C4/C4S USA
	M64.24	3.6	210/285	911 Carrera (993) USA Tiptronic
	M64.60	3.6	300/408	911 Turbo (993) RoW and USA/CDN
1998	M64.21	3.6	210/285	911 Carrera (993) /C4/C4S RoW
	M64.22	3.6	210/285	911 Carrera (993) RoW Tiptronic
	M64.23	3.6	210/285	911 Carrera (993) /C4 & C4S USA/CDN
	M64.24	3.6	210/285	911 Carrera (993) USA/CDN Tiptronic
	M64.60	3.6	300/408	911 Turbo (993) RoW and USA/CDN

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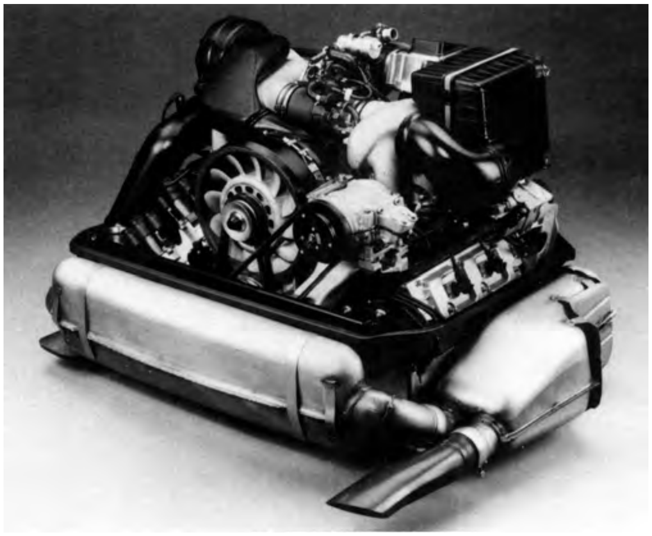
Engines



General

The 1984 - 911 Carrera 3.2 liter engine featured the following changes from the prevoius 911 SC engine:

- Displacement increased by changing stroke from 70.4 to 74.4 mm
- New crankcase with improved basic strength and new sealing cap for intermediate shaft
- Crankshaft from 911 Turbo with modified flywheel installation
- New flywheel for DME
- New connecting rods (unchanged from 911 Turbo)
- New drive belt pulley
- New pistons
- New cylinders
- Modified cylinder heads
- New chain tensioner with hydraulic damping via lubricating oil circuit
- Modified lubricating circuit
- New crankcase and oil tank venting
- Fan wheel with ventilation slots
- Modifications on heater blower, heat exchanger and exhaust system
- Combination of fuel injection and ignition in DME (Digital Motor Electronics)

Yearly Changes

1986 Model
- Turbo engine with catalytic converter only for USA

1987 Model
- Cylinder head tightened with torque and torque angle = 15 Nm and 1 x 90 (retroactively since 1984 models)

1988 Model
- Conrod bolts tightened with torque and torque angle = 20 Nm and 1 x 90°

1989 Model
- 911 Carrera (no modifications)
- 911 Carrera 4 (964) (introduction)

1990 Model
- 911 Carrera 2 (964) (introduction) with rear wheel drive, 5-speed manual or Tiptronic transmission
  Engine Types:
  M64.01 - Manual Transmission
  M64.02 - Tiptronic Transmission
- Stronger piston pin circlips
- M 64.02 changed ratio for cooling fan

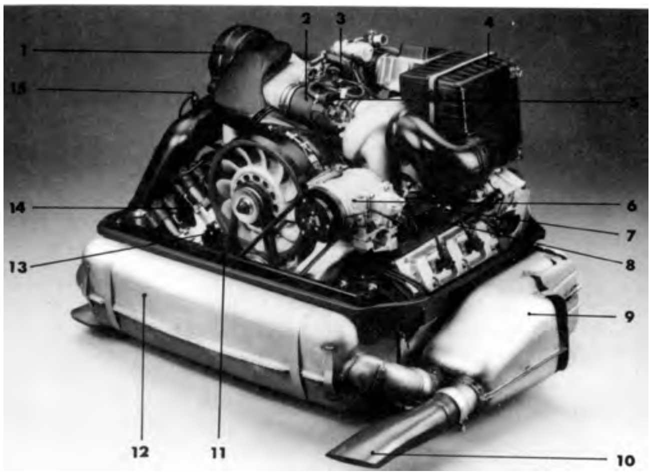
Engine M64.01/02 – 911 Carrera 2/4 (964) 1989-94)

The engine 911 Carrera (964) engine is a further development of the previous 911 Carrera engine.

- One engine type worldwide
- Double ignition, i.e. two spark plugs for each combustion chamber
- Knock regulation
- Exhaust ports in cylinder heads designed as ceramic port liners
- Camshaft drive with help of duplex roller chains, hydraulic chain tensioner acting on tensioning rails and additional guide rails
- Vibration damper on crankshaft
- Separate drive for engine fan and alternator
- Oil Cooler with two-stage blower in front end of car on right-hand side
- Two-stage resonance intake system
- Digital Motor Electronics (DME)

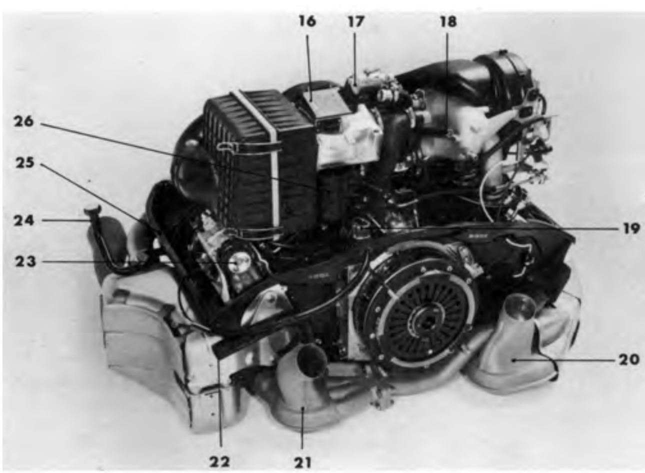
Notes:

911 Carrera (964) Engine



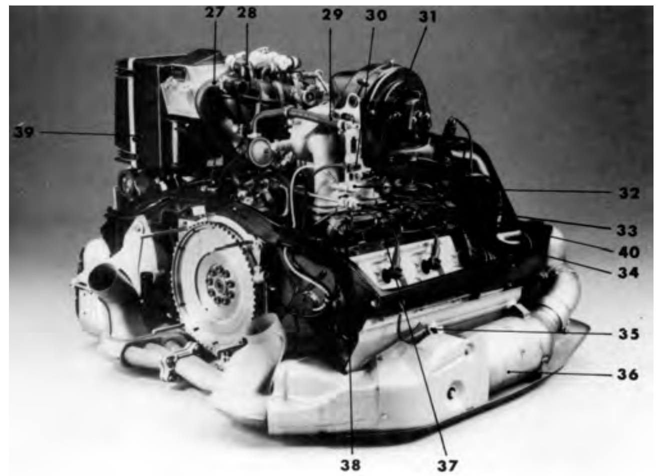
Engine Type M64.01/02 Components

1 - Hot air blower
2 - Throttle valve assembly
3 - Resonance flap control switch
4 - Air Cleaner
5 - Electric tank venting valve
6 - Air conditioner compressor
7 - Fuel feed pipe
8 - Fuel collection pipe, right
9 - Final muffler
10 - Tailpipe
11 - Engine carrier
12 - Intermediate muffler
13 - Drive belt tightness monitor
14 - Double ignition distributor
15 - Heating control temperature switch



Engine Type M64.01/02 Components

16 - Air flow sensor
17 - Idle speed control
18 - Bypass air pipe for oil tank venting
19 - Combination oil temperature and pressure switch
20 - Heat exchanger, left
21 - Heat exchanger, right
22 - Engine oil feed from oil tank to engine
23 - Power steering pump
24 - Engine oil return to thermostat
25 - Engine cover, right
26 - Vacuum reservoir for resonance flap control

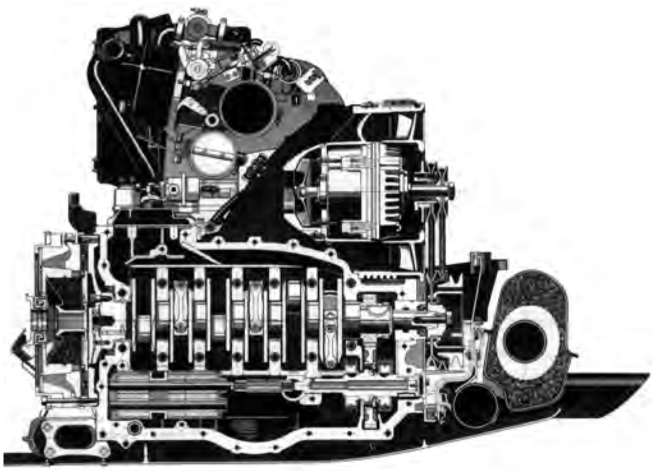


Engine Type M64.01/02 Components

27 - Crankcase venting
28 - Oil tank venting
29 - Fuel tank venting
30 - Speed sender
31 - Knock sensor 1
32 - NTC 2
33 - Fuel pressure testing connection
34 - Fuel return pipe
35 - Oxygen sensor
36 - Catalytic converter
37 - Fuel injector
38 - Fuel collection pipe, left
39 - Carbon canister connection
40 - Heater blower control resistor

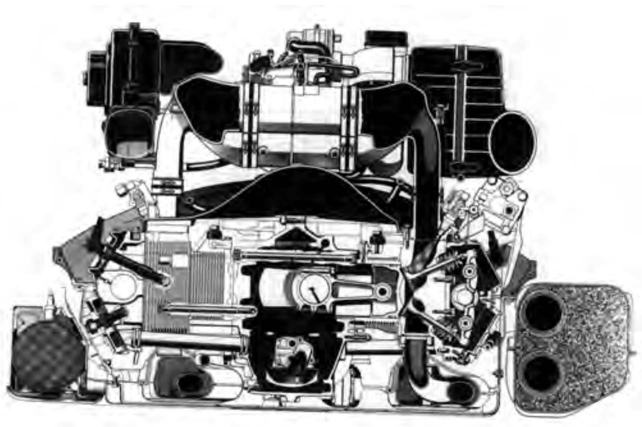
Notes:

Longitudinal Section of the Engine



Engine Type M64.01/02 Side View Cutout

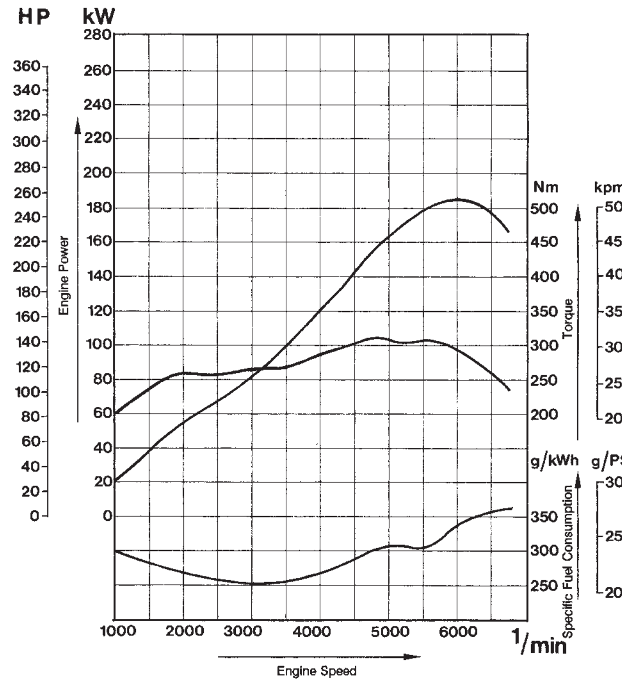
Cross Section of the Engine



Engine Type M64.01/02 Front View Cutout

Notes:

Full-Load curve of the M64.01/02



Engine Data

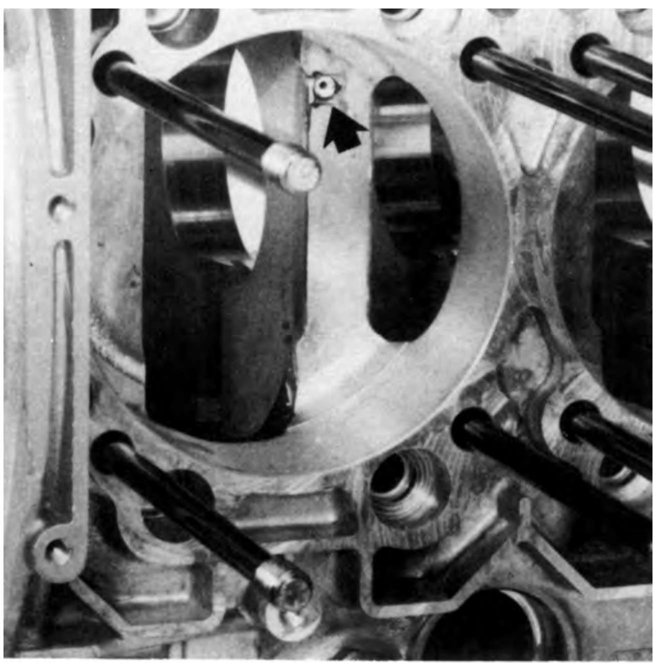
Displacement	3.6 l (76.4 mm stroke, 100 mm bore dia.)
Rated power	184 kW / 247 H.P. SAE NET
Rated speed	6100 rpm
Max. torque	at 4800 rpm 195 ft. lb. (310 Nm)
Compression ratio	11.3 to 1
Fuel grade	98 RON/88 MON (Premium Unleaded)

Notes:

Crankcase

Arrow points to new rib.

The two-piece crankcase made of an aluminum/silicon alloy now has a rib as a guide for cooling air (arrow).

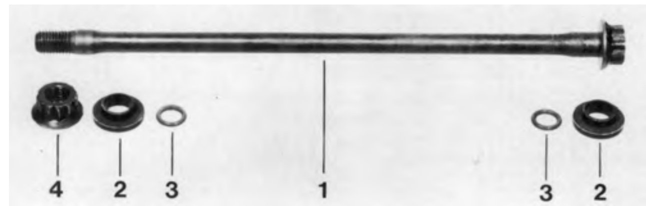


Location of oil spray jet.

The adapting diameter on the cylinder base is 106.8 mm. 2 mm diameter oil spray jets are provided in the crankcase for cooling of pistons (arrow).

Notes:

Crankcase Mounting Bolts

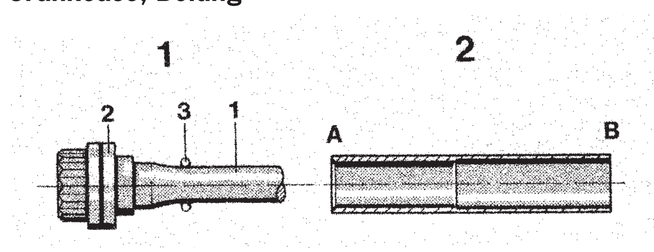


Crankcase Bolt Components

1 - Crankcase bolt
2 - Insulator
3 - Round seal
4 - Multiple-tooth nut

The mating surfaces of both crankcase sections are sealed with Loctite No. 574. Crankcase bolts are tightened with a torque of 40 Nm. The tightening torque for other mounting bolts is 23 Nm.

Crankcase, Bolting



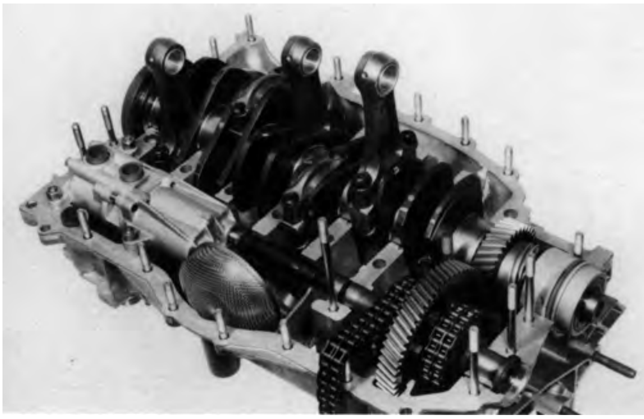
Installation Sequence of Studs with Special Tool 9511.

1 - Lubricate all studs (1) and round seals (3) with oil.
2 - Place insulator (2) on stud (1).
3 - Guide round seal (3) with tapered sleeve over the threaded zone and push on to head end of the bolt shaft (see Figure 1).
4 - Prepare the remaining studs accordingly.
5 - Insert studs (1) in to the crankcase against the mechanical stop.
6 - Install tapered sleeve with mounted round seal (3) on the threaded end. Slide round seal with the B-end of the cylindrical sleeve off of the tapered sleeve. Pull off tapered sleeve and slide round seal with the A-end of the cylindrical sleeve into final position (see Figure 2).

Note: Only slight force may be applied for this step. Counterhold on the head.

7 - Install insulator (2) dry and multi-tooth nut (4) lubricated with oil.
8 - Counterhold on the bolt head while tightening the multi-tooth nut. Tightening torque = 40 Nm.
9 - Continue with the remaining studs in the same manner (check the tightening sequence). Tightening torque for other bolts = 23 Nm.

Crankshaft

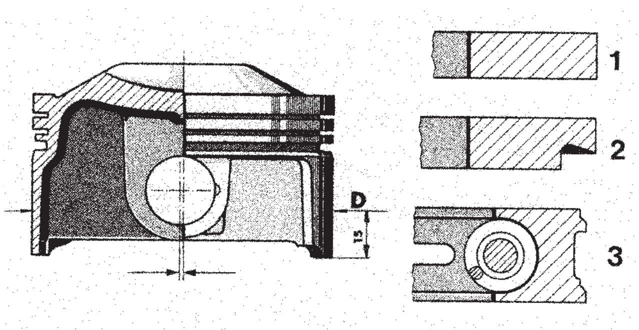


The crankshaft running on eight bearings is a new design. Crankshaft stroke is 76.4 mm. All journal diameters and widths are taken from the Carrera engine, so that the set of main and connecting rod bearing shells remains identical.

Connecting Rods

Connecting rods and corresponding caps are bolted together with conrod bolts in material grade 12.9. The settling torque is 15 Nm; afterwards the bolts are tightened twice with a torque angle of 90° . It is basically necessary to always replace bolts and nuts after removal.

Pistons



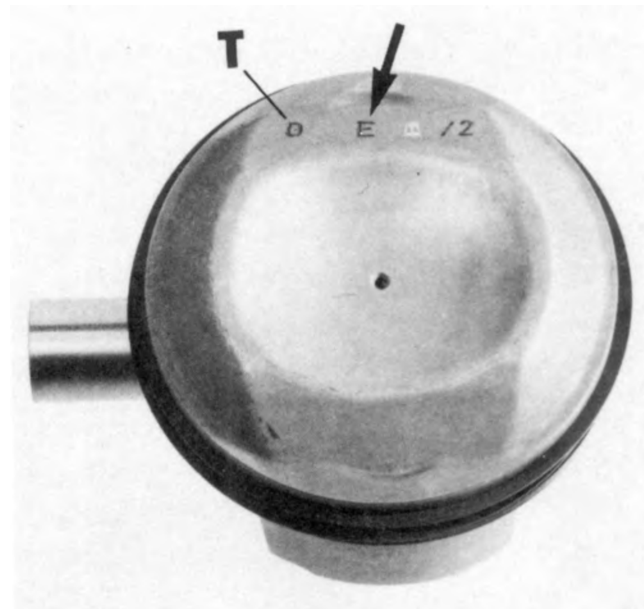
Piston and Ring Construction

1 - Groove 1: Taper faced compression ring
2 - Groove 2: Stepped taper faced compression ring
3 - Groove 3: Double-bevelled oil control ring with hose-covered spring

Notes:

Pistons

The pressed light alloy piston has a diameter of 100 mm. The piston pin bore is off-centered by 0.9 mm. When installing a piston, make sure that the letter "E" stamped on the piston crown faces the intake end (arrow).



Piston Identification Markings

Piston Testing Method

Pistons are divided into four diameter stages (0 ... 3). The code of tolerance group T is located next to the letter "E". The diameter is measured at a height of 15 mm.

Piston Diameter D in mm	Tolerance Group T Diameter Stages
99.996 ± 0.005	3
99.989 ± 0.005	2
99.982 ± 0.005	1
99.975 ± 0.005	0

Notes:

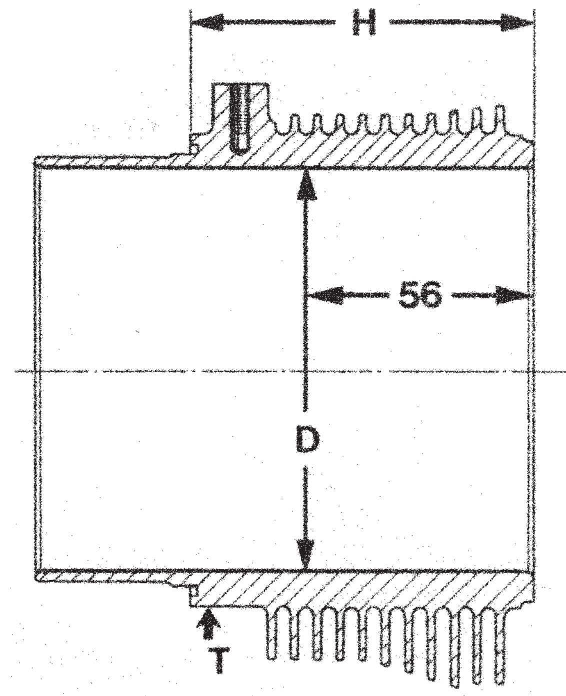
Cylinders

The cylinders with a bearing surface diameter of 100 mm are made of a high temperature light alloy. The actual bearing surface coat (Mahle - Nikasil) is applied galvanically.

Cylinders are designed with a slight conical effect in the upper bearing surface zone due to the varying thermic loads. The cylinder bore is smaller by about 0.03 mm in the area of the upper reversing point of the piston. A round silicon seal is used for sealing the cylinder base.

