STRALIS AT/AD

REPAIR MANUAL

MECHANICAL

ELECTRIC

ELECTRONIC

IVECO

STRALIS AT/AD

REPAIR MANUAL

IVECO

This publication describes the characteristics, the data, the correct methodology of the repairs that can be made on each individual component of the vehicle.

By complying with the instructions supplied and using the specific tools it is possible to perform any repair intervention correctly, within the specified time frames, while protecting the technicians against incidents.

Before starting any repair work, make sure that all accident prevention devices are ready at hand.

Check and wear the protective personal equipment provided for by the safety standards: goggles, helmet, gloves, shoes.

Check the efficiency of all processing, lifting and transport tools before using them.

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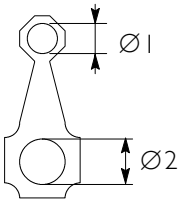
SPECIAL REMARKS

The workshop manuals for mechanical parts have been divided into Sections, each of which has a number and its relevant contents are indicated in the General Specifications. Each section features a main Unit (e.g. engine, gears etc.).
The subjects usually dealt with in each section are:
Technical data table, Driving torques, Equipment, Diagnostic, Removal and Fitting in place, Repair operations.
Where possible, the same sequence of procedures has been followed for easy reference.
Diagrams and symbols have been widely used to give a clearer and more immediate illustration of the subject being dealt with, (see next page) instead of giving descriptions of some operations or procedures.

Example



Ø 1 = housing for connecting rod small end bush

Ø 2 = housing for connecting rod bearings

Tighten to torque
Tighten to torque + angular value

Furthermore, within each section, every heading or sub-heading concerning the operations to be carried out is preceded by a six digit number. This number is the Product Code that is to be found in the repair operation described in the REPAIR TIMES CHARTS and in the FAULT CODES.
For quick reference the indication of how to read this code is described below (see the Repair time charts also).

Product Code:

5	0		
PRODUCT		UNIT	SUB-ASSEMBLY COMPONENT

Example:
Product 50 = Frame;
Product 52 = Axles;
Product 53 = Gears etc.

Unit Code:

	0	1	
PRODUCT		UNIT	SUB-ASSEMBLY COMPONENT

Figures three and four identify the ASSEMBLY within the PRODUCT
Example:
Product 50 = Frame;
Unit 01 = Chassis;
Unit 02 = Bumpers etc .

Sub-assembly Code:

		4	0
PRODUCT	UNIT	SUB-ASSEMBLY COMPONENT	

Example:
Product 50 = Frame;
Unit 01 = Chassis;
Sub-assembly 40 = Chassis cross members etc.

Graphs and symbols

	Removal Disconnection
	Refitting Connection
	Removal Disassembly
	Fitting in place Assembly
	Tighten to torque
	Tighten to torque + angle value
	Press or caulk
	Regulation Adjustment
	Warning Note
	Visual inspection Fitting position check
	Measurement Value to find Check
	Equipment
	Surface for machining Machine finish
	Interference Strained assembly
	Thickness Clearance
	Lubrication Damp Grease
	Sealant Adhesive
	Air bleeding

	Intake
	Exhaust
	Operation
	Compression ratio
	Tolerance Weight difference
	Rolling torque
	Replacement Original spare parts
	Rotation
	Angle Angular value
	Preload
	Number of revolutions
	Temperature
	Pressure
	Oversized Higher than.... Maximum, peak
	Undersized Less than.... Minimum
	Selection Classes Oversizing
	Temperature < 0° Cold Winter
	Temperature > 0° Hot Summer