Notes:

Cylinder Testing Method



Cylinder Measurement Points

Height H in mm (- 0.020)	Cyl. Dia. D in mm (+ 0.007)	Tolerance Group T/ Diameter Stages
82.770	100.021	6/3
82.770	100.014	6/2
82.770	100.007	6/1
82.770	100.000	6/0
82.750	100.021	5/3
82.750	100.014	5/2
82.750	100.007	5/1
82.750	100.000	5/0

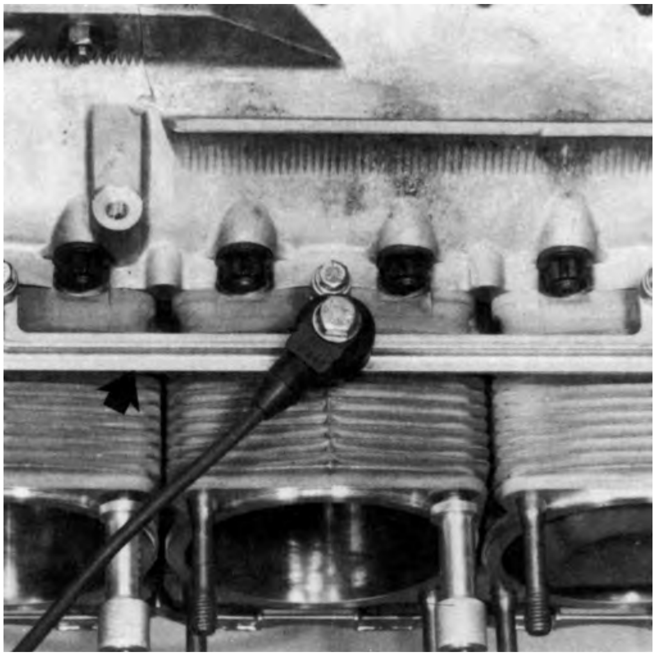
In order to be able to determine the correct cylinder group, distance H is measured first and classified in height groups 5 and 6. Each height group (5 or 6) is subdivided into diameter stages of 0 ... 3.

The pertinent cylinder diameter (D) is measured at a height of 56 mm.

Only cylinders of the same height group (5 or 6) may be installed on one side of the engine. The pertinent tolerance group (T) is die-stamped on the knock bridge mounting boss on the opposite side.

Knock Bridge

One knock bridge (arrow), which holds a knock sensor, is mounted on the bosses cast on the cylinders for each bank of cylinders.



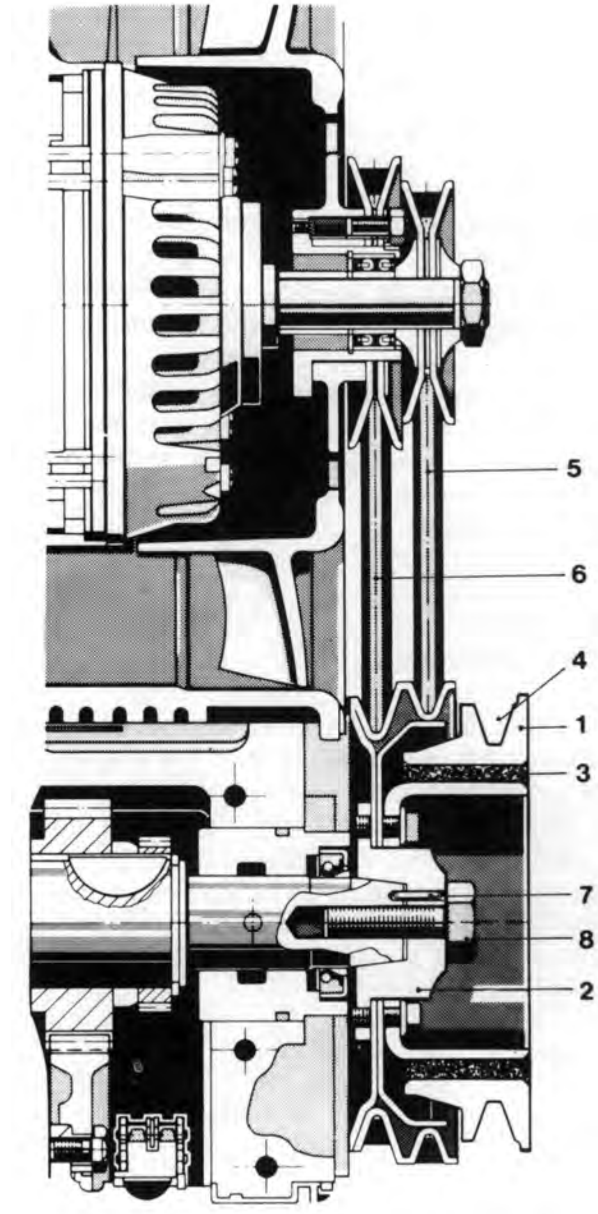
Knock Sensor Bridge (arrow)

There must be conformance with the following sequence of installation.

1. Mount cylinders 1 ... 3 or 4 ... 6.
2. Mount knock bridges and screw in three M6 mounting screws.
3. Mount cylinder heads and tighten
4. Tighten M6 screws of knock bridges. Tightening torque = 9.7 Nm.

Pulley with Vibration Damper

Crankshaft Pulley



Crankshaft Pulley Components

A pulley assembly including torsional vibration damper (1) is mounted on the rear end of the crankshaft with help of a cone connector. The vibration damper has the task of cushioning the engine's rotational oscillation, which is produced by mass and gas forces.

This is accomplished with a rotation mass, which is connected with steel hub (2) in a rotational elastic manner with help of a vulcanized rubber ring (3). The damper uses its own oscillation to oppose and considerably cushion the oscillation of the engine.

The rotation body of the vibration damper is used simultaneously as a pulley for the drive of A/C compressor (4). Both of the other pulley grooves are used to drive the fan (6) as well as for separate drive of alternator (5).

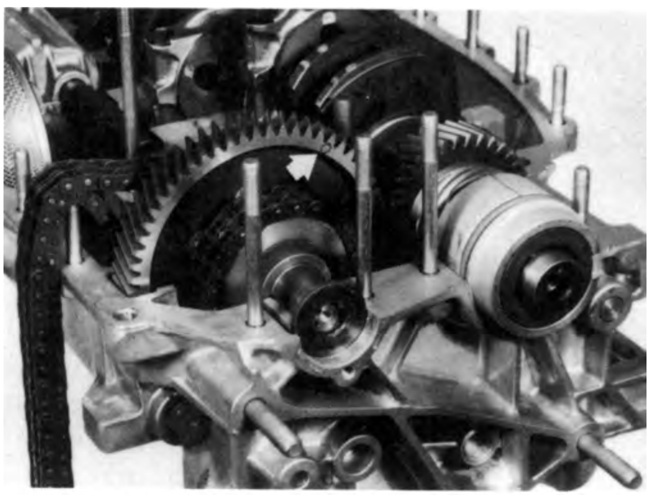
Pulley with Vibration Damper (cont'd)

Dowel pin (7) determines the position of pulleys to the crankshaft. This is necessary, because there are TDC marks for the different cylinders (3 notches with 120° spacing between each). The notch for cylinder no. 1 (ignition TDC) is marked additionally with Z 1.

The M14 x 1.5 central bolt (8) must be tightened to a torque of 235 Nm. Since the vibration damper and pulleys are balanced together, they should never be disassembled.

Intermediate Shaft

The steel intermediate shaft gear wheel is paired with the control gear wheel on the crankshaft to guarantee optimum smooth running. Both gear wheels are supplied as a set without a pairing number.



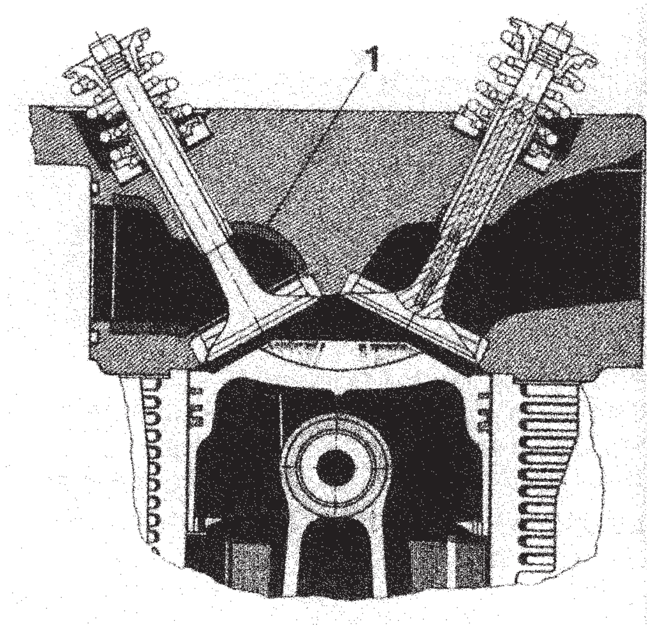
Arrow Shows Markings

Sprockets on the intermediate shaft for drive of the camshaft are made of sintered steel. The number (arrow) on the intermediate shaft gear wheel is a code for tolerance group 0 or 1 (distance between shafts in the crankcase).

Notes:

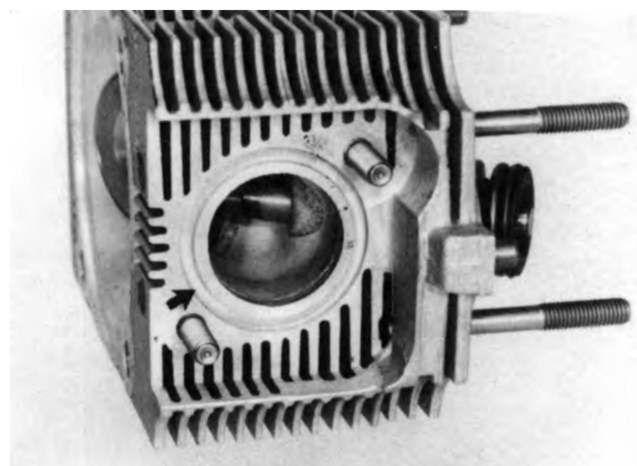
Cylinder Head

Cooling ribs have been modified to optimize the flow of cooling air in the area of the cylinder head.



Cylinder Head Cutout

Ceramic port liners (1) are inserted in the exhaust ports of the cylinder head. These port liners reduce the temperature on the cylinder head by about 40° C.



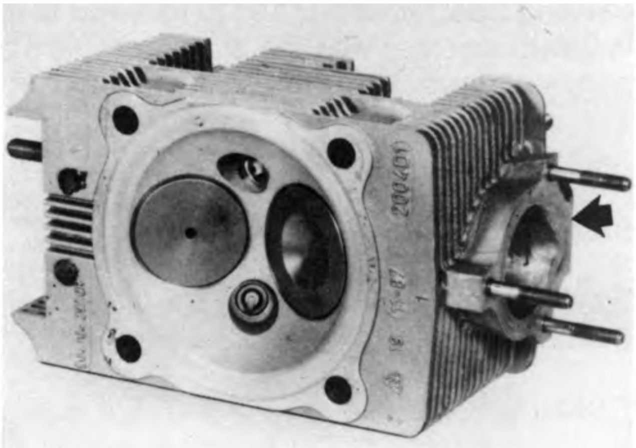
Sealing Groove (arrow)

The threads and bearing surfaces of the multiple-tooth nuts of the cylinder head bolts must be coated with Optimoly HT. The setting torque is 15 Nm; afterwards they are tightened once to a torque angle of 90°.

Filling seals are used for sealing on the exhaust end of the exhaust manifold. A corresponding groove (arrow) is provided on the cylinder head end.

Cylinder Head

A triple hole flange with studs (arrow) is used on the intake end due to the altered position of fuel injectors.



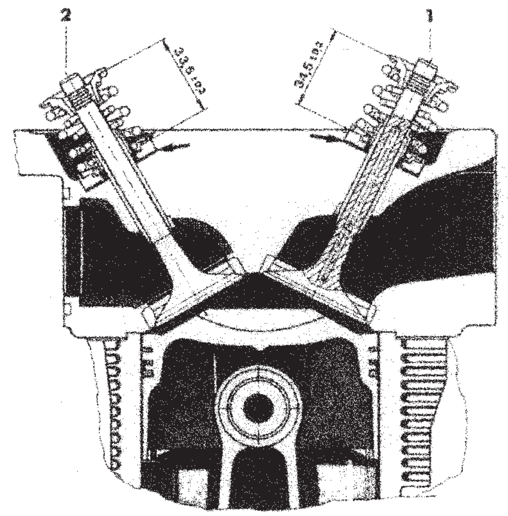
Intake Manifold Sealing Surface

Spark Plugs

The wrench size for spark plugs is 16 mm. A pertinent spark plug wrench is included with the car tools.

Notes:

Valves



Valve Layout

1 - Intake valve
2 - Exhaust valve

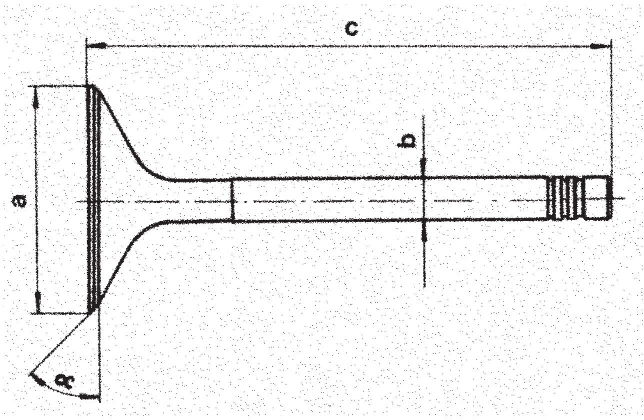
Intake valves are filled with sodium to improve the transfer of heat from intake valves to the cylinder head. This measure is not necessary for exhaust valves, since they have a more homogeneous distribution of heat.

Valve seals are pressed in against stop (max. 2000 N) and have a locking groove for the shaft seal.

Notes:

Valves (cont'd)

Existing Special Tool **P 10c** is required to check the installed length of valve springs. It is installed together with the shim, spring disc, spring retainer and both collets belonging to a pertinent valve. Read the distance and correct it accordingly with shims (arrows).



Valve Dimensions

Installed Length:

Intake Valve Springs	34.5 ± 0.3 mm
Exhaust valve springs	33.5 ± 0.3 mm

Distance	Intake (sodium filled)	Exhaust (b = conical)
a	49 mm	42.5mm
b	8.97 mm	8.94 ... 8.96 mm
c	110.1 mm	109 mm
a	45°	45°

Rocker Arms

Rocker arms and rocker arm shafts were utilized from the 911 Carrera engine without modifications. Tightening torque for rocker arm shafts is 20 Nm.

Camshafts

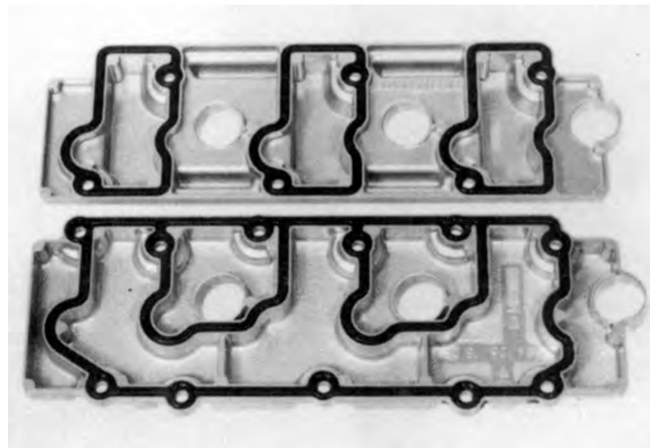
The cast camshafts are made of a high-value, chilled casting material. Intake lift is 11.9 mm; exhaust lift 10.9 mm. Bearing diameters are the same as for 911 Carrera engines.

Code for left camshaft:	964.247.07
Code for right camshaft:	964.246.09

Camshaft Housing

The camshaft housing is identical for left and right sides, but has mounting bosses with M8 threads on the face for installation of the final muffler.

Covers for Camshaft Housings



Magnesium covers are fitted with molded gaskets. Aluminum washers and M6 lock nuts are used for installation of camshaft housing covers to prevent corrosion by contact. Tightening torque: 9.7 Nm.

Chain Drive

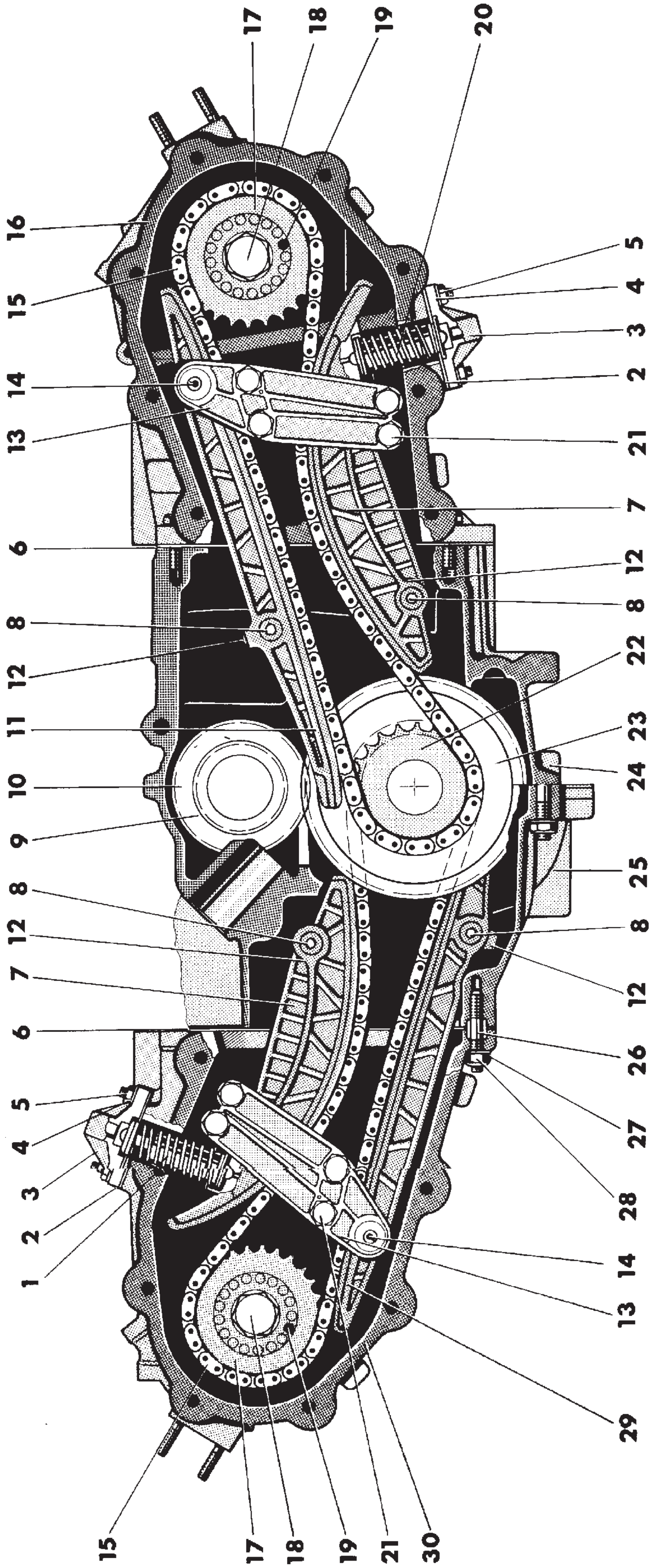
Both double chains (15) for drive of the camshafts are tightened by two moving tensioning rails (7). Two non-moving guide rails (11 and 29) are required to guide the chains. All rails are made of glass fiber-reinforced polyamide. Chain bearing surfaces are made of heat-stabilized polyamide and sprayed direct on the rails. All guiding and tensioning rails are each connected with crankcase sections (24 and 25) with help of a shaft bolt (8). Non-moving guide rails (11 and 29) are each positioned additionally to the shaft bolts with a heavy type dowel pin (14).

Shaft bolt (8) is used as a pivot point for the moving tensioning rails; chains are tightened with help of hydraulically operated chain tensioners (1 and 20). A spring-loaded pressure piece (12) is screwed into the rail carrier for axial positioning of guide and tensioning rails. Bearing bridges (13), which are each mounted on chain housings (16 and 30) with four hexagon head bolts (21), serve as lateral guides for guiding and tensioning rails.

Bearing bridges are also used as positioning points for heavy type dowel pins (14) and therefore for guide rails (11 and 29).

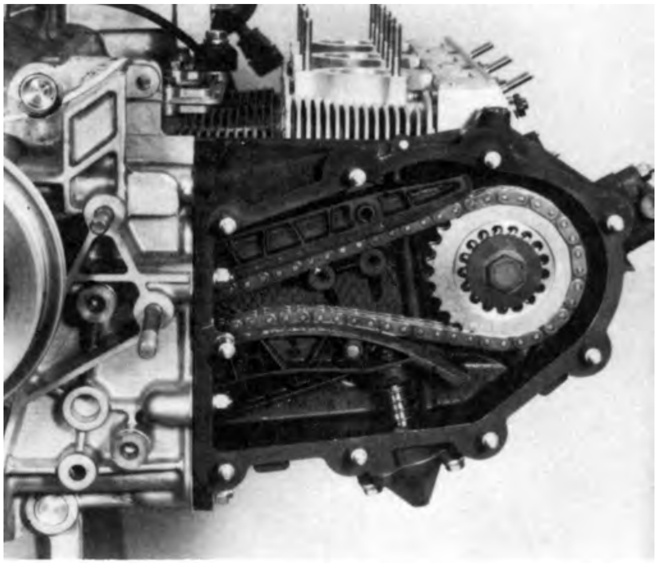
Tightening torque for sprockets (17)	**120 Nm**
Tightening torque for shaft bolts (8)	**31 Nm**
Tightening torque for hex. Head bolts (21)	**9.7 Nm**

Chain Drive Layout



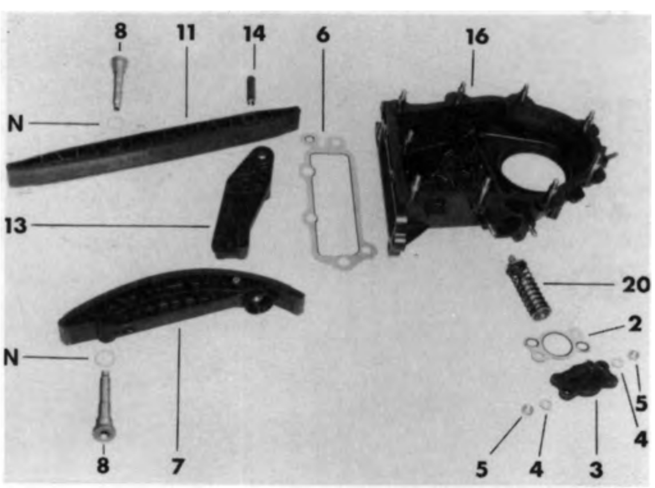
1 - Chain Tensioner
2 - Gasket For Chain Tensioner
3 - Cover For Chain Tensioner
4 - Aluminum Washer
5 - M6 Lock Nut
6 - Gasket For Chain Housing
7 - Tensioning Rail
8 - Shaft Bolt
9 - Distributor Drive Gear
10 - Control Sprocket On Crankshaft (34 Teeth)
11 - Guide Rail, Right
12 - Spring-loaded Pressure Piece
13 - Bearing Bridge
14 - Dowel Pin
15 - Duplex Roller Chain
16 - Chain Housing, Right
17 - Sprocket (28 Teeth)
18 - M12 X 1.5 Hex Bolt
19 - Dowel Pin (6mm Dia.)
20 - Chain Tensioner, Right
21 - M6 Hex Head Screw
22 - Sprocket (24 Teeth)
23 - Intermediate Shaft Sprocket (60 Teeth)
24 - Crankcase Section, Right
25 - Crankcase Section, Left
26 - Dowel Sleeve
27 - Aluminum Washer
28 - M8 Lock Nut
29 - Guide Rail, Left
30 - Chain Housing, Left

Chain Housings



Right Chain Housing

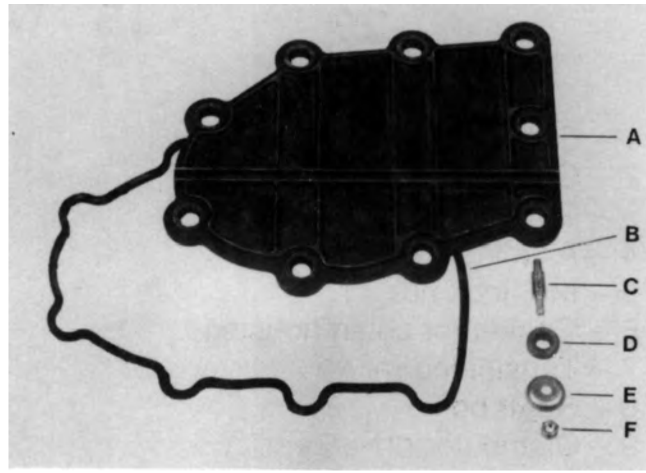
Chain housings (16 and 30) are made of a magnesium alloy. A 1 mm thick aluminum gasket (6) with vulcanized rubber sealing lips is used as a seal on the crankcase. Chain housings are mounted on the crankcase with aluminum washers (27) and lock nuts (28).
Tightening torque = 23 Nm.



Chain Housing Components

2 - Gasket for chain tensioner
3 - Cover for chain tensioner
4 - Aluminum washer
5 - M6 lock nut
6 - Chain housing gasket
7 - Tensioning rail
8 - Shaft bolt
11 - Guide rail, right
13 - Bearing bridge
14 - Heavy type dowel pin
16 - Chain housing, right
20 - Chain tensioner, right
N - Aluminum washer

Aluminum washers (4) and lock nuts (5) are used to mount chain tensioner cover (3).



Chain Housing Cover Components

A - Chain housing cover
B - Rubber gasket
C - Stud
D - Rubber ring
E - Washer
F - Lock nut

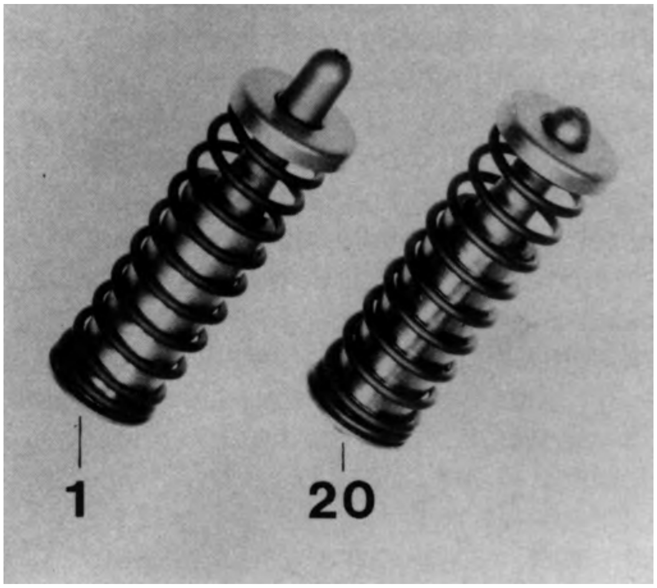
Noise is reduced by mounting the cover on the chain housing with rubber elements. Tightening torque = 5.5 Nm.

Camshaft Drive Chain

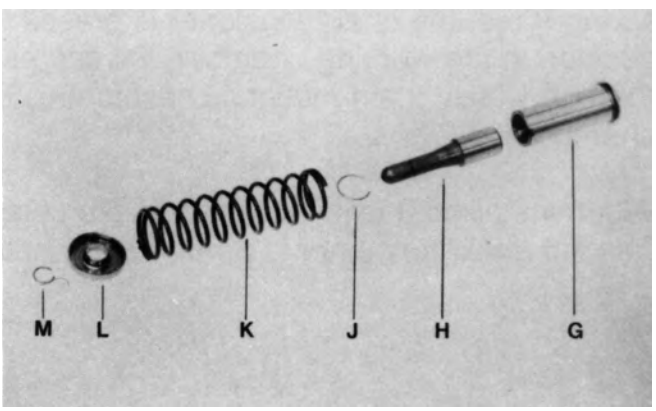
A double chain (duplex roller chain) without lock is installed. A chain with lock may not be installed.

Notes:

Chain Tensioners



1 - Chain tensioner, left
20 - Chain tensioner, right

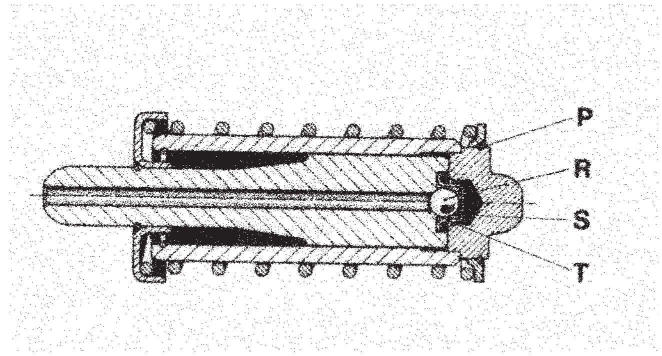


G - Housing (cylinder)
H - Piston
J - Circlip
K - Spring
L - Spring retainer
M - Circlip

Chain tensioners have the task of cushioning the vibration of timing chains. They work with help of hydraulic cushioning and a return spring, and are connected direct in the camshaft housing oil supply circuit.

Chain tensioners are each held in position by a cover bolted on the chain housing. Oil is supplied to the left chain tensioner by a piston, whereby the oil reaches the working chamber of the chain tensioner through a check valve located in the piston.

The right chain tensioner is supplied with oil via the housing. The check valve, consisting of a valve ball, valve spring and valve cage, is located in the housing.



P - Circlip
R - Valve ball
S - Valve Spring
T - Valve cage

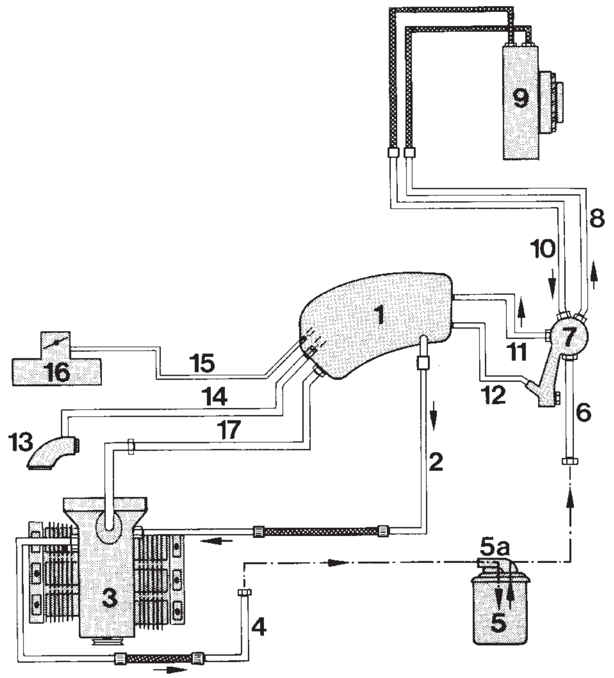
The check valve opens with a pressure of 0.2 bar. The piston of the chain tensioner has an axially ground surface on the cylindrical section, 3 mm wide for the left side and approximately 1 mm wide for the right side. Oil can escape out of the working chamber through a leak gap produced in this manner and by the play between the piston and housing, through which the cushioning degree is determined.

The chain tensioner is pressed apart and the chain is tensioned, if the force during operation of the engine, which the chain exerts on the chain tensioner, is less than the oil pressure plus chain force. If chain forces are greater than the oil pressure plus spring force, the chain tensioner is pressed together or the piston is moved against the oil cushion in the working chamber. Oil can escape via the leak gap and piston/housing clearance, through which chain motion is cushioned. The leak gap also guarantees bleeding of the working chamber

When installing it is important to make sure that the chain tensioner piston always faces up. The left chain tensioner is 8 mm longer because of the design.

Notes:

Engine Lubrication

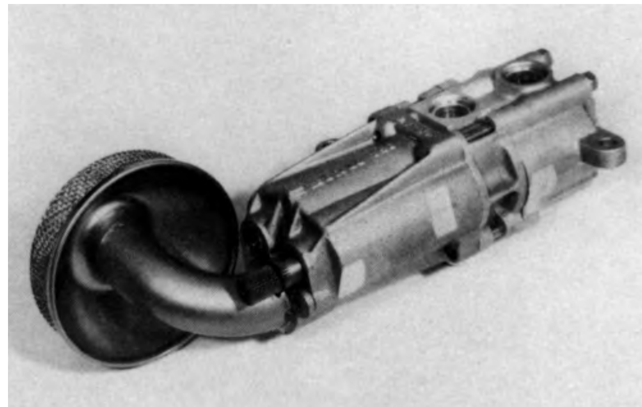


Oil System Layout

1 - Oil tank
2 - Oil supply pipe
3 - Crankcase (engine)
4 - Oil return pipe, rear
5 - Oil filter
5a - Oil filter flange
6 - Oil return pipe, front
7 - Oil thermostat
8 - Oil cooler supply pipe
9 - Oil cooler with two-stage blower
10 - Oil cooler return pipe
11 - Oil return hose
12 - Oil drain hose (molded)
13 - Cowl
14 - Crankcase venting pipe with 6 mm dia. orifice in oil tank
15 - Bypass air pipe with 1.5 mm dia. orifice in oil tank
16 - Throttle valve assembly
17 - Oil tank venting pipe

Notes:

Oil Pump



The oil pump has a magnesium alloy body. The intake suction rate is greater in order to return the oil from the crankcase to the oil tank faster. The pressure stage has a delivery rate of about 65 liters per minute. Tightening torque for oil pump on crankcase = 23 Nm.

Oil Pipes

Oil supply pipes for chain tensioners and camshaft housings are integrated in the chain housings. The oil supply pipe to the camshaft housing has a 2.5 mm dia. orifice. This reduces the oil flow rate to the camshaft housing by about 50%, which in turn prevents foaming of the oil. The oil filter is located in the right rear return pipe. Oil filter flange and oil pipe are mounted on the body with help of rubber elements in the interest of noise reduction.

Oil Cooler

The oil cooler fitted with a two-stage blower is located ahead of the right front wheel. The first blower stage cuts in at 105° C; the second blower stage at an oil temperature of 118° C.

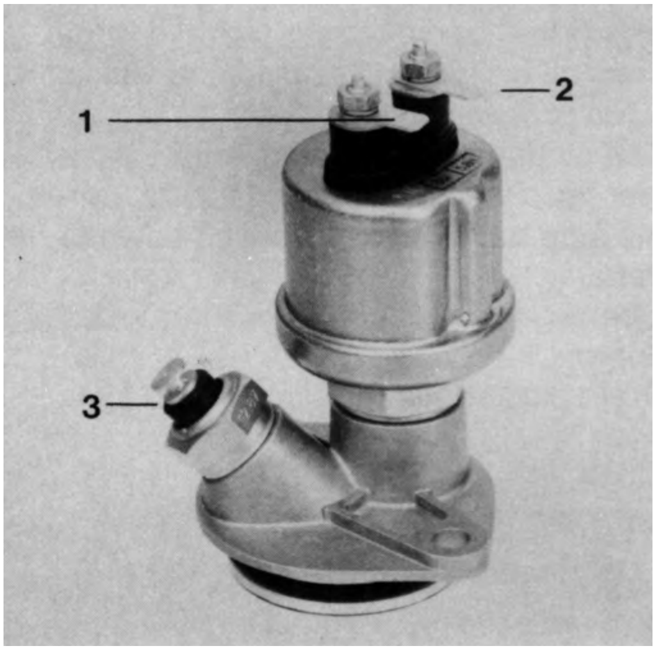
Oil Tank

The stainless steel oil tank is positioned ahead of the right rear wheel. Its capacity is approx. 11.5 liters. First fill with about 1.6 gallons (6 liters) run engine at idle speed and pour in 2 quarts (2 liters) at the same time. Run the engine warm until the thermostat has opened and then pour in approx. 3 quarts (3 liters) (note instrument display!). Oil change volume with replacement of filter: approx. 2.4 gallons (9 liters).

Tightening torque for pipe connections on oil filter housing, oil thermostat and oil cooler: 80 ... 100 Nm.

Oil Circuit

The functions of the combination oil temperature and pressure switch:



Connector Designations

1 - Oil pressure monitor (WK)
2 - Oil pressure display (G)
3 - Oil temperature display

Oil Level

Oil level control is accomplished at operating temperature and idle speed only via an electric oil level display instrument in the dashboard (approx. 90° C = 1st mark on temperature gage). The vehicle must be on a level surface during oil level control.

The amount of oil between the MIN and MAX marks on the oil dipstick is 1.9 quarts (1.75 liters). The MIN/MAX marks on the oil dipstick cover a larger range than the oil instrument display. The range monitored by the instrument begins approx. 0.3 quarts (0.3 liter) above the MIN mark of the oil dipstick and ends approx. 0.2 quarts (0.2 liter) below the MAX mark.

In engine inspections oil must be filled until the level reaches the MAX mark on the instrument, at idle speed and operating temperature of the engine (equal to approx. 25 mm below the oil dipstick's MAX mark). The distance between the MIN and MAX marks on the oil dipstick is about 110 mm.

Oil Thermostat

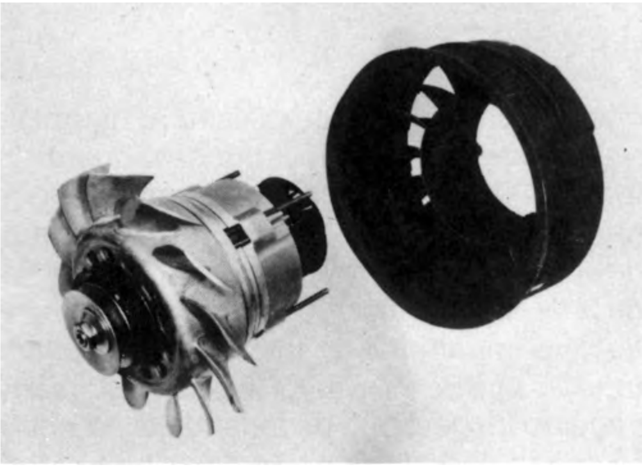
The previous tapped bore of the oil pressure switch in the crankcase is required for oil pressure testing on the engine test stand and is sealed with a plug.

Oil Drain Location

The oil drain is integrated in the oil thermostat (arrow) for better accessibility due to the side member panel pulled down to the bottom. Opening temperature of the oil thermostat is approx. 83° C.
Drain plug tightening torque = 70 Nm.

Notes:

Cooling



Blower Housing

Cooling Fan Drive

Fan housing is made of magnesium and is fitted with 17 air guide vanes. It is held on the crankcase by a clamp mounted with bolts. Tightening torque = 8 Nm.

This clamp must be retightened with a torque of 8 Nm after running the engine to operating temperature upon completion of reinstallation or repairs!

Six washers are provided for adjustment of the drive belt tightness. Basic adjustment should be made with four washers between the pulley sections. Blower ratio = 1.6 to 1. The fan wheel is fitted with 12 air vanes.

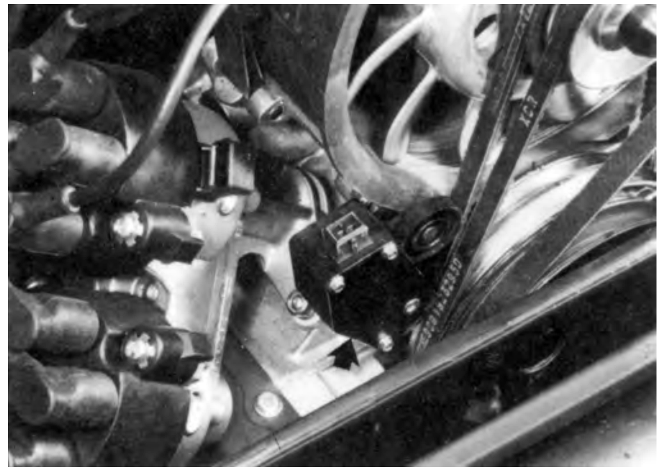
Cooling Fan Drive – Tiptronic

Engine idle speed is reduced from 880 rpm to 750 rpm in order to reduce the creeping tendency when a drive selected. The ratio had to be increased from 1 : 2.23 to 1 : 2.68 in order to reach a sufficient alternator speed.

The pulley for drive of the alternator is smaller in outside diameter.
Size of new alternator drive belt = 9.5 x 763 mm.
Size of fan drive belt = 9.5 x 776 mm (same as for 911 Carrera 4 (964).

Notes:

Drive Belt Monitor

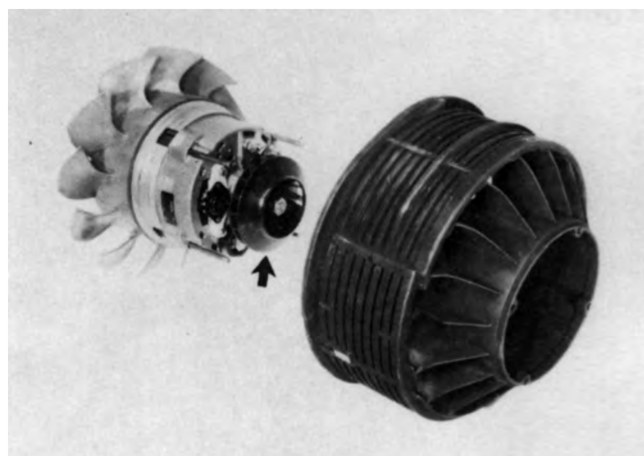


The engine blower drive belt is controlled by a drive belt monitor (arrow).

If a warning lamp in the instrument cluster lights up, this indicates a faulty drive belt or a plug which is not connected on the drive belt monitor.

Tightening torque:

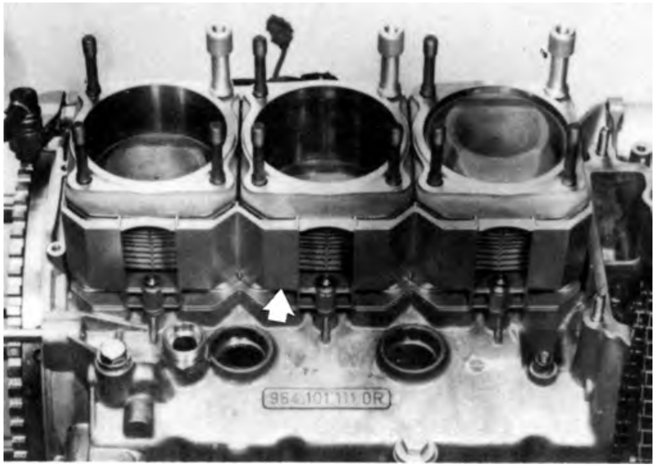
1 - Alternator pulley	50 ± 5 Nm
2 - Blower pulley	9.7 Nm
3 - Belt monitor holder	15 - 20 Nm
4 - Belt monitor to holder	9.7 Nm



An additional fan is mounted on the shaft of the alternator (arrow) to cool the alternator.
Tightening torque = 14 ±1 Nm.

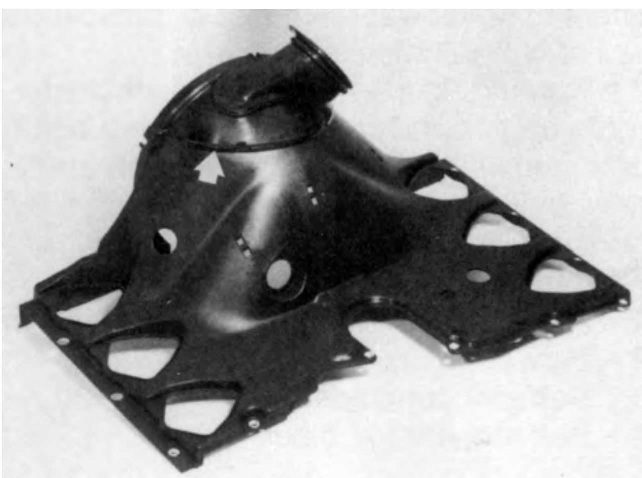
Notes:

Cylinder Air Guide



An air guide (arrow) made of magnesium is used to cool the cylinders and mounted on the crankcase with aluminum washers and lock nuts to avoid contact corrosion.

Upper Air Guide

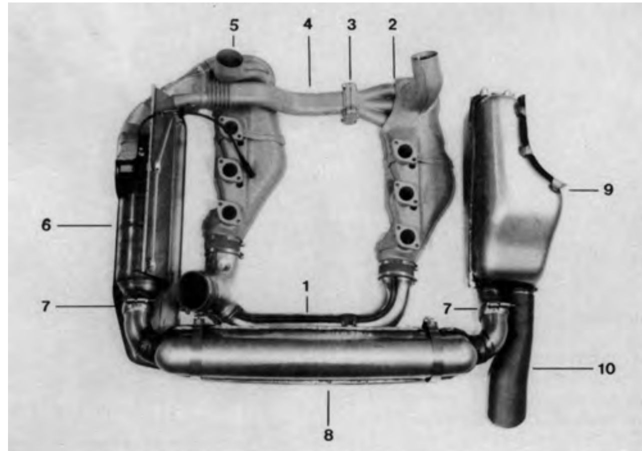


Upper Air Guide

The upper air guide is a two-piece design (arrow) for removal of the alternator. The air guide is available in a second version for cars with cruise control (M 454), which has additional openings for installation of the cruise control bracket on the crankcase.

Notes:

Exhaust System



Exhaust System Components

1 - Heating air distribution pipe
2 - Heat exchanger, right
3 - Flat gasket
4 - Exhaust crosspipe
5 - Heat exchanger, left
6 - Catalytic converter
7 - Ball flange clamp
8 - Intermediate muffler
9 - Final muffler
10 - Removable tailpipe

Exhaust crosspipe (4) is welded on left heat exchanger (5). Heat exchangers have better sealing on the connections to avoid the loss of heat. Ball flange clamps are used for connection of the intermediate muffler on the catalytic converter and final muffler. The final muffler is fitted with a removable tailpipe.