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Base – January 2003

UPDATE DATA

Section	Description	Page	Revision date

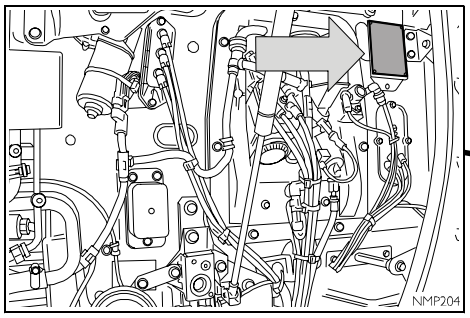
INDEX OF SECTIONS

SECTION 1

General

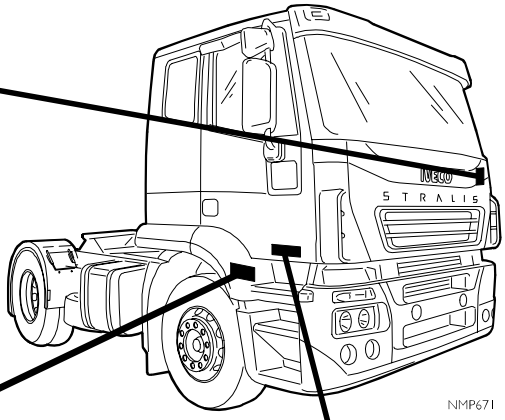
VEHICLE IDENTIFICATION DATA

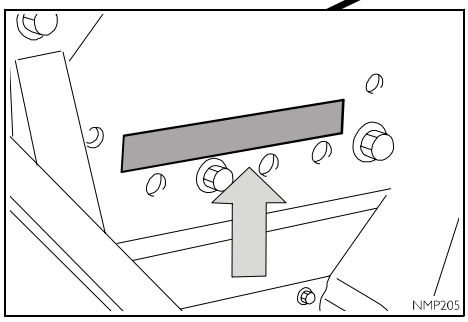
The type and number of engine, type and number of chassis and manufacturer's plate comprise the vehicle identification data.



Manufacturer's plate

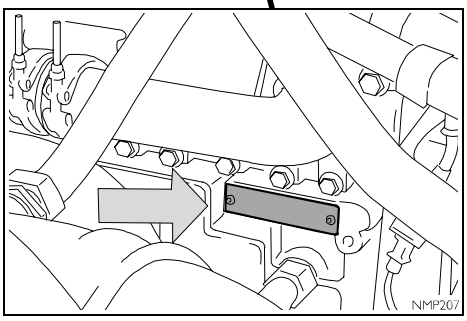
To identify the vehicle in accordance with the E.E.C. directive
(under the front radiator cowling).





Chassis frame

Punching (front on right side member of chassis frame).



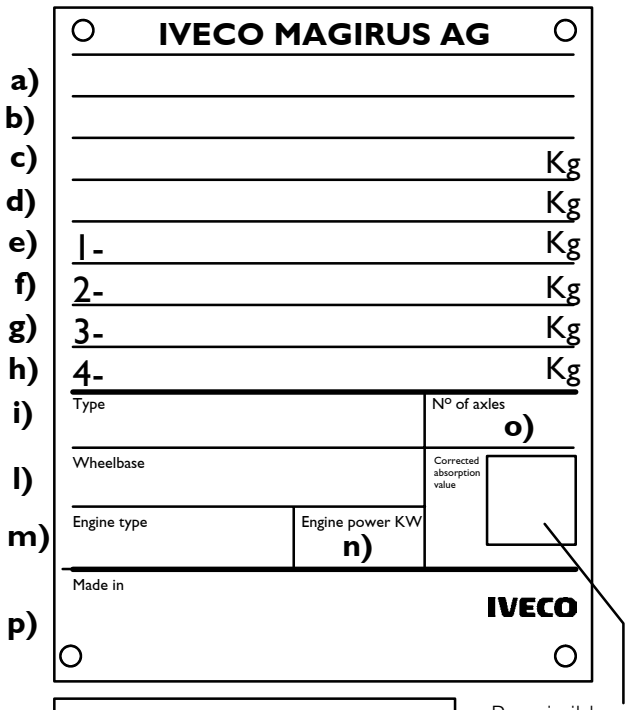
Engine

Plate on the left rear side of the crankcase

Vehicle Identification Plate

Plate legend

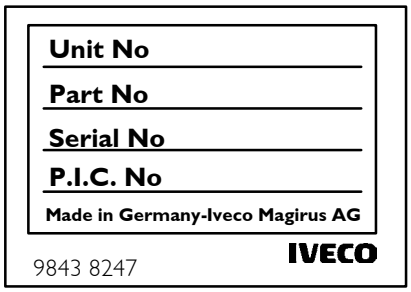
a) Type-approval number marking (if applicable).
b) Vehicle identification code number (V.I.N.).
c) Total tractor weight.
d) Total weight of tractor + trailer (if applicable).
e) Permissible weight limit on 1st axle.
f) Permissible weight limit on 2nd axle (if applicable).
g) Permissible weight limit on 3rd axle.
h) Permissible weight limit on 4th axle (if applicable).
i) Specific identification of type.
l) Wheelbase in mm.
m) Engine type.
n) Engine power.
o) No. of axles.
p) Place of manufacture.