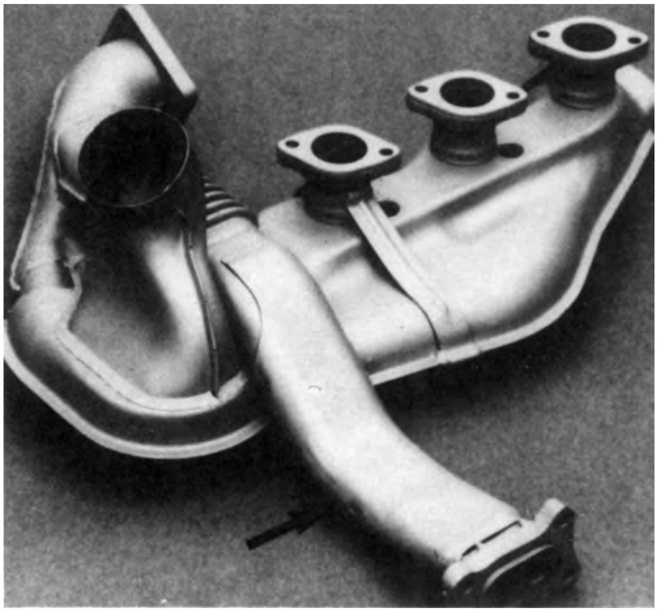
Tightening torque:

1 - Heat exchanger to cylinder head = 23.0 Nm
2 - Left heat exchanger flat gasket to catalytic conv. = 23.0 Nm
3 - Ball flange clamps = 20.5 Nm
4 - Intermediate muffler retaining strap = 14.0 Nm

Notes:

Exhaust System (cont'd)

Left Heat Exchanger – Tiptronic



Left Tiptronic Heat Exchanger

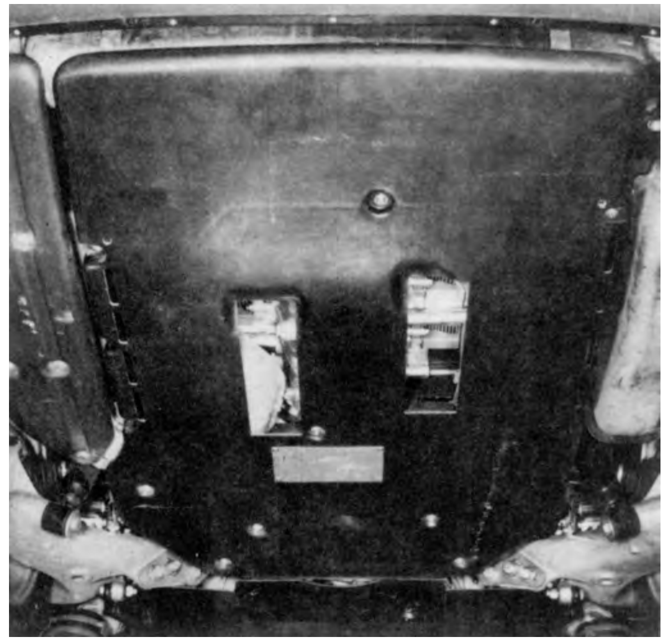
The shape of the cross tube was changed due to the limited space in conjunction with a Tiptronic transmission. A heat shield (arrow) is welded on the top of the cross tube along the entire length.

Power Steering Pump

The power steering pump for the hydraulically assisted steering gear is driven by a toothed belt off of the right camshaft. Drive belt tightness cannot be adjusted, but it should be checked at intervals of 12,000 miles (20,000 km). Tightening torque of toothed belt sprocket on camshaft = 120 Nm.

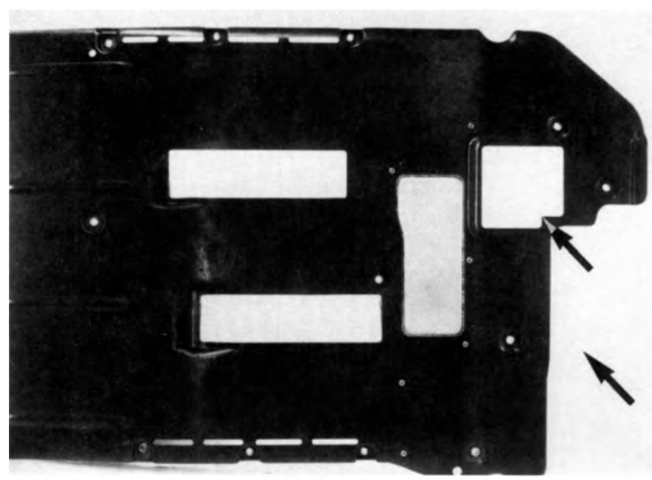
Notes:

Engine Paneling



Underside Engine Paneling

Engine paneling is new for the 911 Carrera (964). The underside of the car is paneled in plastic in order to reduce the reflection of noise.



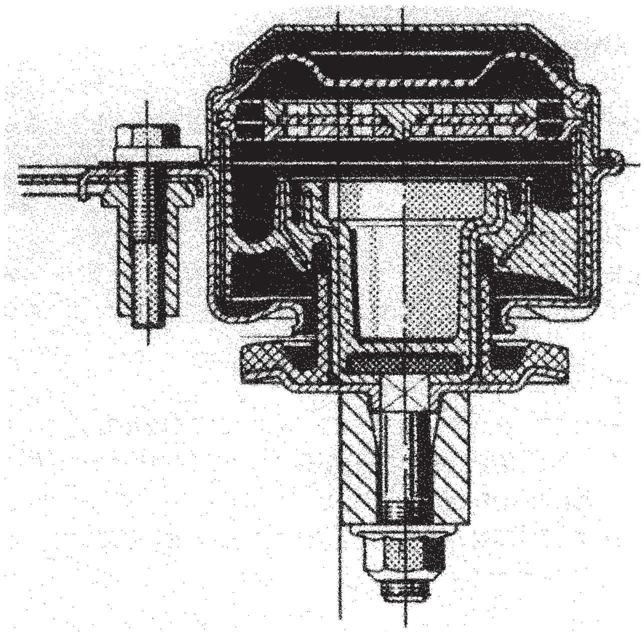
Tiptronic Underside Engine Paneling Showing Additional Openings

Underside paneling is identical with that of the 911 Carrera 4 (964) in size and function.

Two additional large openings (arrows) are required in the area of the engine/transmission flange only for cars with a Porsche Tiptronic transmission.

Engine Suspension

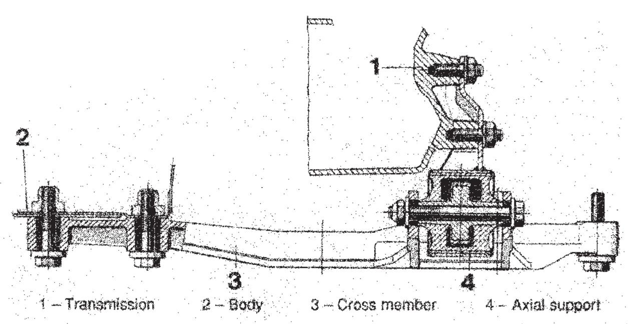
The entire engine/transmission assembly is held on the body with three suspension points. Rear engine mounts are designed as hydraulic mounts and are inserted in body take-up points from above. Hydraulic mounts absorb vertical drive unit vibrations.



Rear Engine Mount

Tightening torque:

1 - Engine carrier bolts M12 = 85 Nm
2 - To body M8 = 23 Nm



Mounting Components

1 - Transmission
2 - Body
3 - Cross member
4 - Axial support

The third mount, a rubber mount, is located between the transmission case and cross member. It absorbs horizontal drive unit vibrations.

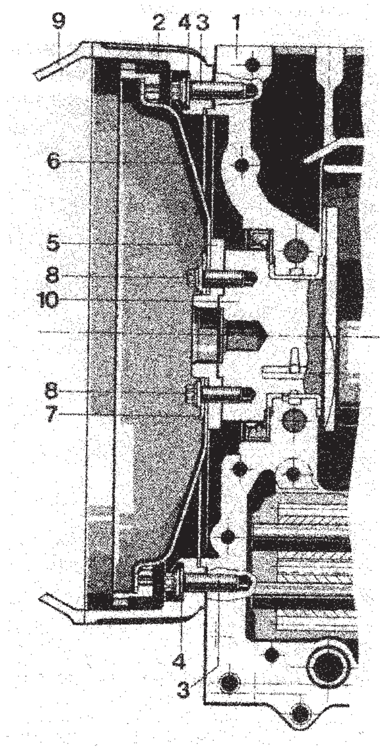
Third Mount Location

Tightening torque:

1 - To cross member (1x) M10 = 46 Nm
2 - Cross member to body (6x) M10 = 46 Nm
3 - Axial support to transmission (3x) M10 = 46 Nm

Notes:

Tiptronic to Engine Mounting



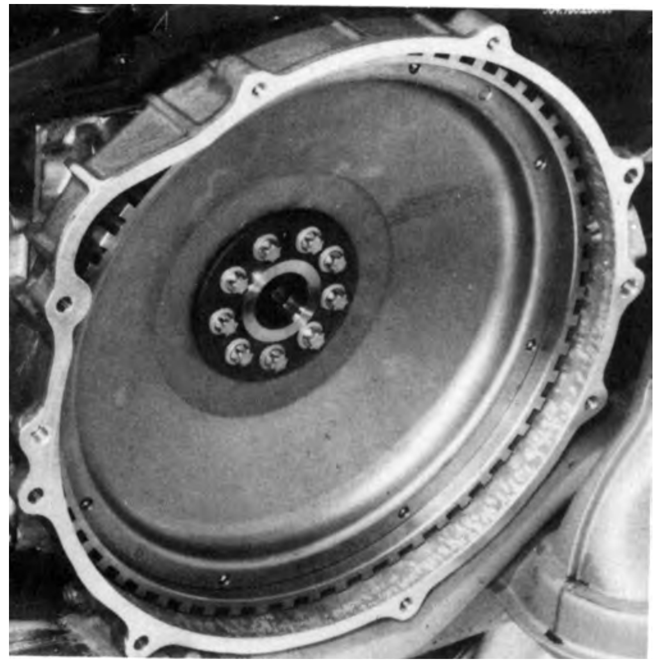
Tiptronic Transmission to Engine Layout

1 - Crankcase
2 - Converter housing
3 - M10 x 35 Torx bolt (4 x)
4 - A 10.5 washer
5 - Intermediate flange
6 - Drive plate
7 - Perforated disc
8 - M10 x 1.25 x 23.5 Torx bolt (9 x)
9 - Transmission
10 - Crankshaft

In conjunction with a Porsche Tiptronic transmission crankcase (1) no longer has the four studs (9) for mounting of the former transmissions.

Converter housing (2) is mounted with four M10 x 35 Torx bolts (3) and four washers (4). Tightening torque = 65 Nm. Afterwards intermediate flange (5), drive plate (6) and perforated disc (7) are mounted on crankshaft (10) with nine M10 x 1.25 x 23.5 Torx bolts (8).
Tightening torque = 90 Nm.

Notes:



Torque Converter Drive Plate

Notes:

Engine		911 Carrera 2 RoW	911 Carrera 2 USA
Engine Type			
Manual Transmission Tiptronic Transmission		M64.01 M64.02	M64.01 M64.02
Bore	mm (in)	100 (3.94)	100 (3.94)
Stroke	mm (in)	76,4 (3.01)	76,4 (3.01)
Displacement	cm^3 (cu.in)	3600 (219.7)	3600 (219.7)
Compression ratio		11.3:1	11.3:1
Max. engine power to EG 80/1269 to SAE J 1349 at engine speed	 kW (PS) kW (HP) RPM	 184 (250) - 6100	 - 184 (247) 6100
Max. torque to EG 80/1269 to SAE J 1349 at engine speed	 Nm (kpm) Nm (lbft.) RPM	 310 (31.6) 4800	 310 (228) 4800
Max. liter output to EG 80/1269 to SAE J 1349	 kW/l (PS/l) kW/l (HP/l)	 51.1 (69.4) -	 - 51.1 (68.6)
Max. engine speed	RPM	6720	6720
Speed governed at	RPM	6700±20	6700±20
Engine weight (dry)	kg (lbs)	238 (525)	230 (507)
Valve arrangement for each combustion chamber		 1 intake 1 exhaust	 1 intake 1 exhaust
Valve clearance Intake Exhaust	 mm (in) mm (in)	 0.1mm (.004) 0.1mm (.004)	 0.1mm (.004) 0.1mm (.004)
Valve timing at 1 mm valve clearance Intake opens Intake closes Exhaust opens Exhaust closes	 ° Crankshaft ° Crankshaft ° Crankshaft ° Crankshaft	 4° beforeTDC 56° after BDC 45° before BDC 50° after TDC	 4° beforeTDC 56° after BDC 45° before BDC 50° after TDC
Intake valve lift (in overlapped TDC) (20° after overlapped TDC)	 mm mm	 1.26±0.1 -	 1.26±0.1 -

911 Carrera (964) Engine – Technical Data

		911 Carrera 2 RoW	911 Carrera 2 USA
Engine Cooling			
Type		Air Cooled	Air Cooled
Fan drive		Belt-driven from crankshaft	Belt-driven from crankshaft
Fan ratio		1:1.60	1:1.60
Air delivery rate	l/s	1010	1010
Engine Lubrication		Dry sump	Dry sump
Oil cooling		Thermostatically controlled air cooler in air stream, & a two stage electrical blower	Thermostatically controlled air cooler in air stream, & a two stage electrical blower
Oil pressure	bar	6.5	6.5
Testing conditions			
Engine speed	RPM	5000	5000
Oil temperature	80° - 100° C		
Oil consumption	l/1000 km	aprox. 1.5	aprox. 1.5
Emission Control		Catalytic converter w/heated oxygen sensor	Catalytic converter w/heated oxygen sensor
Fuel System			
Fuel delivery		1 electric pump EKP 4	1 electric pump EKP 4
System pressure without vacuum	bar	3.6 - 4.0	3.6 - 4.0
Idle speed manual transm.	RPM	880±40	880±40
CO level in % by volume with cat. conv. at idle speed		0.4 - 1.2	0.4 - 1.2
Testing conditions		oxygen sensor connected, measuring in front of cat.	oxygen sensor connected, measuring in front of cat.
CO level in % by volume without cat. conv. at idle speed		0.5 - 1.0	-
Fuel Consumption			
Manual Transmission (Tiptronic)			
City	mpg	-	16 (16)
Highway	mpg	-	25 (23)
Combined	mpg	-	19 (19)

Electrical Equipment		911 Carrera 2 RoW	911 Carrera 2 USA
Alternator ratings	W (A)	1610 (115)	1610 (115)
Battery	V (Ah)	12 (72)	12 (72
Ignition		DME, twin spark ignition with knock sensor	DME, twin spark ignition with knock sensor
Firing order		1-6-2-4-3-5	1-6-2-4-3-5
Spark plugs			
Bosch		FR 5 DTC	FR 5 DTC
Beru		14FR5DTU	14FR5DTU
Electrode gap			
Bosch	mm (in)	0.7 (.028)	0.7 (.028)
Beru	mm (in)	0.7 (.028)	0.7 (.028)

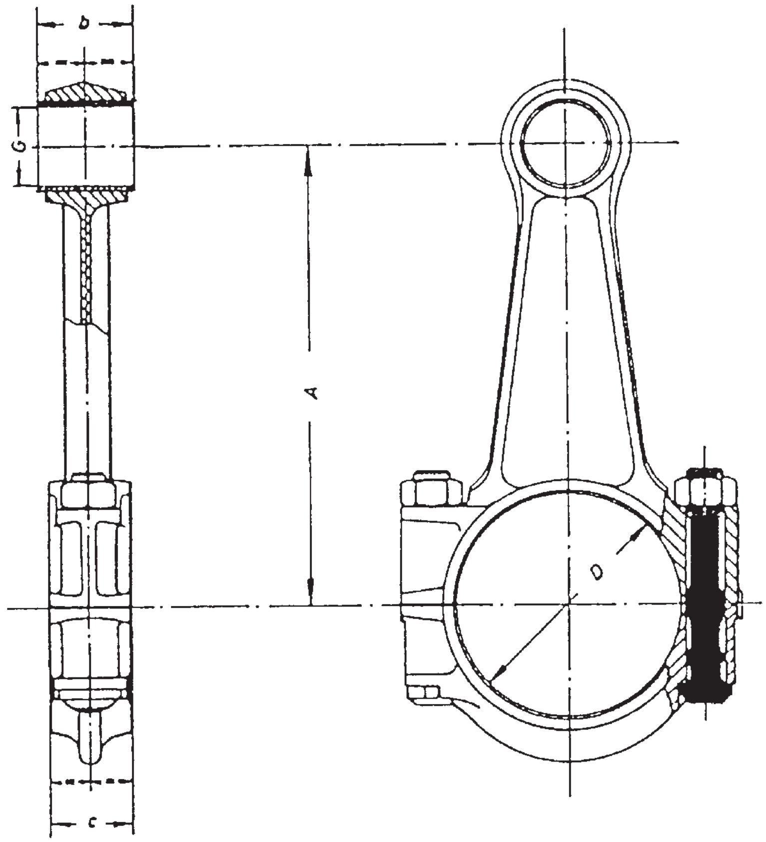
Notes:

911 Carrera (964) Engine – Tolerances

Point of Measurement (B = Bore Diameter, S = Shaft Dia.)	**Installed Size with Tolerances in mm**	**Clearance (+) or Press-fit (-) in mm from...to**	**Wear Limit in mm**
Crankshaft			
Main bearings Bearings 1 ... 7	B 60.020...60.059 W 59.971...59.990	+0.010...+0.072	visual inspection 59.960
Main bearings Bearing 8	B 31.041...31.084 W 30.980...30.993	+0.048...+0.104	visual inspection 30.970
Conrod bearings	B 55.020...55.059 W 54.971...54.990	+0.030...+0.088	visual inspection 54.960
Crankshaft runout (measured on Bearings 4 and 8 with bearings 1 7 on v-blocks)			max. 0.04
Crankshaft imbalance			max. 10 cmg
Crankshaft - main bearing axial play		+0.110...+0.195	0.30
Crankshaft - timing gear	B 41.975...42.000 W 42.002...42.013	-0.002...-0.038	
Crankshaft - distributor drive	B 41.975...42.000 W 42.002...42.013	-0.002...-0.038	
Crankshaft - flywheel	B 90.000...90.030 W 89.780...90.000	0.0...+0.049	
Crankshaft - pulley	B 30.000...30.033 W 29.960...29.993	+0.007...+0.073	
Pulley - radial runout lateral runout			max. 0.15 max. 0.20
Crankcase			
Case bore for main bearings Bearings 1 ... 8 Oversize	 65.000...65.019 65.250...65.269		
Case bore for intermediate shaft Bearing 1 (thrust bearing) Bearing 2	 27.500...27.521 26.500...26.521		

Point of Measurement (B = Bore Diameter, S = Shaft Dia.)	Installed Size with Tolerances in mm	Clearance (+) or Press-fit (-) in mm from...to	Wear Limit in mm
Intermediate Shaft			
Bearing 1 Crankcase bore - shaft	B 27.500...27.521 W 25.000...24.980		
Bearing 2 Crankcase bore - shaft	B 26.500...26.521 W 23.980...23.967		
Intermediate shaft			
Running play		+0.030...+0.084	
Axial play		+0.040...+0.133	0.16
Guide rail - shaft bolt	B 8.000...8.015 W 7.822...7.837		
Pinion - distributor shaft	B 12.466...12.474 W 12.444...12.455	+0.001...+0.030	
Distributor - crankcase	B 27.000...27.021 W 26.947...26.980	+0.020...+0.074	
Flywheel			
Lateral runout			max. 0.10
Radial runout			max. 0.20

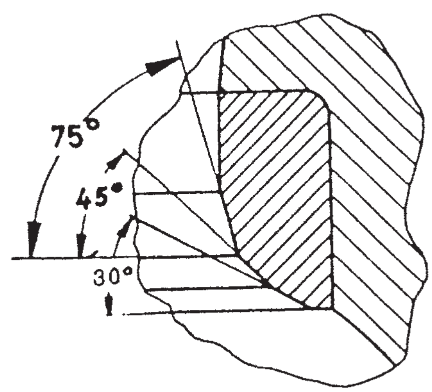
Notes:



Point of Measurement (B = Bore Diameter, S = Shaft Dia.)	**Installed Size with Tolerances in mm**	**Clearance (+) or Press-fit (-) in mm from...to**	**Wear Limit in mm**
Connecting Rods			
A - Distance between bore centers	126.95...127.00		
b - Width of conrod small end bush	24.5...25.0		
c - Width of conrod big end	21.7...21.8		
Since 1986 models	21.85...21.90		
Bearing width on crank journal	22.00...22.05	+0.2000...+0.350 +0.100...+0.200	
D - Conrod dia. (without bearing shell)	58.000...58.019		
G - Conrod bush dia./press-fit in Conrod (final size)	23.020...23.033		
Play between conrod bush and piston pin		+0.020...+0.037	0.055

Notes:

Point of Measurement (B = Bore Diameter, S = Shaft Dia.)	**Installed Size with Tolerances in mm**	**Clearance (+) or Press-fit (-) in mm from...to**	**Wear Limit in mm**
Pistons - Cylinders			
Piston / cylinder		0.02...0.03	0.12
Piston rings			
End clearance			
Groove 1		0.2...0.4	0.8
Groove 2		0.2...0.4	1.0
Groove 3		0.3...0.6	2.0
Side clearance			
Groove 1		0.07...0.102	0.2
Groove 2		0.04...0.072	0.2
Groove 3		0.02...0.052	0.1
Cylinder Head and Valves			
Valve guide - outside diameter	13.049...13.060		
Cylinder head - valve guide bore dia.	13.000...13.018		
Intake valve guide - inside dia.	9.000...9.015	+0.030...+0.057	0.15
Intake valve stem dia.	8.958...8.970	+0.030...+0.057	0.15
Exhaust valve guide - inside dia.	9.000...9.015	+0.050...+0.077	0.20
Exhaust valve stem dia.	8.938...8.950	+0.050...+0.077	0.20
Valve Seats			
Seat angle	45°		
Outer correction angle	75°		
Inner correction angle	30°		
Seat width			
Intake	1.5		
Exhaust	1.5		



Notes:

911 Carrera (964) Engine – Tolerances

Point of Measurement (B = Bore Diameter, S = Shaft Dia.)	**Installed Size with Tolerances in mm**	**Clearance (+) or Press-fit (-) in mm from...to**	**Wear Limit in mm**
Camshaft Case - Camshaft			
Camshaft bearing Camshaft	B 48.967...48.992 W 48.926...48.942	+0.025...+0.066	0.10
Camshaft axial play		+0.150...+0.200	0.40
Camshaft - sprocket flange	B 30.000...30.013 W 29.979...30.000	0.000...+0.034	
Camshaft runout (measured on middle bearing, between peaks			max. 0.02
Rocker arm shaft - camshaft case	B 18.000...18.018 W 17.992...18.000	Rocker arm shaft held in tight fit by key	
Rocker arm - rocker arm shaft	B 18.016...18.027 W 17.992...18.000	+0.016...+0.035	0.080
Axial play		+0.100...+0.350	0.50
Oil Circuit			
Oil pressure at 80° C and 5000 rpm engine speed		6.5 bar	5.0 bar
Oil consumption in liters per 600 miles (1,000 km)		approx. 1.5 ltr.	

Notes:

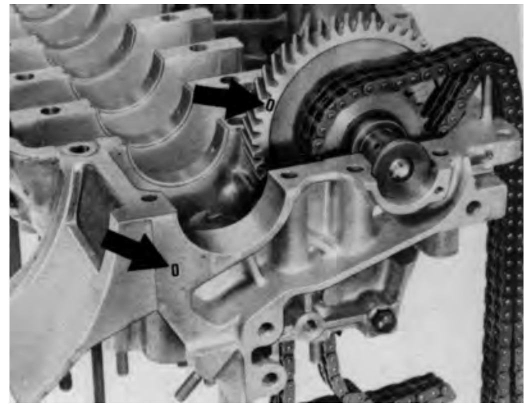
Intermediate Shaft/Drive Gear

Intermediate shaft and drive gear of 911 Carrera 2/4 (964) changed from the previous 911 Carrera 3.2 l and are paired and may only be replaced together. Check the crankcase identification.

Intermediate Shaft/Drive Gear Installation – 911 Carrera 3.2 l Pre-1989

Identification (0 or 1) is die-stamped in the left crankcase below the alternator take-up.

Gear wheels and crankcase may be paired with each other only as shown in the table below.



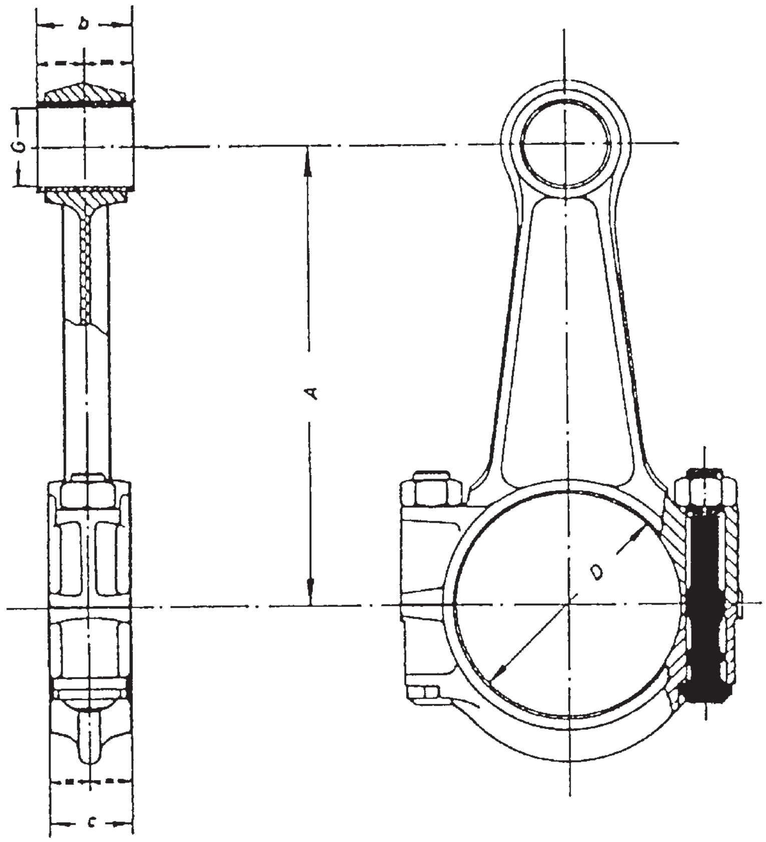
Crankcase and Gear Pairing – 911 Carrera 3.2 l Pre-1989

Distance Betw. Centers in mm	Crankcase Identification	Drive Gear on Crankshaft Identification	Intermediate Shaft Gear Identification	Backlash in mm
103.975 ... 103.990	0	0	0	0.029 ... 0.049
		installation still permitted		
		1	0	0.016 ... 0.042
		0	1	0.017 ... 0.043
103.990 ... 104.000	1	1	1	0.012 ... 0.041
		installation still permitted		
		0	1	0.025 ... 0.049
		1	0	0.025 ... 0.048

Notes:

911 Carrera (964) Engine – Connecting Rods

Specifications and Differences of Connecting Rods Since 1964



Type Distance	2.0 l	2.2 l	2.4 l	3.0 SC	3.3 l Turbo 911 Carrera 911 Carrera 2/4
A	130	[1]	127.80 -0.05	127.80 -0.05	127.00 -0.05
b	26.00 -0.20	[1]	26.00 -0.20	25.00 -0.20	25.00 -0.50
c	21.80 -0.1	[1]	23.70 +0.1	21.70 +0.1	21.70 +0.1
D	61.000 +0.019	[1]	56.000 +0.019	56.000 +0.019	58.000 +0.019
G	22.020 +0.013	[1]	22.020 +0.013	22.020 +0.013	23.020 +0.013
[2]	0.020... 0.039 max. 0.055	0.020... 0.039 max. 0.055	0.020... 0.039 max. 0.055	0.020... 0.039 max. 0.055	0.020... 0.039 max. 0.055

Footnotes

[1] Same as 2.0 ltr. Engine, but stronger! Cannot be installed in 2.2 liter engine.
[2] Play between bush and piston pin

Connecting Rod Weights

Connecting rods are divided into weight groups. The final digits of the part number can be used to find a pertinent weight group. These final digits are inscribed in the shaft of connecting rods, which are supplied for replacements.

Weight		Repair	Repair	
More than Grams	Up to Grams	Connecting Rod Weight Group	Connecting Rod Part Number	Connecting Rod Code
615	624	3	964.103.020.53	53
624	633	4	964.103.020.54	54
633	642	5	964.103.020.55	55
642	651	6	964.103.020.56	56
651	660	7	964.103.020.57	57
660	669	8	964.103.020.58	58
669	678	9	964.103.020.59	59
678	687	10	964.103.020.60	60
687	696	11	964.103.020.61	61

Note:
Connecting rods may only be installed in one engine when their difference in weight does not exceed 9 grams. Weight a complete connecting rod, but without bearing shells, to determine the weight group. Connecting rod codes for repair connecting rods are inscribed electrically.

Notes:

911 Carrera (964) Engine – Pistons & Cylinders

Piston & Cylinder Markings and Dimensions

For the 911 Carrera 2/4 (964), the cylinders are stamped on the opposite side of the knock sensor bridge mounting. The stamps include one mark for cylinder bore tolerance group and one mark for cylinder height tolerance group.

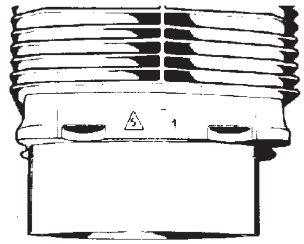


Figure 1

Example in Figure 1 shows a cylinder with a △5 cylinder height group mark and a **1** bore tolerance group mark.

The cylinder bore measurement **D** (see Figure 2) is taken at a point 56 mm down from the top of the cylinder. The height is measured at **H**, and the tolerance group stamps are in location **T**.

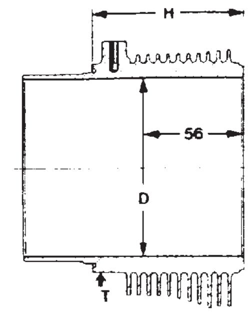


Figure 2

Note:
Only cylinders with the came height group number (5 or 6) may be installed in the same cylinder bank of the engine.

The 911 Carrera 2/4 (964) pistons have the markings on the top (see Figure 3). The letter **E** is stamped in the center (facing Intake side); to the right is a internal Mahle designation, and to the left, the tolerance group 0, 1, 2, or 3. The weight group (– –, –, +, ++) is stamped next to the tolerance group mark.

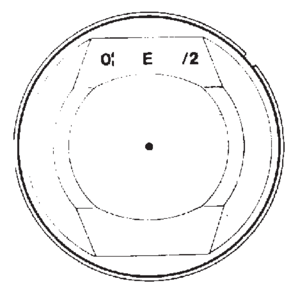


Figure 3

Note:
The weight group – – (double dash) may be applied vertically or horizontally

Cylinder Tolerance Group Chart

Height (H) -0.020	**Cylinder Bore** (D) +0.007	**Height Group** Stamp	**Bore Group** Stamp
82.750	100.000	△5	0
82.750	100.007	△5	1
82.750	100.014	△5	2
82.750	100.021	△5	3
82.770	100.000	△6	0
82.770	100.007	△6	1
82.770	100.014	△6	2
82.770	100.021	△6	3

Piston Tolerance Group Chart

Tolerance Group Stamp	**Cylinder Bore**	**Piston Diameter**
0	100.000 - 100.007	99.970 - 99.980
1	100.007 - 100.014	99.977 - 99.987
2	100.014 - 100.021	99.984 - 99.994
3	100.021 - 100.028	99.991 - 100.001

Weight Groups of Pistons - 911 Carrera (3.2) and 911 Carrera 2/4 (964)

Mahle Pistons – Pistons are weighed with piston pin, piston rings, circlips.

	Complete Piston Weight in Grams Weight Group Within Set			Code
Engine Type	930.20/25/26	930.21	M 64.01/02	
Standard production	618 ... 622 622 ... 626	613 ... 617 617 ... 621	644 ... 648 648 ... 652	– – –
Max. difference in weight: 4 grams	626 ... 630 630 ... 634	621 ... 625 625 ... 629	652 ... 656 656 ... 660	+ + +
Max. difference in weight for service: 8 grams	618 ... 626 626 ... 634	613 ... 621 621 ... 629	644 ... 652 652 ... 660	– – or – + or + +

KS Pistons (only 911 Carrera 3.2) **–** Pistons are weighed with piston pin, piston rings, circlips.

	Complete Piston Weight in Grams Weight Group Within Set	Code
Engine Type	930.21 USA	
Standard production	654 ... 650 654 ... 658	– – –
Max. difference in weight: 4 grams	658 ... 662 662 ... 666	+ + +
Max. difference in weight for service: 8 grams	654 ... 662 662 ... 670	– – or – + or + +

Installing Instructions

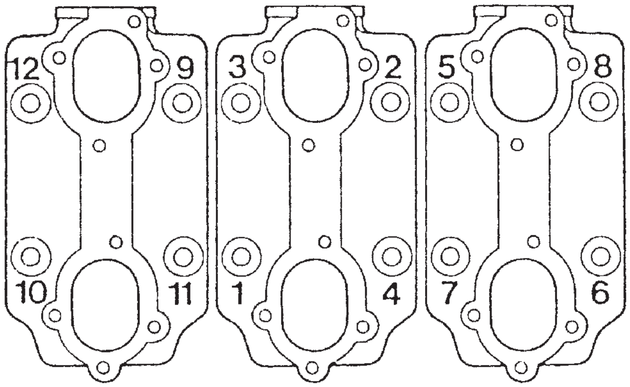
1. Fundamentally only pistons of the same make and in the same pertinent weight group may be used within one engine.

2. Piston pins must always remain with the corresponding pistons, since piston weight is balanced out with the piston pins.

Notes:

Installing Cylinder Heads

Tightening and torquing the cylinder head studs is described below.



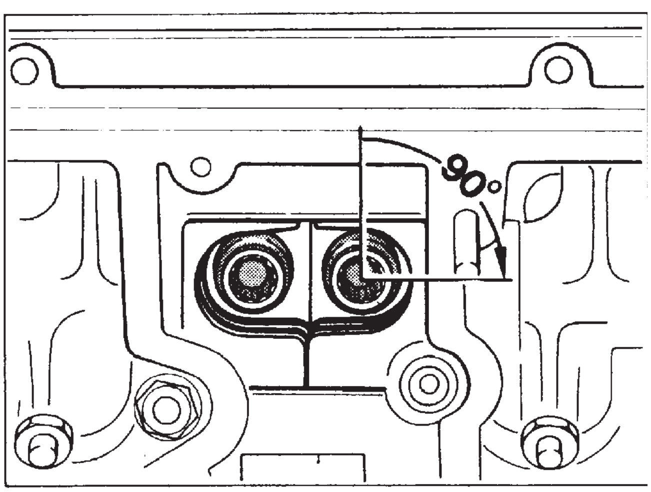
Cylinder Head Torquing Pattern

Instructions

1 - Apply a thin coat of Optimoly HT (copper paste) to the studs.
2 - Install cylinder heads.
3 - Apply a thin coat of Optimoly HD to the cylinder head nuts and tighten as follows:

Stage 1 - Torque to 25 Nm (18 ftlb) as per the above torque sequence.

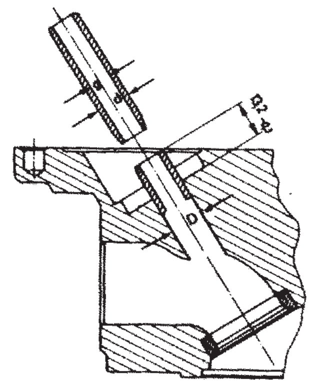
Stage 2 - 1 x 90° ± 2° following the torque pattern



90° Tightening Procedure Illustration

Note:
Before the cylinder head nuts are tightened, the head bolts of the knock sensor bridge must be fastened, leave loose and do not tightened until after heads have been torqued.

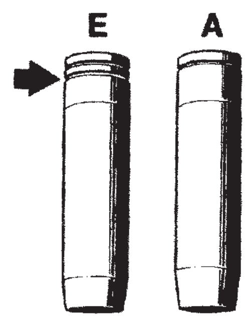
Dimensions For Installing Valve Guides



Valve Guide Dimensions

Valve Guide	Valve Guide OD*	Bore Diameter in Cyl. Head
Standard	13.060	13.000 - 13.018
Oversize	13.260	13.000 - 13.200

* Resurface outside diameter **d** of valve guide to appropriate bore diameter **D** considering negative allowance.



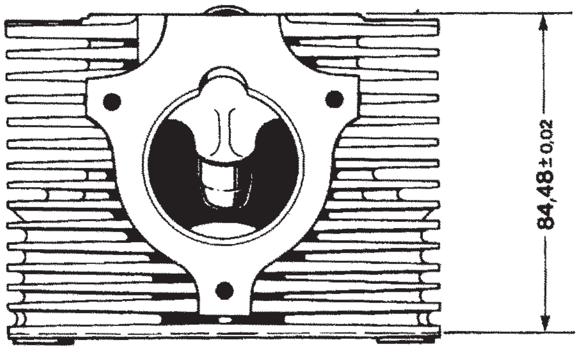
*Distinguishing Features – The intake valve guide **E** has an additional groove (arrow)*

Notes:

Cylinder Head Reconditioning

Cylinder heads may be reconditioned twice (0.1 ± 0.02 mm may be machined off each time). Reconditioned heads must be stamped with “- 10” or “- 20” on the intake port flange.

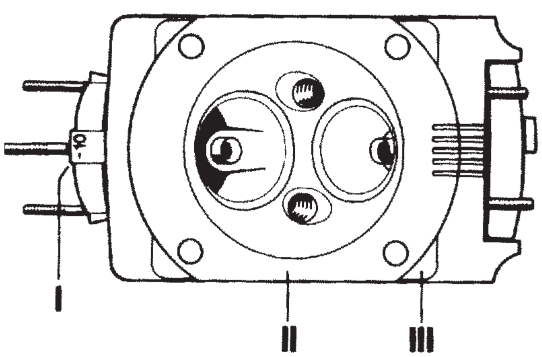
For uniform height, all the cylinder heads of one cylinder bank **must** be machined to the same size.



Original Cylinder Head Height is 84.48 ± 0.02 mm

Important:

It is not possible to machine the cylinder head mating surface with normal workshop equipment. The following procedure applies to using a machine shop mill or lathe.

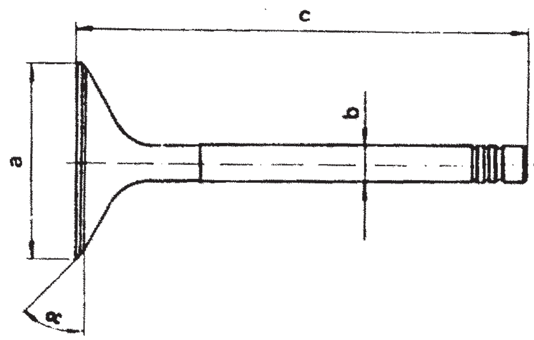


1. Clean cylinder head; media blast if necessary.

2. Mount cylinder in milling equipment level and mill 0.10 ± 0.02 mm off each of inner (II) and outer (III) surface. Cylinder heads may be reconditioned twice, taking off 0.10 mm each time.

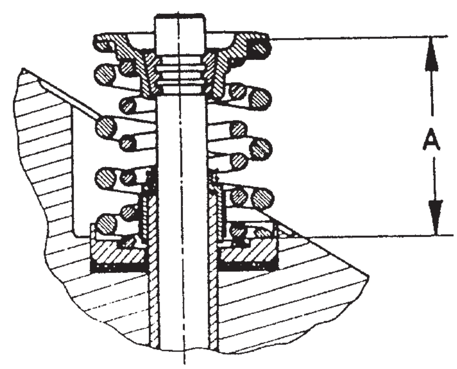
3. Slightly bevel edges of machined surfaces and mark (stamp) cylinder head “**-10**” or “**-20**” in area (I).

Valve Dimensions



Dimensions	Intake	Exhaust
a	49mm	42.5mm
b	8.97mm	8.94...8.96mm
c	110.1mm	109mm
d	45°	45°

Checking Valve Spring Height



1. Install Special Tool **P 10c** together with the shim belonging to a pertinent valve, spring retainer, spring disc and both collets.

2. Read distance “A” on Special Tool **P 10**c and correct, if necessary, by installing or removing shims.

Notes:

911 Carrera (964) Engine – Cylinder Head

Installed Length

Vehicle Type:	**911 T**	**911 E**	**911 S**
Engine Type: 2.0 liters	901.01/03/05	901.06/09	901.02/10
Intake valve:	36 ± 0.3 mm	35 ± 0.3 mm	35.5 ± 0.3 mm
Exhaust valve:	36 ± 0.3 mm	35 ± 0.3 mm	34.5 ± 0.3 mm
Engine Type: 2.2 - 2.4 liters	911.03/57/67	911.01/52/62	911.02/53/63
Intake valve:	35 ± 0.3 mm	34 ± 0.3 mm	35.5 ± 0.3 mm
Exhaust valve:	35 ± 0.3 mm	34 ± 0.3 mm	34.5 ± 0.3 mm

Vehicle Type:	**911**	**911 S**	**Carrera**
Engine Type: 2.7 liters	911.92/97	911.93/98	911.83
Intake valve:	35.0 ± 0.3 mm	35.0 ± 0.3 mm	35.5 ± 0.3 mm
Exhaust valve:	35.5 ± 0.3 mm	35.5 ± 0.3 mm	34.5 ± 0.3 mm

Vehicle Type:	**911**	**Carrera 3.0**	**Turbo 3.0 Ltr.**
Engine Type: 2.7 - 3.0 liters	911.81/86	930.02/12	930.50/52
Intake valve:	35.0 ± 0.3 mm	34.5 ± 0.3 mm	33.5 ± 0.3 mm
Exhaust valve:	35.5 ± 0.3 mm	34.5 ± 0.3 mm	33.5 ± 0.3 mm

Vehicle Type:	**911 SC/911 Carrera**	**Turbo 3.3**	**911 Carrera 2/4** (964)
Engine Type: 3.0 - 3.6 liters	930.03/13/20	930.60...68	M 64.01/02
Intake valve:	34.5 ± 0.3 mm	33.5 ± 0.3 mm	33.5 ± 0.3 mm
Exhaust valve:	34.5 ± 0.3 mm	33.5 ± 0.3 mm	34.5 ± 0.3 mm

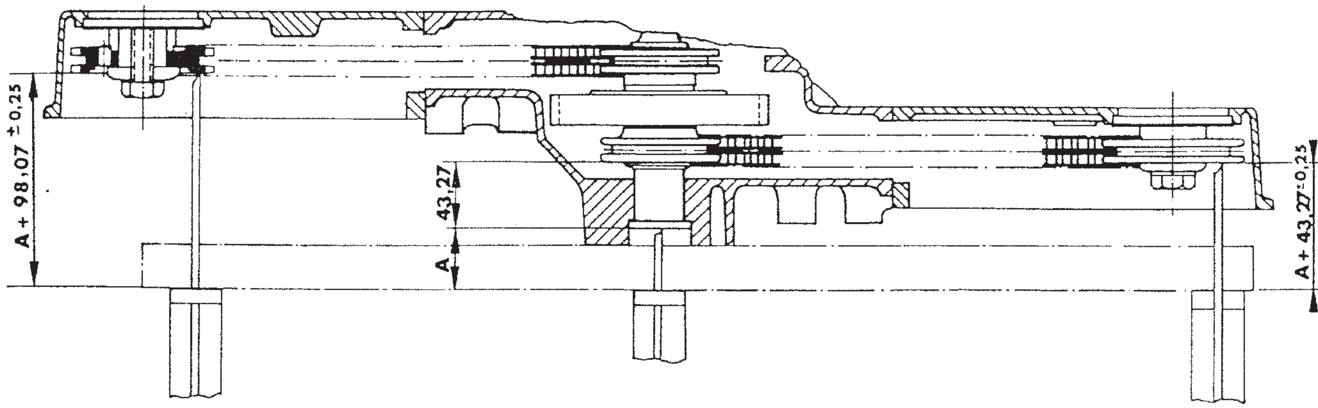
Tightening Procedures for Cylinder Head of 911 Carrera

Cylinder head tightening procedures are changed from the old tightening torque method to the new torque angle tightening method.
The changed tightening procedures offer more safety against the loosening of cylinder head nuts with greater bolt tensile force and more uniforem tightening of bolts among each other, in addition to less leakage on the cylinder head and cylinder base.
The modified procedures are for the time being only valid for the Service Sector (due to reasons of manufacturing) and concern all Carrera engines, including Carrera 2 and 4 (not the 911 Turbo, which still uses a tightening torque of 32 Nm).

Procedures:

1. Coat threads of studs in the crankcase lightly with Optimoly HT.
2. Mount cylinder heads.
3. Install washers.

Design Dimensions For Chain Sprockets on Intermediate Shaft



From front edge of crankcase to face of intermediate shaft.

The intermediate shaft and camshaft must be pushed in axial direction toward the flywheel prior to measuring, in order to have the guide collar of the bearing in correct position.