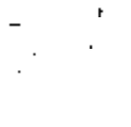
Permissible grade of smoke

Production identification plate

This plate shows the P.I.C. (production identification code number), which is needed when referring to the **spare parts catalogue** (electronic and/or microfiche catalogue). The P.I.C. is also given on the vehicle warranty card.
Note: When consulting the catalogues, use only the first 8 digits of the product identification code number.



COMPOSITION OF MODELS

ASSEMBLIES	CHASSIS CABS - 4x2 MODELS		AD 190 S 27	AT 190 S 27	AD 190 S 27/P	AT 190 S 27/P	AD 190 S 27/FP-D	AT 190 S 27/FP-D	AD 190 S 30	AD 190 S 30/P	AD 190 S 31	AT 190 S S31	AD 190 S 31/P	AT 190 S 31/P	AD 190 S 31/FP-D	AT 190 S 31/FP-D	AD 190 S 35	AT 190 S 35	AD 190 S 35/P	AT 190 S 35/P	AD 190 S 35/FP-D	AT 190 S 35/FP-D	AD 190 S 40	AT 190 S 40	AD 190 S 40/P	AT 190 S 40/P	AD 190 S 40/FP-D	AT 190 S 40/FP-D	AT 190 S 40/FP-CT	AD 190 S 43	AT 190 S 43	AD 190 S 43/P	AT 190 S 43/P	AD 190 S 43/FP-D	AT 190 S 43/FP-D	AT 190 S 43/FP-CT
	F2BE0681F (270 CV)		○	○	○	○	○	○																												
	F2BE0681E (300 CV)								○	○																											
	F2BE0681B (310 CV)										○	○	○	○	○	○																				
	F2BE0681A (350 CV)																○	○	○	○	○	○														
	F3AE0681B (400 CV)																						○	○	○	○	○	○	○							
	F3AE0681D (430 CV)																													○	○	○	○	○	○	○
	Single disc 16"		○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○														
	Single disc 17"																						○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
	ZF 9 S 109 D.D.		○	○	○	○	○	○			○	○	○	○	○	○																				
	ZF 16 S 151 D.D.																○	○	○	○	○	○															
	ZF 16 S 181 O.D.																																			
	ZF 16 S 181 D.D.																						○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
	ZF 16 S 221 O.D.																																			
	EuroTronic Automated 12 AS 2301 O.D.																																			
	EuroTronic Automated 12 AS 2301 D.D.			○	○	○	○					○	○	○	○			○	○	○	○			○	○	○	○	○			○	○	○	○	○
	Allison MD 3060 P - MD 3066 P		○						○	○			○																							
	FRONT AXLE:	5876/4 (F 8021)	⊗	⊗	⊗	⊗			⊗	⊗	⊗	⊗	⊗	⊗			⊗	⊗	⊗	⊗			⊗	⊗	⊗	⊗			⊗	⊗	⊗	⊗	⊗			⊗
		5876/5 (F 8021)	●	●	●	●			●	●	●	●	●	●			●	●	●	●			●	●	●	●			●	●	●	●	●			●
		5886/5 (F 9021)					○	○							○	○					○	○					○	○						○	○	
	ADDED AXLE:																																			
	Steering central	5876/4 (F 8021)																																		
	Rigid rear	55080/D1 (N 8071) *																																		
	Rigid rear	56082/D1 (N 9171) *																																		
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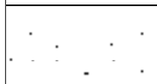	MERITOR MS 13-175/T - MS 13-175/D		○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
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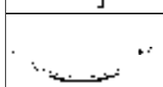	FRONT MECHANICAL	Front	□	□	□	□			□	□	□	□	□	□			□	□	□	○			□	□	□	□				□	□	□	□			
		Rear	□	□					□		□	□					□	□					□	□						□	□					
	PNEUMATIC	Front					○	○							○	○					○	○					○	○	○					○	○	○
		Rear			○	○	○	○		○			○	○	○	○			○	○	○	○			○	○	○	○	○			○	○	○	○	○
		Added axle																																		