Example:

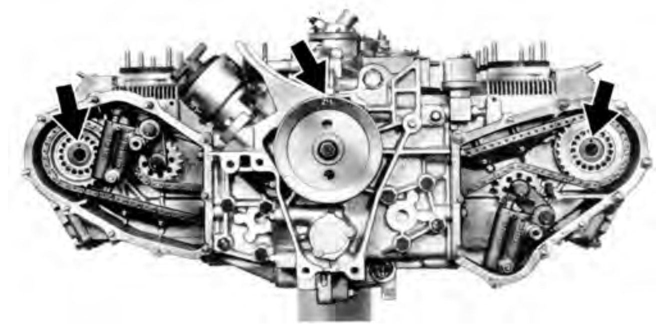
Distance A = 35.5 mm

Which means for cyl. 1 ... 3 sprocket:
A + 98.07 = 35.5 + 98.07 = 133.57 mm

And for cyl. 4 ... 6 sprocket:
A + 43.27 = 35.5 + 43.27 = 78.57 mm

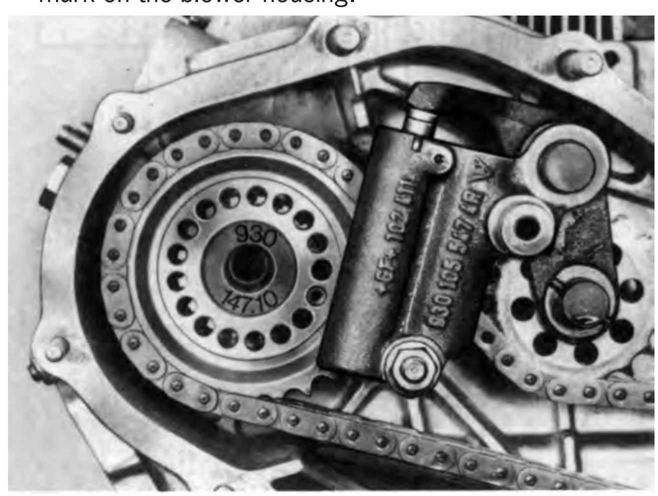
Notes:

Adjusting Engine Timing – Since 1982

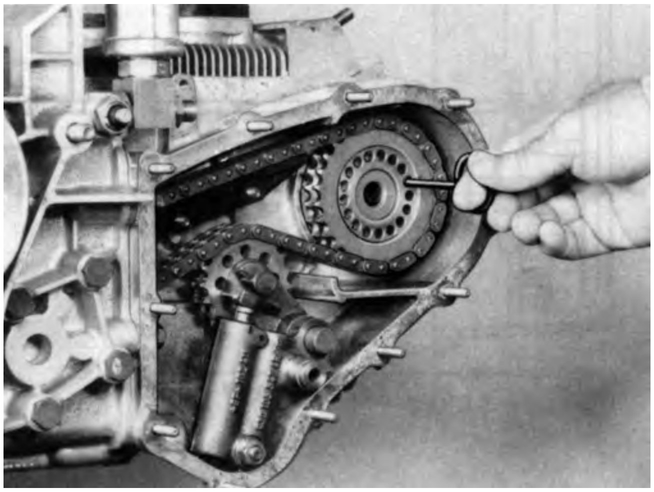


Timing Mark Locations

1. Turn crankshaft until mark “Z 1” on the pulley is precisely aligned with the joint of the crankcase or dash mark on the blower housing.



2. Turn both camshafts to have the punch marks or code 930 facing up. Engine will be in its basic position, valves of cylinder no. 1 in ignition TDC and valves of cylinder no. 4 overlapping, after aligning mark “Z 1” on pulley with the joint and having punch marks of the camshafts face up.



3. Insert dowel pins.

4. Coat hexagon head bolts lightly with Optimoly HT. Screw on sprocket with hexagon head bolts finger tight.

5. Adjust valve clearance precisely (0.010 mm).

6. Mount dial gage with Special Tool **P 207** on stud of camshaft case. Set dial gage to 0 (zero) with approx. 10 mm preload on the spring retainer of the intake valve in cylinder no. 1, with the valve closed.

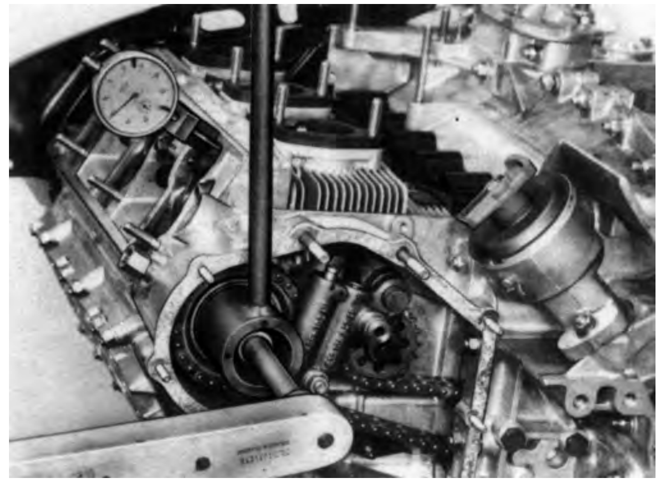
7. Now turn the crankshaft clockwise by about one turn slowly from Z 1 (TDC), while observing the dial gage at the same time. Turn so far until the mean value of the adjusting tolerances is reached. See Adjusting Values Section at end of "Setting Timing " section.

8. Loosen mounting bolt on the left sprocket, remove sprocket and pull out dowel pin with Tool **P 212.**

9. Turn crankshaft accordingly until mark Z 1 on the pulley is precisely aligned with the joint of the crankcase or dash mark on the blower housing.

10. Reinstall dowel pin and tighten hexagon head bolt lightly, while counterholding.

11. Turn crankshaft clockwise two more turns (720°) and recheck the adjustment. The read value must now be within the specified tolerances for adjustment.



12. Tighten hexagon head bolt of the left camshaft to final torque of 120 Nm (12 kpm), while have a second person counterhold with Special Tool **P 9191**.

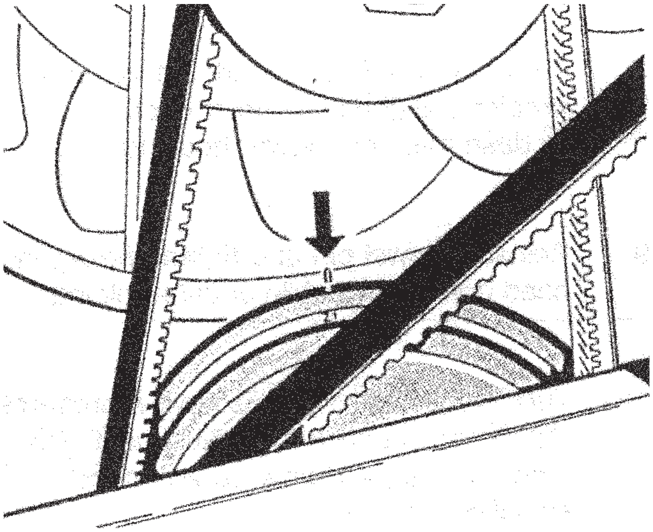
Adjusting Right Camshaft (Cyl. No. 4)

1. Adjust cylinder to ignition TDC (valves overlapping in cylinder no. 1).

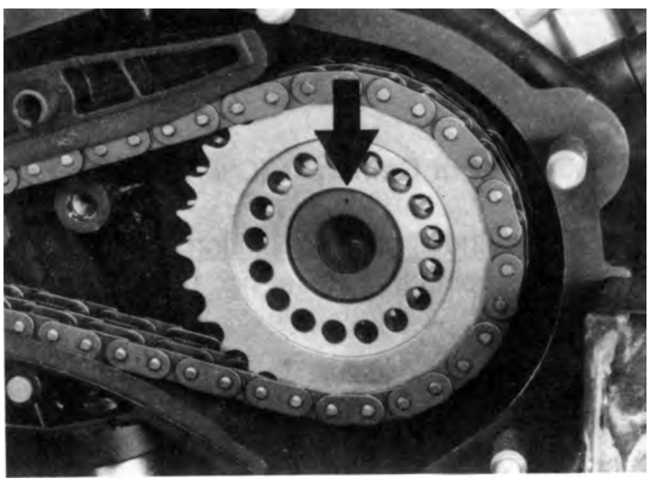
2. Repeat the adjusting procedures on cylinder no. 4 as described in points 2 through 8.

Notes:

Basic Adjustment – 911 Carrera 2/4 (964)



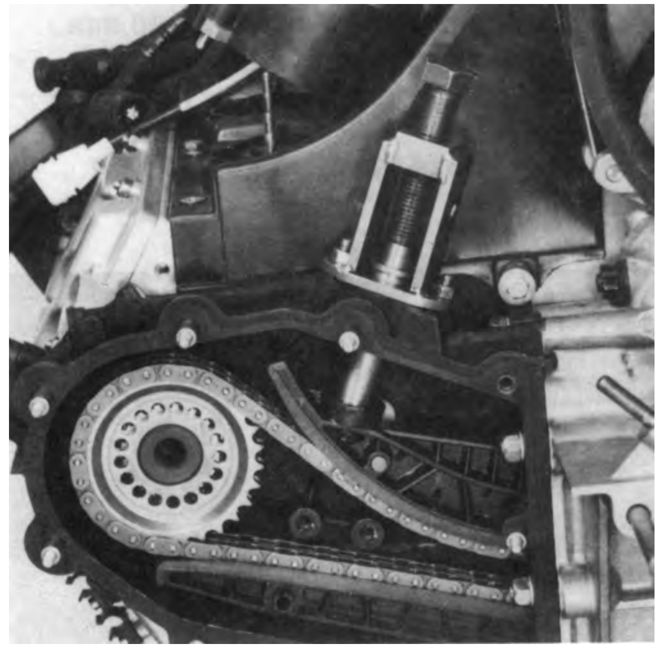
1. Turn crankshaft until mark on pulley is precisely aligned with joint of crankcase or dash mark on blower housing.



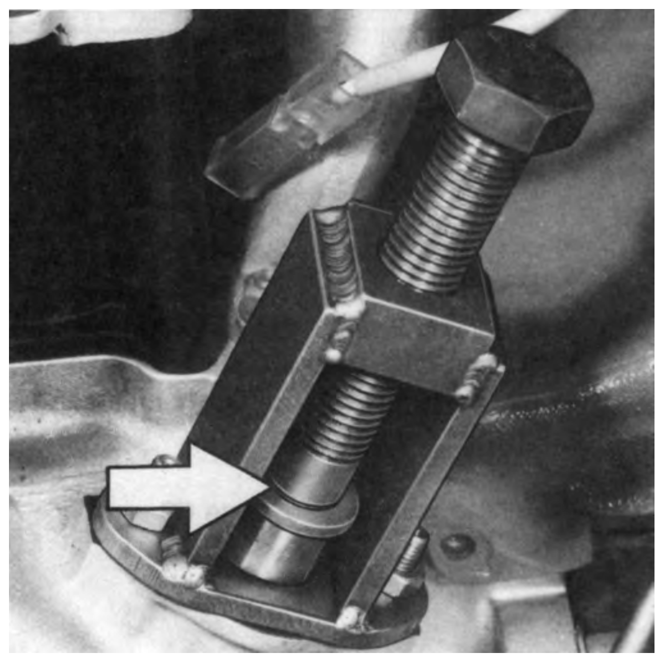
2. Turn both camshafts until the punch marks face up.

3. Mount both auxiliary chain tensioners (Special Tool **9401**).

Notes:



Shows auxiliary chain tensioner on the left side.



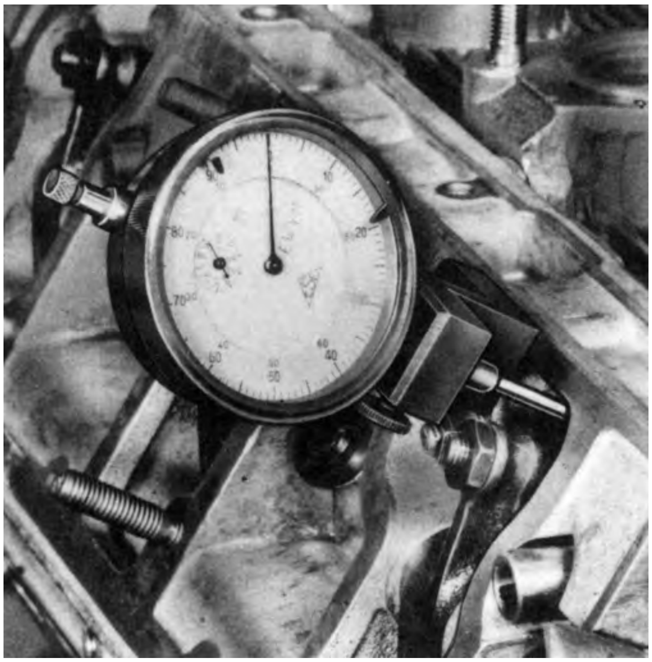
The recess in the pressure piece should be just visible.

4. Adjust valve clearance precisely (0.10 mm)

Notes:

Adjusting Left Camshaft (Cyl. No. 1) – 911 Carrera 2/4 (964)

5. Mount dial gage with Special Tool **P 207** on stud of the camshaft case. Set dial gage to 0 (zero) with approx. 10 mm preload on the spring retainer of the intake valve in cylinder no. 1.



6. Now turn the crankshaft clockwise by about one turn slowly from Z 1 (TDC) slowly, while observing the dial gage at the same time. Continue turning until the mean value of the specified tolerances for the adjustment is reached. See Adjusting Values Section at end of "Setting Timing " section.

7. Loosen hexagon head bolt on left sprocket, remove sprocket and pull out dowel pin with Tool **P 212**.

8. Turn crankshaft until mark Z 1 on pulley is precisely aligned with joint of crankcase or dash mark on blower housing.

9. Reinstall dowel pin and tighten hexagon head bolt lightly, while counterholding.

10. Turn crankshaft clockwise two more turns (720°) and recheck the adjustment. The read value must now be within the specified tolerances.

11. Tighten hexagon head bolt of the left camshaft to final torque of 120 Nm (12 kpm), while have a second person counterhold with Special Tool **P 9191**.

Adjusting Right Camshaft (Cyl. No. 4) – 911 Carrera 2/4 (964)

1. Set cylinder no. 4 to ignition TDC (valves overlapping in cylinder no. 1).

2. Repeat adjusting procedures on cylinder no. 4 as described in points 2 through 8.

Notes:

Specifications for Cylinder Head Installation - 6 Cyl. Engines Since 1978 Models

Engine Type	Model Year	Tightening Method	Timing	Remarks
930.04...06 930.10 930.15 (911 SC)	1978 ... 1983	Step 1: 10 Nm Step 2: 32 Nm	0.9 ... 1.1 mm lift in overlapping TDC	Camshaft No. right: 930 148 08 or 10 left: 930 147 08 or 10
930.03/ 07...09 13/16/ 17/19 (911 SC)	1978 ... 1983	Step 1: 10 Nm Step 2: 32 Nm	1.4 ... 1.7 mm lift in overlapping TDC	see above
930.60 up to 68 (911 Turbo)	1978 ... 1989	Step 1: 10 Nm Step 2: 32 Nm	0.65 ... 0.80 mm lift in overlapping TDC	Camshaft No. right: 930 142 00 or 03 left 930 143 00 or 03
930.20/ 21/25/26 (911 Carrera)	1984 ... 1989	Settling torque 15 Nm Torque angle 1 x 90° ± -2°	1.1 ... 1.4 mm lift in overlapping TDC	Camshaft No. right: 930 148 10 left: 930 147 10
M 64.01/02 (911 Carrera 2/4 (964))	1989-94	Settling torque 15 Nm Torque angle 1 x 90° ± 2°	1.16 ... 1.36 mm lift in overlapping TDC	Camshaft No. right: 964 246 07 left: 964 247 09

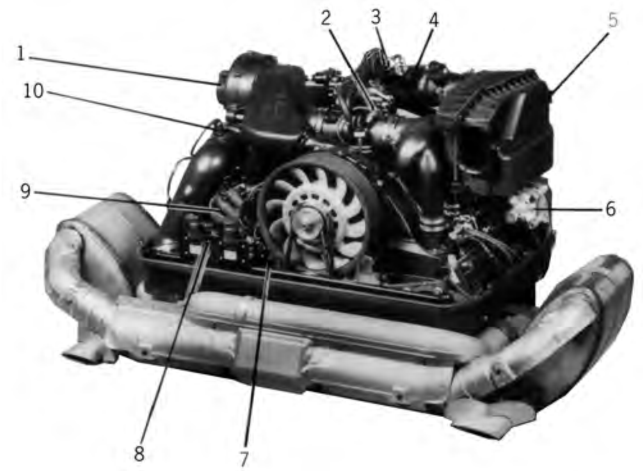
Notes:

Notes:

Notes:

Notes:

Engine



Engine Type M64.05/06 Components

1 - Hot air blower
2 - Switch for resonance flap control
3 - Idle speed control
4 - Mass air flow sensor
5 - Air filter
6 - Servo pump
7 - Belt tension monitor
8 - Ignition coils
9 - Twin ignition distributor
10 - Heating control temperature switch

General

M64.05/06 Engine

The engine for the new 911 Porsche Carrera is the logical redevelopment of the previous Carrera engine. The air cooled, horizontally opposed light-alloy six-cylinder engine was modified with the following development aims:

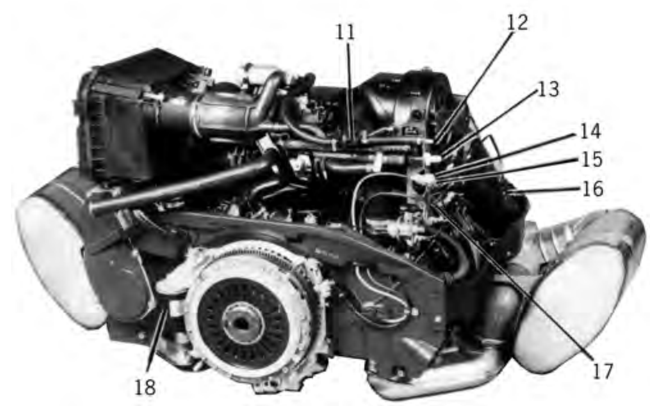
- Power increase of 10%
- Reduction of fuel consumption
- Easier maintenance
- Matching to the new rear axle

Engine Features

- Six-cylinder horizontally opposed engine
- Light-alloy engine
- Air cooled
- Twin-valve engineering
- Hydraulic valve lash adjuster
- Dry sump lubrication
- Resonance charging with two-stage intake
- DME with hot film air flow sensor
- Twin ignition knock control
- Engine idle charge regulation
- Three way catalytic converter with metal carriers and
- Lambda control

Important Innovations

The new M64.05/06 engines differentiate from the previous M64.01/02 engines due to their lighter crank drive without vibration dampers as well as the hydraulic valve lash adjuster, the engine management system with hot film sensor for mass air flow metering and the twin-pipe exhaust system.



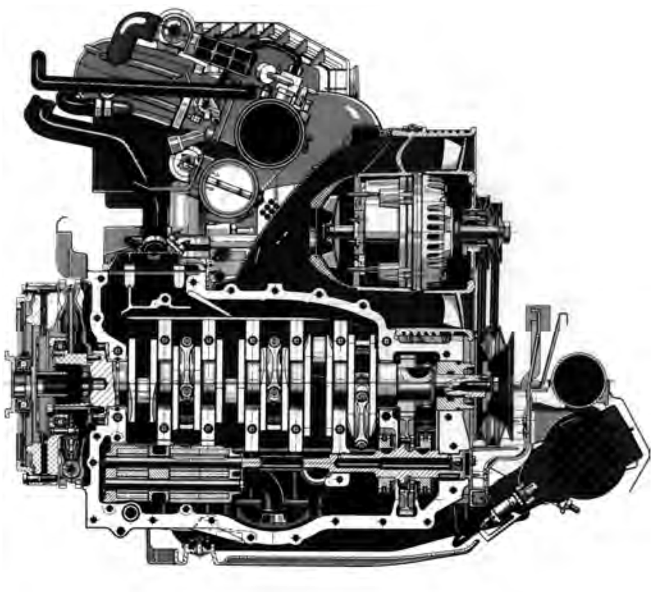
Engine Type M64.05/06 Components

11 - Tank vent
12 - Carbon canister connector
13 - Power brake connector
14 - NTC 2 connector
15 - Knock sensor 1 connector
16 - Resistor for heating control
17 - Connector for speed and reference mark sender
18 - Secondary oil filter

USA Secondary Air Injection not shown

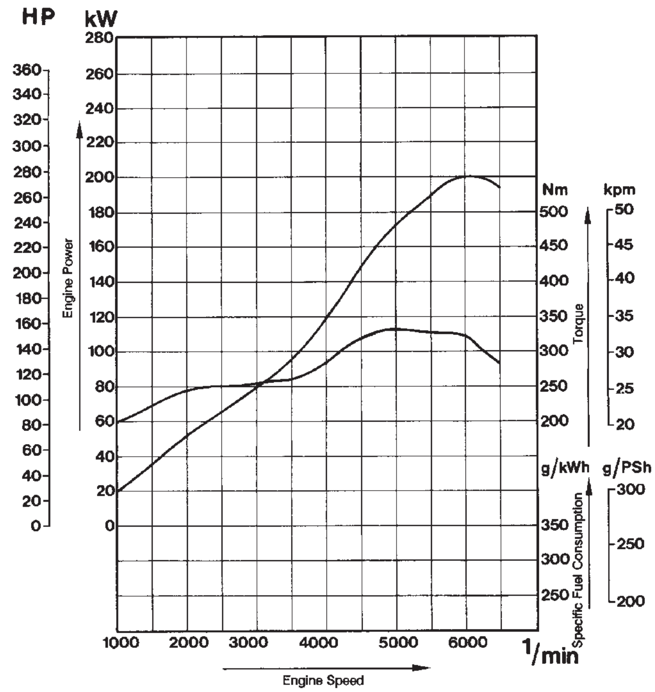
911 Carrera (993) Engine

Longitudinal Section of the Engine



Engine Type M64.05/06 Side View Cutout

Full-Load Curve of the M64.05/06 Engine



Cross Section of the Engine

Engine Type M64.05/06 Front View Cutout

Notes:

Engine Data

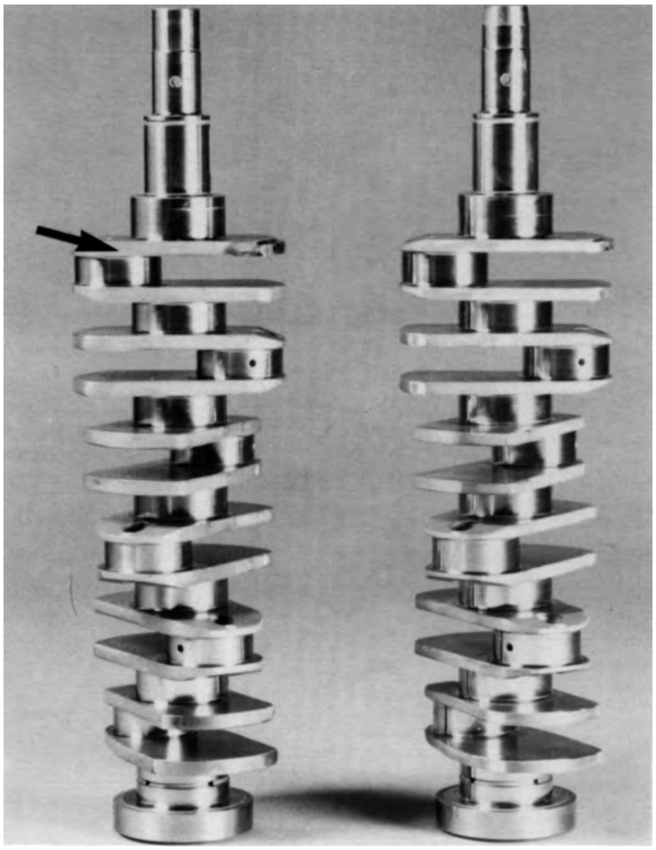
Displacement	3.6 l (Stroke 76.4mm x Bore 100mm)
Rated Power	200 kW/270HP
Nominal RPM	6100 rpm
Max. Torque	330 Nm @ 5000 rpm
Compression Ratio	11.3 : 1
Fuel	98 RON/88 MON (Premium unleaded)

Notes:

Crankcase

The split aluminum-silicon alloy crankcase as well as the crankcase bolting arrangement were adopted without any changes from the 911 Carrera (964) 2/4

Crankshaft



Increased Crankshaft Web Area

The bending and torsional stiffness of the eight-bearing crankshaft was increased by increasing the crank web dia. from 7.9 mm to 9.4 mm (see arrow). In conjunction with the reduction of the oscillating masses, this allowed the torsional vibration dampers on the crankshaft to be omitted. The weight of crankshaft as an individual component increased from 14.4 kg to 15.4 kg, yet the total weight of the complete crankshaft assembly was reduced by 0.818 kg.