⊗ = With brake calliper assembly at 57° without parking brake
● = With brake calliper assembly at 0° with parking brake
◇ = With longitudinal and transversal bars
□ = With parabolic leaf springs
* = TI with drum brakes

T = 4x2 tractor
TX = 6x2 C tractor (central added axle cannot be lifted)
TY = 6x2 P tractor (rear added axle can be lifted)
TN = 6x2 vehicles with mechanical rear suspensions and raisable rigid rear added axle
TZ = 6x4 tractor (bogie rear axle)
P = 4x2 – 6x2P – 6x2C vehicles with air suspension on rear axle and 6x2P vehicles with rigid rear axle that can be lifted with single wheels
PT = 6x2P vehicles with air suspension on rear axle and rigid rear added axle that can be lifted with twin wheels
PS = 6x2P vehicles with air suspension on rear axle and on steering rear added axle that can be lifted with single wheels
FP = 4x2 – 6x4 – 6x2P – 6x2C vehicles with front and rear air suspensions
FS = 6x2P vehicles with front and rear air suspensions, steering rear added axle can be lifted with single wheels
4x2 = Vehicles with two axles with rear driving axle
6x2P = Vehicles with three axles with rear driving axle and rear added third axle that can be lifted
6x2C = Vehicles with three axles with rear driving axle and central added third axle that cannot be lifted
6x4 = Vehicles with three axles with two rear driving axles (in tandem)
CM = Movable Boxes
LT = Tractor with lowered chassis frame
CT = Chassis cab with lowered chassis frame
RR = Rough Roads
D = Distribution
HR = Hub Reduction
AT = Active Time
AD = Active Day

COMPOSITION OF MODELS

CHASSIS CABS - 6x2 P MODELS

ASSEMBLIES			AD 260 S 27Y/P	AT 260 S 27Y/P	AD 260 S 27Y/PS	AT 260 S 27Y/PS	AD 260 S 27Y/FP-D	AT 260 S 27Y/FP-D	AD 260 S 27Y/FS-D	AT 260 S 27Y/FS-D	AD 260 S 30Y/PS	AT 260 S 30Y/PS	AT 260 S 30Y/FS-D	AD 260 S 31Y/P	AT 260 S 31Y/P	AD 260 S 31Y/PS	AT 260 S 31Y/PS	AD 260 S 31Y/FP-D	AT 260 S 31Y/FP-D	AD 260 S 31Y/FS-D	AT 260 S 31Y/FS-D	AD 260 S 35Y/P	AT 260 S 35Y/P	AD 260 S 35Y/PS	AT 260 S 35Y/PS	AD 260 S 35Y/FP-D	AT 260 S 35Y/FP-D	AD 260 S 35Y/FS-D	AT 260 S 35Y/FS-D	AD 260 S 27Y/PT	AT 260 S 27Y/PT	AD 260 S 27Y/TN	AT 260 S 27Y/TN	AD 260 S 31Y/PT	AT 260 S 31Y/PT	AD 260 S 31Y/TN	AT 260 S 31Y/TN	AD 260 S 35Y/PT	AT 260 S 35Y/PT	AD 260 S 35Y/TN	AT 260 S 35Y/TN
	F2BE0681F (270 CV)		○	○	○	○	○	○	○	○																			○	○	○	○								
	F2AE0681E (300 CV)										○	○	○																											
	F2BE0681B (310 CV)													○	○	○	○	○	○	○	○												○	○	○	○				
	F2BE0681A (350 CV)																					○	○	○	○	○	○	○	○								○	○	○	○
	F3AE0681B (400 CV)																																							
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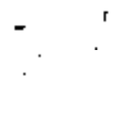
	Single disc 16"		○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
	Single disc 17"																																							
	ZF 9S 109 D.D.		○	○	○	○	○	○	○	○	○	○		○	○	○		○	○	○	○									○	○	○	○	○	○	○	○				
	ZF 16S 151 O.D.																					○	○	○	○	○	○	○	○									○	○	○	○
	ZF 16S 181 O.D.																																							
	ZF 16S 181 D.D.																																							
	ZF 16S 221 D.D.																																							
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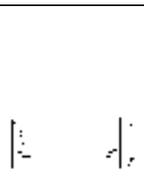
	Allison MD 3060 P - MD 3066 P				○	○			○	○	○	○	○	○	○	○				○														○	○	○	○	○	○		
	FRONT AXLE:	5876/4 (F 8021)	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗					⊗	⊗	⊗	⊗					⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗
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		5886/5 (F 9021)																○	○	○	○					○	○	○	○												
	ADDED AXLE:																																							
	Steering central	5876/2 (F 8021)																																						
	Rigid rear	55080/D1 (N 8071) *	○	○			○	○						○	○			○	○			○	○			○	○													
	Rigid rear	56082/D1 (N 9171) *																												○	○	○	○	○	○	○	○	○	○	○	○
	Steering rear	57080/D1 (N 8072) *			○	○			○	○	○	○	○			○	○			○	○			○	○			○	○											
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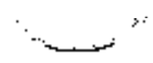	FRONT MECHANICAL	Front	□	□	□	□					□	□		□	□	□	□					□	□	□	□					□	□	□	□	□	□	□	□	□	□	□	□
		Rear																														□	□			□	□			□	□
	PNEUMATIC	Front					○	○	○	○			○					○	○	○	○					○	○	○	○												
		Rear	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○			○	○			○	○		
		Added axle	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○			○	○			○	○		