Main Bearings

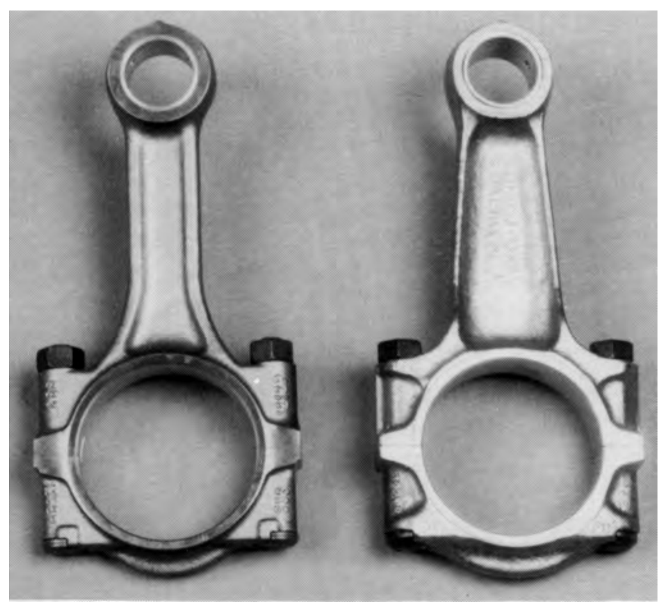
The crankshaft main bearings were adopted without any changes from the 911 Carrera (964) 2/4 engine.

Belt Pulley

Crankshaft Belt Pulley

A belt pulley is mounted on the cylindrical (formerly conical) end of the crankshaft. In place of the torsional vibration damper. This reduces the overall weight from an original 1161 g to 429 g.

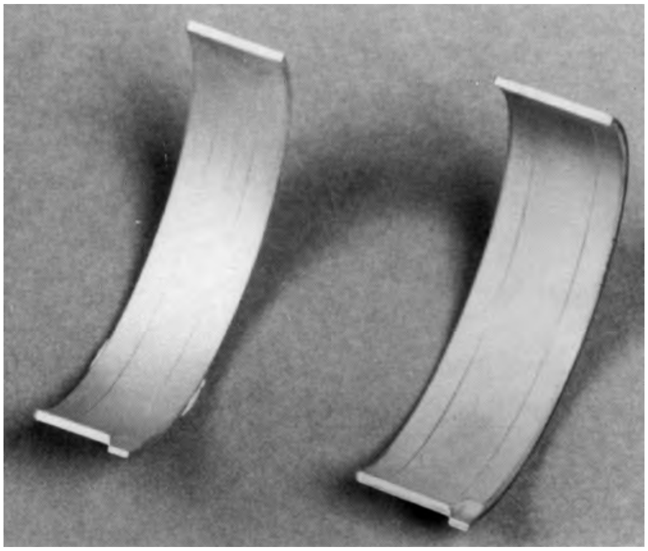
Connecting Rods



Connecting Rod Differences

The reduction in weight of the connecting rods from 632 g to 520 g was achieved by recalculating the design strength and by reducing the big end width from 21.9 mm to 18.9 mm. There are 7 weighting classes offered for the after sales service. Only con-rods with a weight deviation from each other of less than 6 g may be fitted within one engine.

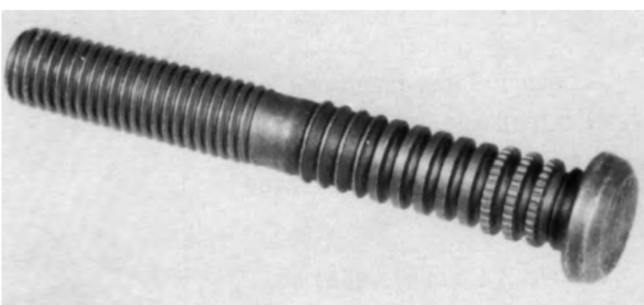
Big End (Connecting Rod) Bearings



Connecting Rod Bearing Shells

As the width of the connecting rod big end has been reduced, the big end bearings had to be adapted as well.

Big End (Connecting Rod) Bolts

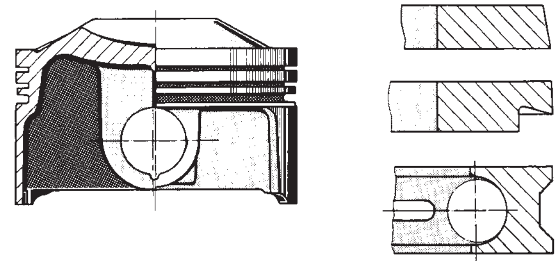


Connecting Rod Bolt

Along with the new connecting rods, a new big end bolt (grooved bolt) with a knurled twist lock surface under the bolt head was introduced. The tightening torque is 30 Nm + 90° torque angle.

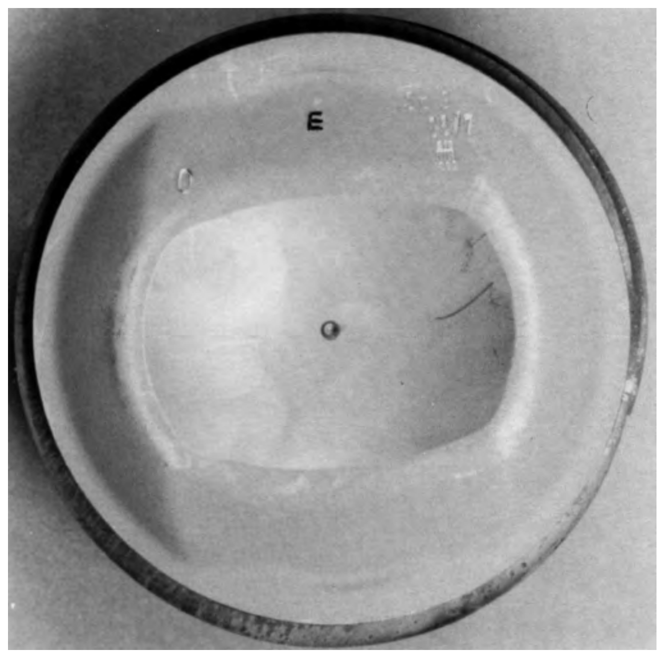
Notes:

Pistons



The pressed light alloy pistons have a diameter of 100mm. The piston pin bore is off centered by 0.9mm.

Groove 1 – Taper faced ring (1.5mm).
Groove 2 – Stepped taper faced ring (1.75.mm).
Groove 3 – Double-level oil control ring with tubular spring (2.0mm).



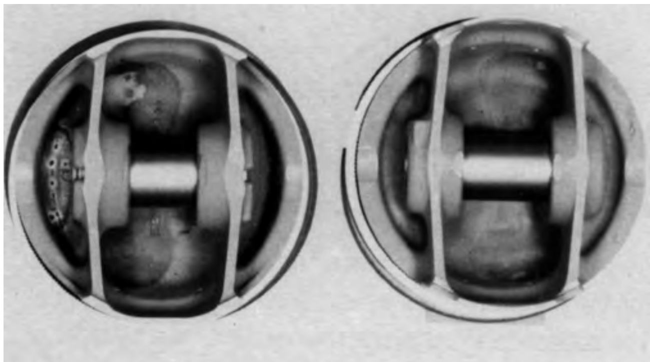
Piston Top

Care has to be taken on assembly to ensure that the cast-in identification letter **"E"** on the piston crown points towards the inlet side of the cylinder.

Piston Test Methods

The pistons are subdivided into four diameter tolerance groups (0/1/2/3). The designation of the tolerance group is located next to the letter "E". The diameter is determined at a height of 15 mm. In addition, the pistons are subdivided into weight groups ranging from - -to ++.

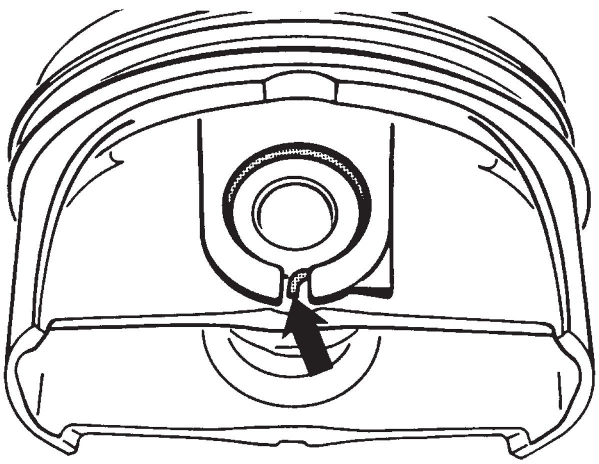
Pistons



Underside of Piston

The total weight of the piston has been reduced from 657 g to 602 g by reducing the wall thickness of the box-shaped piston skirt area and by using a shorter piston pin (see left hand side).

Wrist Pin Snap Ring



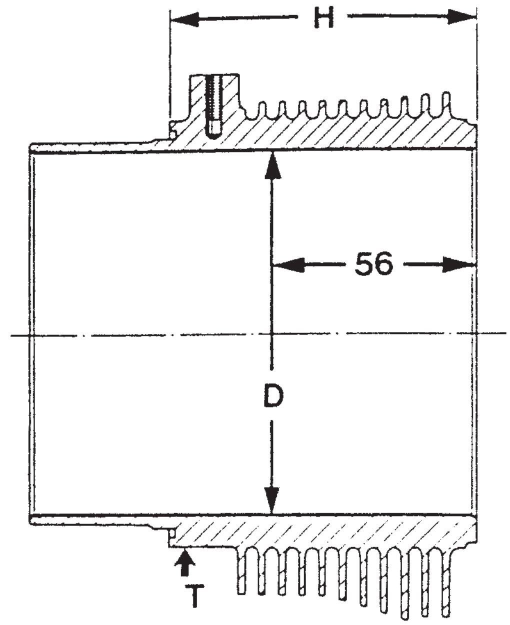
Piston Pin Snap Ring

The wrist pin snap ring design prevents the ring from turning in its groove.

Notes:

Cylinders

The cylinders have a bore diameter (D) of 100 mm and are made of high-temperature resistant light alloy. The bore surface coating (Nikasil) is applied galvanically. In order to compensate for the differing temperatures across the height of the cylinder and to maintain a constant running clearance, the bore is machined with a slight taper.

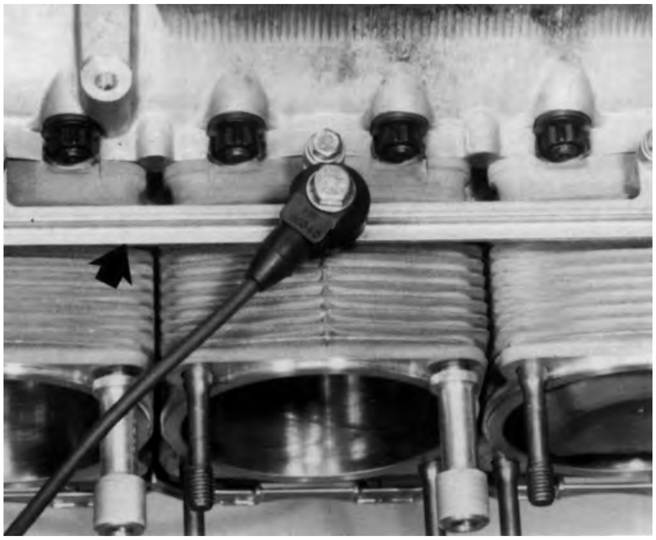


As before, the cylinders are subdivided into two groups for the length tolerances and four diameter tolerances. The tolerance groups are stamped into the cylinder base (T).

Notes:

Knock Sensor Bridge

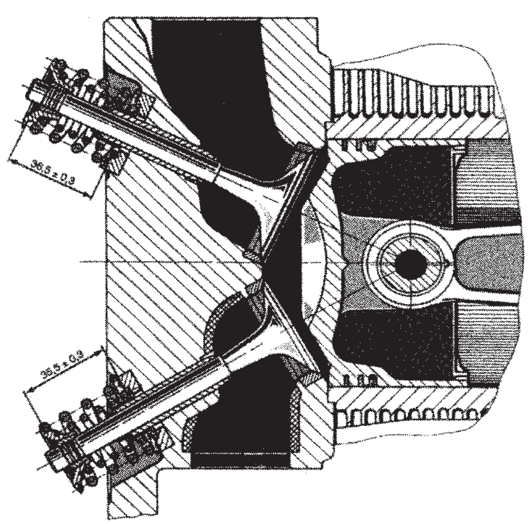
The lugs cast on the cylinders are used for fitting of one knock bridge (arrow) for each row of cylinders that is used to accommodate a knock sensor. Observe the following assembly procedure:



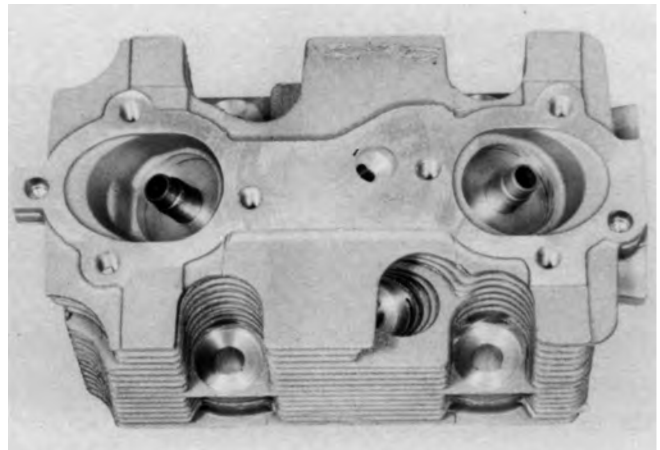
Knock Sensor Bridge Location

- Pre-assemble cylinders 1 ... 3 or 4 ... 6.
- Fit the knock bridge and screw in the three M6 fastening bolts.
- Install the cylinder heads and tighten them down.
  Note: Never tighten knock bridge until the cylinder heads are torqued down.
- Tighten the M6 bolts of the knock bridge, to a tightening torque 10 Nm.

Cylinder Head



The inlet port dia. has been increased from 41.5 mm to 43 mm. A ceramic port liner is fitted into the outlet ports of the cylinder head. The port liner provides for a temperature drop of approx. 400° C at the cylinder head. A further positive effect of the port liner is that cooling of the exhaust gas is reduced and that the actual temperature available for heating and for the catalytic converter remains higher. Socket head bolts have replaced the studs in the cylinder head used for fitting of the camshaft housing.

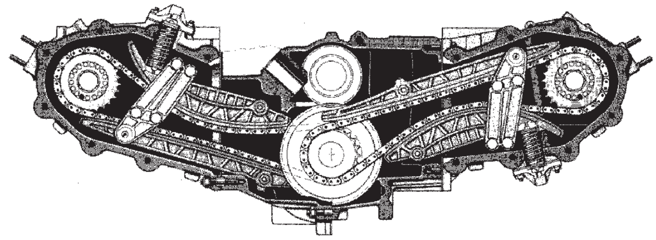


Cylinder Head

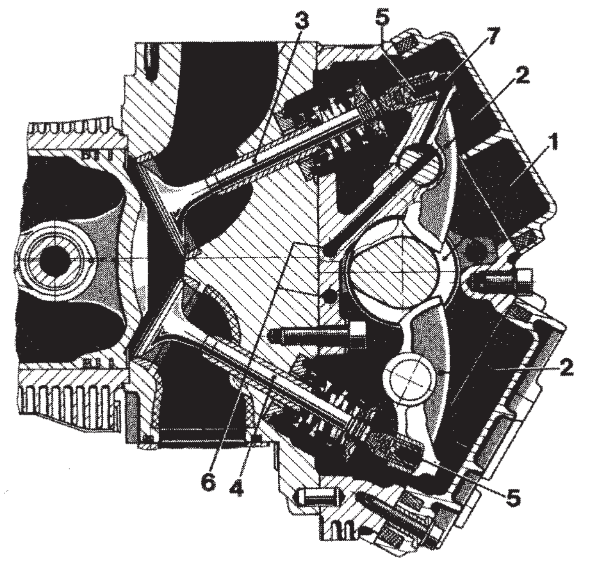
In order to obtain the best possible cooling of the cylinder head. The cooling fins were designed for maximum cooling surface area, the cooling air volume was optimized by reducing flow resistance with the use of thinner cooling fins, and the cylinder head nuts and spark plug connectors were thinned down further.

Valve Train

The camshafts are driven via two duplex roller chains by the intermediate shaft, which rotates, at half the crankshaft speed. The chains are guided by tensioning and guide rails made of plastic with a sprayed-on slideway lining. Chain tensioners; integrated into the oil circuit of the engine are used to tension the chains and to dampen the chain oscillations.



Notes:



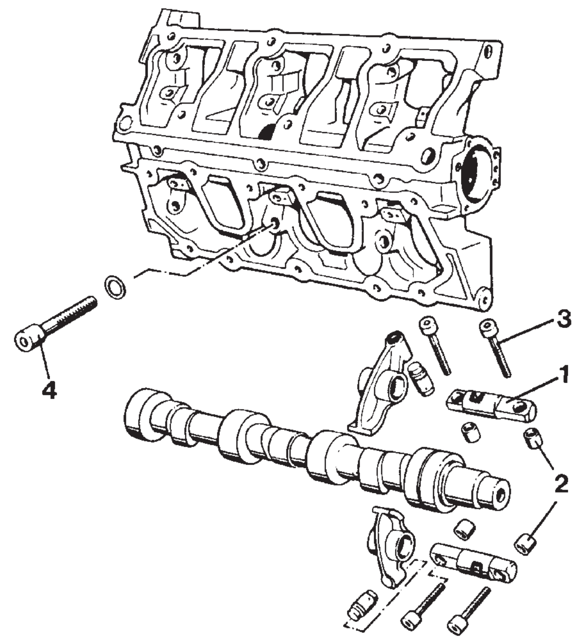
Valve Train Components

1 - Camshaft
2 - Rocker arm
3 - Inlet valve
4 - Exhaust valve
5 - Valve lash adjuster
6 - Oil supply bore
7 - Oil supply reservoir

The camshafts (1) actuate one inlet (3) and one exhaust valve (4) per cylinder via rocker arms (2). Whereas in the case of the earlier model engines the valve clearance had to be reset every 24,000 km/15,000 miles, the rocker arms in the M64.05/06 engines are fitted with hydraulic valve lash adjusters (5) which automatically correct any change of the valve clearance. Oil is supplied to these adjusters (5) across the camshaft housing (6) and the rocker arm bearing bores. In order to protect the adjuster of the upper (inlet) rocker arm against oil starvation, it has an additional oil supply reservoir (7). Apart from reducing maintenance requirements, the hydraulic valve lash adjusters also serve to reduce the exhaust gas emissions in the engines warm-up phase.

Notes:

Camshaft Housing



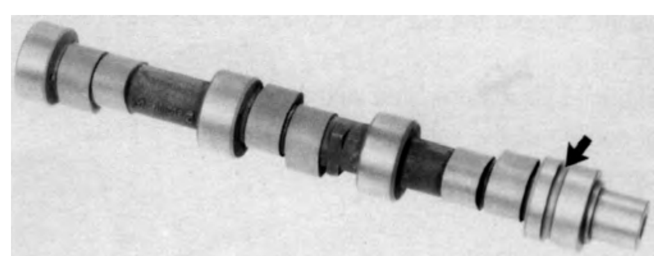
Camshaft Housing Components

The camshaft housing is a completely new design. One major modification is the revised mounting of the rocker arm shafts to incorporate the oil supply to the hydraulic valve lash adjusters.

The rocker arm shafts (1) are fitted with dowel sleeves (2) to ensure exact shaft location and are tightened down with pan head bolts (3). The camshaft housing is also fitted with pan head screws (4). The studs used up until now are no longer used.

Camshafts

The camshafts are manufactured from high quality clear chill castings. The inlet valve lift is 12 mm, and the exhaust valve lift is 11 mm. Oil is supplied to the valve lash adjusters across the peripheral groove (arrow) in the camshaft bearing.

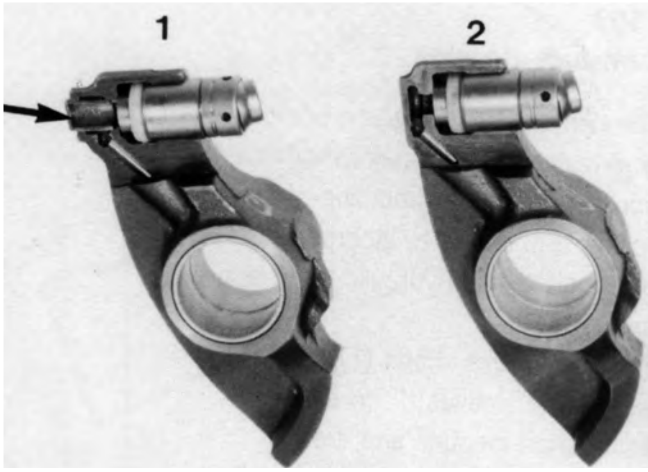


Camshaft Peripheral Groove

Identification number of left-hand camshaft:
993.247.07

Identification number of right-hand camshaft:
993.246.07

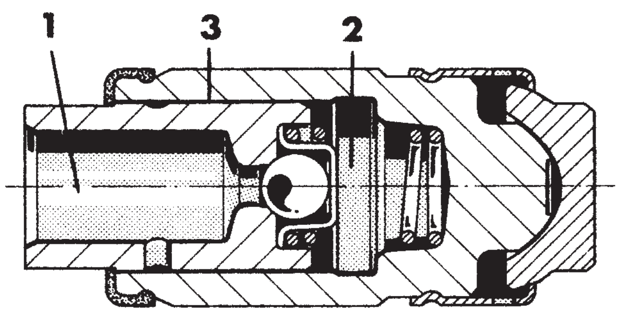
Rocker Arm



Rocker Arm Additional Oil Reservoir

The two rocker arms made of clear chill casting (GGG70) are different for the inlet (1) and exhaust (2) valve gear. The inlet port rocker arm has an additional oil reservoir (arrow) sealed with a cover plate.