⊗ = With brake calliper assembly at 57° without parking brake
● = With brake calliper assembly at 0° with parking brake
◇ = With longitudinal and transversal bars
□ = With parabolic leaf springs
* = TI with drum brakes

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TX = 6x2 C tractor (central added axle cannot be lifted)
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FS = 6x2P vehicles with front and rear air suspensions, steering rear added axle can be lifted with single wheels
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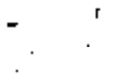
6x2P = Vehicles with three axles with rear driving axle and rear added third axle that can be lifted
6x2C = Vehicles with three axles with rear driving axle and central added third axle that cannot be lifted
6x4 = Vehicles with three axles with two rear driving axles (in tandem)
CM = Movable Boxes
HM = Heavy Mission
LT = Tractor with lowered chassis frame
CT = Chassis cab with lowered chassis frame
RR = Rough Roads
D = Distribution
AT = Active Time
AD = Active Day

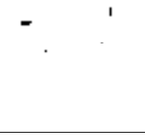
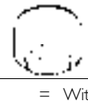
COMPOSITION OF MODELS

ASSEMBLIES	CHASSIS CABS - 6x2 P MODELS		AD 260 S 40Y/P	AT 260 S 40Y/P	AD 260 S 40Y/PS	AT 260 S 40Y/PS	AD 260 S 40Y/FP-D	AT 260 S 40Y/FP-D	AD 260 S 40Y/FS-D	AT 260 S 40Y/FS-D	AD 260 S 40Y/FS-CM	AT 260 S 40Y/FS-CM	AD 260 S 43Y/P	AT 260 S 43Y/P	AD 260 S 43Y/PS	AT 260 S 43Y/PS	AD 260 S 43Y/FP-D	AT 260 S 43Y/FP-D	AD 260 S 43Y/FS-D	AT 260 S 43Y/FS-D	AD 260 S 43Y/FS-CM	AT 260 S 43Y/FS-CM	AD 260 S 40Y/PT	AT 260 S 40Y/PT	AD 260 S 40Y/TN	AT 260 S 40Y/TN	AD 260 S 43Y/PT	AT 260 S 43Y/PT	AD 260 S 43Y/TN	AT 260 S 43Y/TN
	F2BE0681F (270 CV)																													
	F2AE0681E (300 CV)																													
	F2BE0681B (310 CV)																													
	F2BE0681A (350 CV)																													
	F3AE0681B (400 CV)		○	○	○	○	○	○	○	○	○	○	○											○	○	○	○				
	F3AE0681D (430 CV)												○	○	○	○	○	○	○	○	○	○					○	○	○	○
	Single disc 16"																													
	Single disc 17"		○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
	ZF 9S 109 D.D.																													
	ZF 16S 151 O.D.																													
	ZF 16S 181 O.D.																													
	ZF 16S 181 D.D.		○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
	ZF 16S 221 D.D.																													
	EuroTronic Automated 12 AS 2301 D.D.																													
	EuroTronic Automated 12 AS 2301 O.D.		○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○				○	○
	Allison MD 3060 P - MD 3066 P																													
	FRONT AXLE:	5876/4 (F 8021)	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗							⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗
		5876/5 (F 8021)	●	●	●	●	●	●	●	●	●	●	●	●	●	●							●	●	●	●	●	●	●	●
		5886/5 (F 9021)															○	○	○	○	○	○								
	ADDED AXLE:																													
	Steering central	5876/4 (F 8021)																												
	Rigid rear	55080/D1 (N 8071) *	○	○									○	○			○	○												
	Rigid rear	56082/D1 (N 9171) *																					○	○	○	○	○	○	○	○
	Steering rear	57080/D1 (N 8072) *			○	○	○	○	○	○	○	○			○	○			○	○	○	○								
	MERITOR MS 13-175/T - MS 13-175/D		○	○	○	○	○	○	○	○	○	○	○	○	○	○							○	○	○	○	○	○	○	○
	MERITOR RT 160/1																													
	451391 HR																													
	ZF 8098		○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
	FRONT MECHANICA0L	Front	□	□	□	□							□	□	□	□							□	□	□	□	□	□	□	□
		Rear																							□	□			□	□
	PNEUMATIC	Front					□	□	□	□	◇	◇					□	□	□	□	◇	◇								
		Rear	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○			○	○		
		Added axle	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○			○	○		