Hydraulic Valve Lash Adjuster



Hydraulic Valve Lash Adjuster Components

The hydraulic valve lash adjuster is inserted in the rocker arm. The reservoir chamber (1) is supplied with pressurized engine oil. When the valve clearance is readjusted, the oil flows past the ball into the pressure chamber (2). The oil escapes slowly over a drain gap (3) in the cylinder wall in order to ensure correct closing of the valve.

Notes:

Valves

Intake and Exhaust Valves

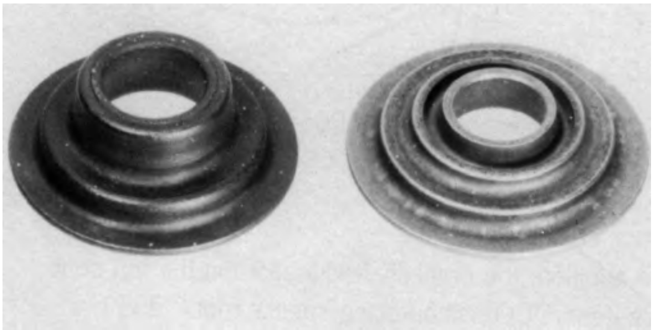
As the valve stem diameter was reduced by 1 mm, the weight of both the inlet and exhaust valves was reduced by 10 g. The inlet valves are filled with sodium to provide additional cooling of the valve head and to ensure a better cylinder charge.

Valve Springs

Valve Spring Assembly

The linear coil design of the valve spring assembly provides an increased closing and final force. The installation direction is not important.

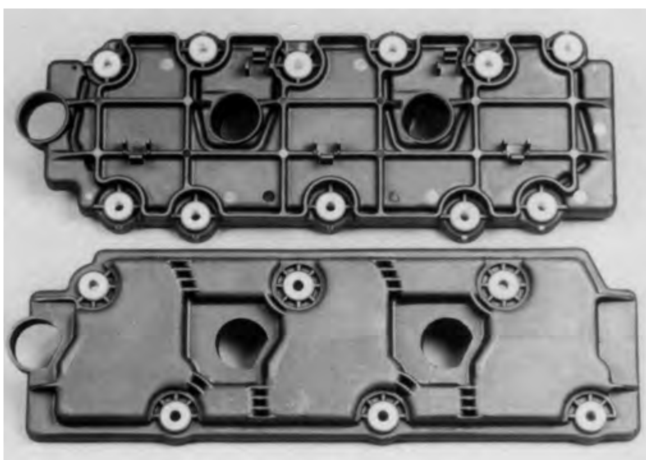
Valve Spring Retainer



Valve Spring Retainer

The valve stem seal, the valve keepers as well as the valve spring caps have been adapted to fit the 8 mm valve stem diameter. In addition, the weight of the valve head was reduced by approx. 10 g.

Camshaft Housing Covers



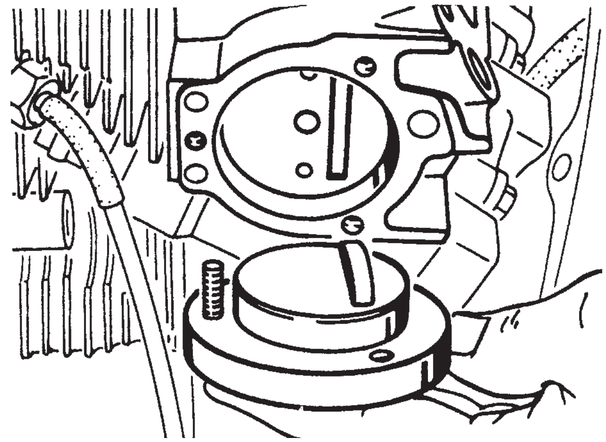
The camshaft housing covers are made from glass fiber reinforced polyamide with inserted bushings fitted with a form seal. M6 bolts are used for fitting the housing cover. Tightening torque 10 Nm.

Notes:

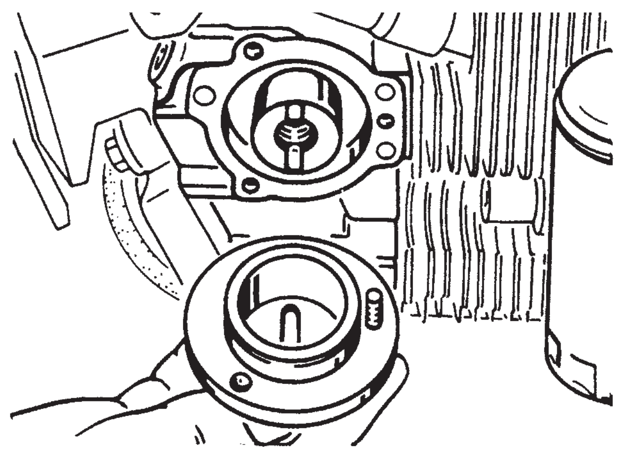
Timing Gear

Setting the Timing

Setting the timing has been greatly simplified compared to previous engines. A slot is machined in each camshaft as a timing reference to allow both camshafts to be locked in a specified position with special tools P 9551 and P 9552.

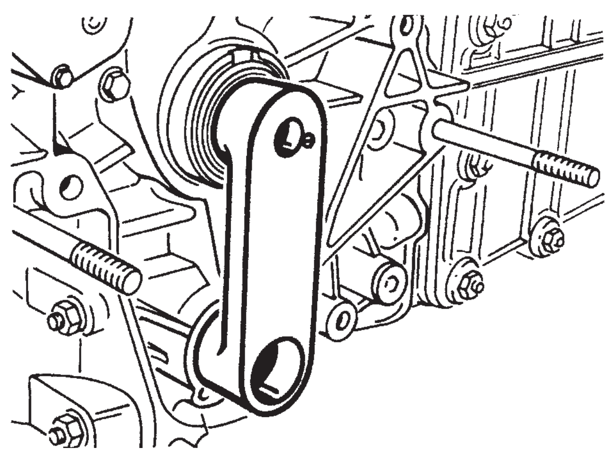


Special Tool 9551



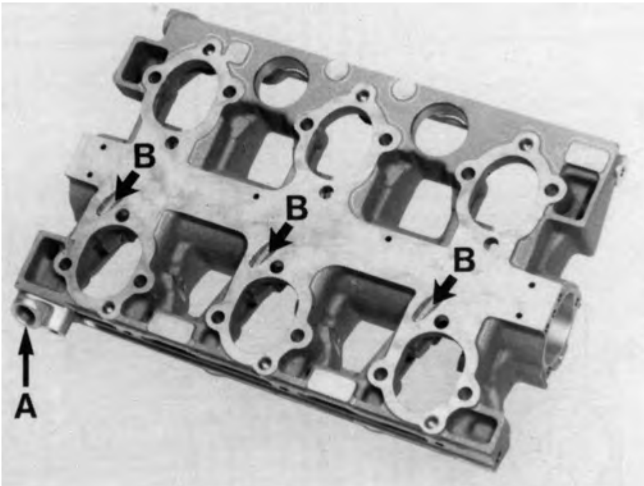
Special Tool 9552

In addition, the crankshaft is located in the top dead center (TDC position using special tool P 9553).



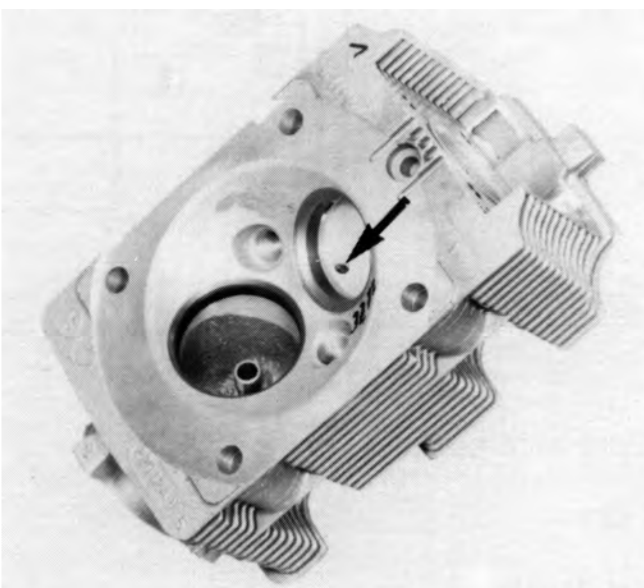
Special Tool 9553

Auxiliary Air Pump



Camshaft Housing

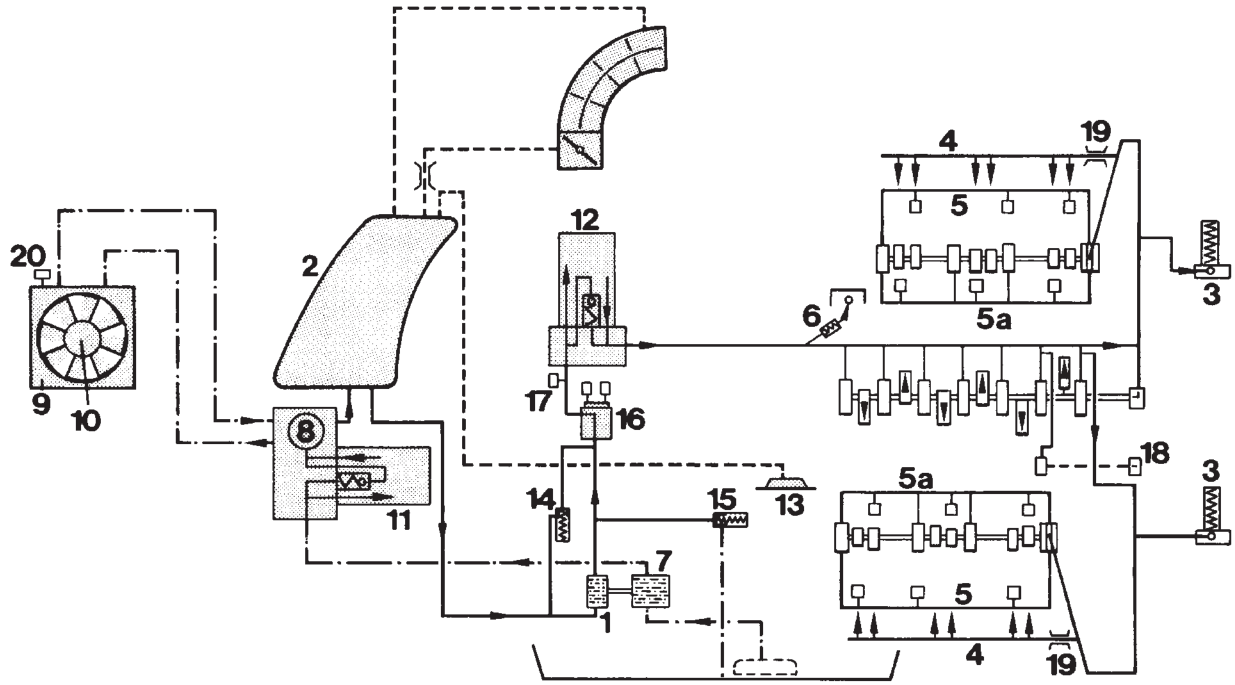
Additional bores for mounting the auxiliary air pump have been machined in the camshaft housing for USA vehicles. The air flows from port (A) acrocee the bores (B) to the cylinder heads.



Air Pump Air Injection Bore In Cylinder Head

The air is blown into the exhaust port through a transverse passage in the cylinder head.

Notes:



Engine Lubrication (Dry Sump)

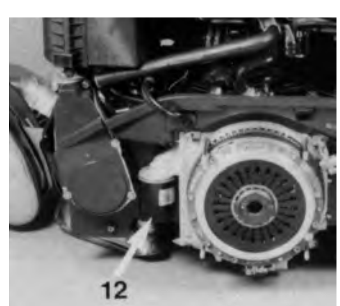
1 - Oil pressure pump
2 - Oil tank
3 - Chain tensioner
4 - Oil passage for the camshaft
5 - Oil passage for valve lash adjusters
6 - Spray nozzles for piston cooling (open at 3 bar)
7 - Scavenge pump
8 - Thermostat (opens at 87° C/188° F)
9 - Oil cooler
10 - Oil cooler fan
11 - Full flow type oil filter with bypass valve
12 - Auxiliary oil filter
13 - Air vent dome
14 - Pressure relief valve (opens at 5.3 bar)
15 - Safety valve (opens at 9 bar)
16 - Oil pressure switch and oil pressure sender for instruments
17 - Oil temperature sender for instruments
18 - Intermediate shaft
19 - Throttle
20 - Temperature sensor

Engine Lubrication

The 911 Carrera (993) has a dry sump lubrication system identical to that of its predecessors. With this system, the oil volume is not collected in an oil pan (sump) in the engine, but in an external oil tank. This supply tank is located in the wheel housing in front of the rear right hand wheel. Its internal design ensures that the circulation oil is sufficiently defrothed (defoamed and dense) and is available at all operating and driving conditions.

For filtration of the engine oil, a full-flow filter (11) is included in the return circuit, and a small auxiliary filter (12) is located at the inlet to the engine to protect the valve lash adjuster elements against contaminates in the oil. Both of these filters have to be replaced every 48,000 km/30,000 miles. The engine oil has to be changed every 24,000 km/15,000 miles. Approx. 9 liters are required for an oil change.

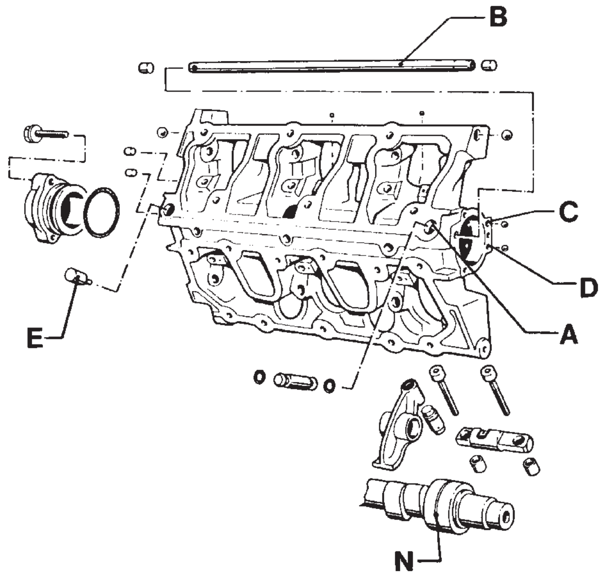
The oil pressure pump in the engine (1) draws the oil from the sump (2) and supplies all bearings, the chain tensioner (3), the camshaft lobes (4), the hydraulic valve lash adjusters (5) and the spray nozzles (6) for piston cooling. The scavenge pump (7) located in the same housing as the oil pressure pump and is used to return the oil from the crankcase back to the oil tank (2). The oil pressure and scavenge oil pumps are low-loss gear type pumps, their common housing is made of die-cast magnesium. When the temperature of the return oil exceeds 87ºC/188ºF, a thermostat (8) deviates the oil across an oil cooler (9) located in the wheel housing in front of the right-hand front wheel. This cooling process is intensified by a fan (10) when the temperature exceeds 100ºC/212ºF.



Oil Filter Location

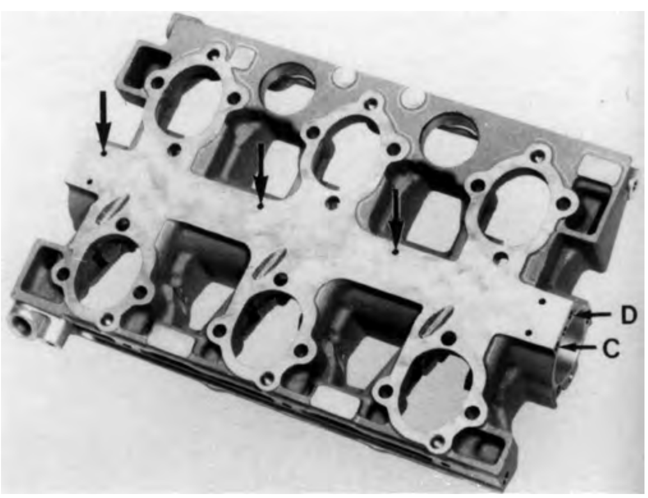
Auxiliary Oil Filter and Bracket

Oil Supply to the Camshafts and Hydraulic Valve Lash Adjusters



Oil Flow Through Cam Housing

The oil flows from the chain housing across a bridge to the inlet (A) of the camshaft housing. From the inlet, a portion of the oil is fed through the spray pipe (B) to lubricate the cams and rocker arms. The remaining oil flows to the rear camshaft bearing, and across a peripheral groove (N) in the camshaft to the distribution channels (C and D). A number of these oil channels are blocked off with ball inserts and aluminum plugs.

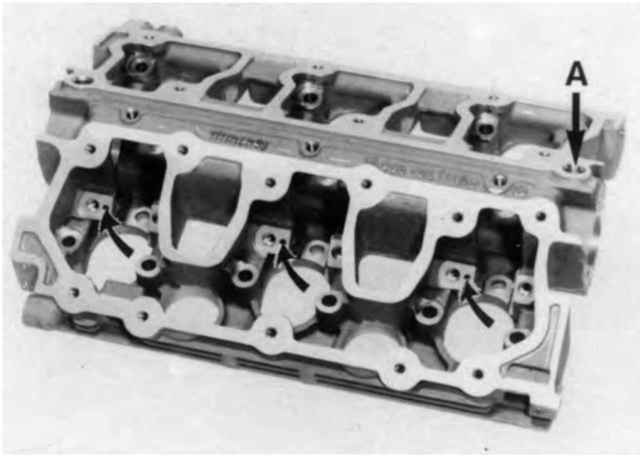


The aluminum plugs (E) serve simultaneously for determining the position of the spray pipe.

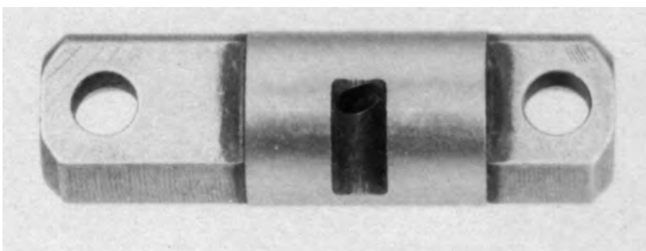
The remaining three camshaft bearings are supplied with lubrication oil over transverse bores (arrow) blocked off with ball inserts.

The junction bores (arrows) that also connect to the distribution channels serve to lubricate the rocker arm shafts and at the same time supply oil to the valve lash adjusters across the rocker arms.

Notes:



Junction Bores in Cam Housing


Rocker Arm Shaft

Note: Rocker arm shafts are installed in one direction only.

Engine Cooling

In line with its predecessors, the Porsche 911 Carrera (993) is fitted with an air-cooled engine. Air cooling is particularly suitable for a compact drive unit mounted in the rear of the vehicle. Apart from ease of maintenance, a particular advantage of air cooling is the high temperature difference between the external surface of the cylinders and the ambient air that allows large amounts of heat energy to be transferred. The cooling air required is drawn in by the engine cooling fan across the screen mounted in the rear spoiler and then passes the finned cylinders, absorbing the heat to be dissipated in the process. Then the hot air is discharged towards the floorpan.

When designing the cylinders and the cylinder heads, sufficient cooling surface and the correct layout of the entire cooling area must be ensured. In addition, a sufficiently sized flow area for the cooling air and correct distribution to the cylinders and cylinder heads must be provided. In order to reduce heating of the cylinder head, the exhaust port is fitted with a ceramic port liner to act as a heat insulator. The fan has been designed and optimized for a high feed rate at high efficiency and low noise levels. At high vehicle speeds, the fan is supported by the retractable rear spoiler that creates an increased pressure ahead of the spoiler due to the increased dynamic pressure ram effect.

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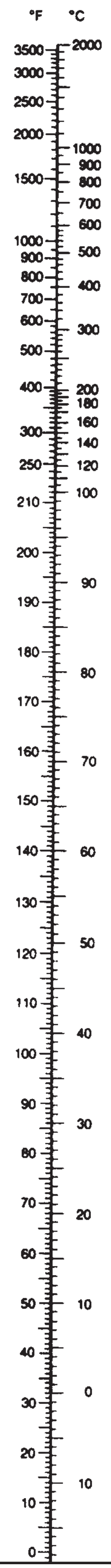
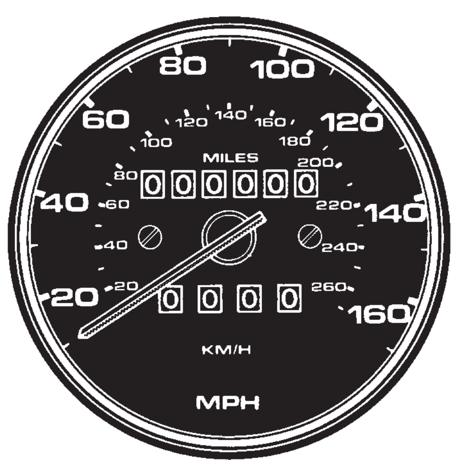
Temperature Conversion



Metric Conversion Formulas

INCH	X	25.4	=	MM
MM	X	.0394	=	INCH
MILE	X	1.609	=	KILOMETER(KM)
KM(KILOMETER).	X	.621	=	MILE
OUNCE	X	28.35	=	GRAM
GRAM	X	.0352	=	OUNCE
POUND(lb).	X	.454	=	KILOGRAM(kg)
kg(KILOGRAM)	X	2.2046	=	lb(POUND)
CUBIC INCH	X	16.387	=	CUBIC CENTIMETER(cc)
cc(CUBIC CENTIMETER)	X	.061	=	CUBIC INCH
FOOTPOUND(ft lb).	X	1.3558	=	NEWTON METER(Nm)
Nm(NEWTON METER)	X	.7376	=	ft lb(FOOT POUND)
HORSEPOWER(SAE).	X	.746	=	KILOWATT(Kw)
HORSEPOWER(DIN)	X	.9861	=	HORSEPOWER(SAE)
Kw(KILOWATT).	X	1.34	=	HORSEPOWER(SAE)
HORSEPOWER(SAE)	X	1.014	=	HORSEPOWER(DIN)
MPG(MILES PER GALLON)	X	.4251	=	Km/l(KILOMETER PER LITER)
BAR.	X	14.5	=	POUND/SQ. INCH(PSI)
PSI(POUND SQUARE INCH)	X	.0689	=	BAR
GALLON.	X	3.7854	=	LITER
LITER.	X	.2642	=	GALLON
FAHRENHEIT	-	32÷1.8	=	CELSIUS
CELSIUS	X	1.8+32	=	FAHRENHEIT



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