⊗ = With brake calliper assembly at 57° without parking brake
● = With brake calliper assembly at 0° with parking brake
◇ = With longitudinal and transversal bars
□ = With parabolic leaf springs
* = TI with drum brakes

T = 4x2 tractor
TX = 6x2 C tractor (central added axle cannot be lifted)
TY = 6x2 P tractor (rear added axle can be lifted)
TN = 6x2 vehicles with mechanical rear suspensions and raisable rigid rear added axle
TZ = 6x4 tractor (bogie rear axle)
P = 4x2 – 6x2P – 6x2C vehicles with air suspension on rear axle and 6x2P vehicles with rigid rear axle that can be lifted with single wheels
PT = 6x2P vehicles with air suspension on rear axle and rigid rear added axle that can be lifted with twin wheels
PS = 6x2P vehicles with air suspension on rear axle and on steering rear added axle that can be lifted with single wheels
FP = 4x2 – 6x4 – 6x2P – 6x2C vehicles with front and rear air suspensions
FS = 6x2P vehicles with front and rear air suspensions, steering rear added axle can be lifted with single wheels
4x2 = Vehicles with two axles with rear driving axle
6x2P = Vehicles with three axles with rear driving axle and rear added third axle that can be lifted
6x2C = Vehicles with three axles with rear driving axle and central added third axle that cannot be lifted
6x4 = Vehicles with three axles with two rear driving axles (in tandem)
CM = Movable Boxes
LT = Tractor with lowered chassis frame
CT = Chassis cab with lowered chassis frame
RR = Rough Roads
D = Distribution
HR = Hub Reduction
AT = Active Time
AD = Active Day

COMPOSITION OF MODELS

ASSEMBLIES		TRACTORS - MODELS	4x2																								6x2 C				6x4
			AD 440 S 31T/P	AT 440 S 31T/P	AD 440 S 35T/P	AT 440 S 35T/P	AD 440 S 35T/P-HR	AT 440 S 35T/P-HR	AD 440 S 40T/P	AT 440 S 40T/P	AD 440 S 40T/P-RR	AT 440 S 40T/P-RR	AD 440 S 40T/P-HR	AT 440 S 40T/P-HR	AT 440 S 40T/FP-CT	AT 440 S 40T/FP-LT	AD 440 S 43T/P	AT 440 S 43T/P	AD 440 S 43T/P-RR	AT 440 S 43T/P-RR	AD 440 S 43T/P-HR	AT 440 S 43T/P-HR	AT 440 S 43T/FP-CT	AT 440 S 43T/FP-LT	AD 440 S 40TX/P	AT 440 S 40TX/P	AD 440 S 43TX/P	AT 440 S 43TXP	AT 440 S 43TZ/P
	F2BE0681F (270 CV)																														
	F2AE0681E (300 CV)																														
	F2BE0681B (310 CV)		○	○																											
	F2BE0681A (350 CV)				○	○	○	○																							
	F3AE0681B (400 CV)								○	○	○	○	○	○	○	○									○	○					
	F3AE0681D (430 CV)																○	○	○	○	○	○	○	○			○	○	○		
	Single disc 16"																														
	Single disc 17"		○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
	ZF 9S 109 D.D.																														
	ZF 16S 151 O.D.		○	○	○	○	○	○																							
	ZF 16S 181 O.D.												○	○							○	○			○	○	○	○			
	ZF 16S 181 D.D.								○	○	○	○			○	○	○	○	○	○			○	○							
	ZF 16S 221 D.D.																														○
	EuroTronic Automated 12 AS 2301 D.D.												○	○							○	○									
	EuroTronic Automated 12 AS 2301 O.D.		○	○	○	○	○	○	○	○					○	○	○	○	○	○			○	○	○	○	○	○	○	○	
	Allison MD 3060 P - MD 3066 P																														
	FRONT AXLE:	5876/4 (F 8021)	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗
		5876/5 (F 8021)	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
		5886/5 (F 9021)																													
	ADDED AXLE:																														
	Steering central	5876/4 (F 8021)																							○	○	○	○			
	Rigid rear	55080/D1 (N 8071) *																													
	Rigid rear	56082/D1 (N 9171) *																													
	Steering rear	57080/D1 (N 8072) *																													
	MERITOR MS 13-175/T - MS 13-175/D		○	○	○	○	○	○	○	○	○	○			○	○	○	○	○	○			○	○	○	○	○	○			
	MERITOR RT 160/1																														○
	451391 HR												○	○							○	○									
	ZF 8098		○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
	FRONT MECHANICAL	Front	□	□	□	□	□	□	□	□	□	□	□	□			□	□	□	□	□	□			□	□	□	□	□		
		Rear																													□
	PNEUMATIC	Front													○	○							○	○							
		Rear	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
		Added axle																													

⊗ = With brake calliper assembly at 57° without parking brake
● = With brake calliper assembly at 0° with parking brake
◇ = With longitudinal and transversal bars
□ = With parabolic leaf springs
* = TI with drum brakes

T = 4x2 tractor
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6x2C = Vehicles with three axles with rear driving axle and central added third axle that cannot be lifted
6x4 = Vehicles with three axles with two rear driving axles (in tandem)
CM = Movable Boxes
HM = Heavy Mission
LT = Tractor with lowered chassis frame
CT = Chassis cab with lowered chassis frame
RR = Rough Roads
D = Distribution
AT = Active Time
AD = Active Day

P.I.C. NUMBER CODING

CAB LIVEABILITY

A	A	A	B	B	C	C	D

- **M** ⇨ = Stralis AD (Active Day)
- **N** ⇨ = Stralis AT (Active Time)

TOTAL WEIGHT ON GROUND - AXLES CONFIGURATION

A	A	A	B	B	C	C	D

- **C** ⇨ = 4x2; 18-20 ton.
- **D** ⇨ = 4x2T; 19-20 ton.
- **E** ⇨ = 6x2C; 26 ton.
- **F** ⇨ = 6x2P; 26 ton.
- **G** ⇨ = 6x2P; 26 ton.
- **H** ⇨ = 4x2T; 19-20 ton.
- **J** ⇨ = 6x2C; 26 ton.
- **K** ⇨ = 6x4; 26 ton.
- **L** ⇨ = 4x2P; 19-20 ton.
- **M** ⇨ = 6x2P; 26 ton.
- **N** ⇨ = 6x2P; 26 ton.

ENGINE

A	A	A	B	B	C	C	D

- **H** ⇨ E 270
- **L** ⇨ E 400
- **K** ⇨ E 430
- **P** ⇨ E 310
- **Q** ⇨ E 300
- **R** ⇨ E 352

SUSPENSION TYPE - REAR AXLE TYPE - TYPE OF ADDITIONAL AXLE

A	A	A	B	B	C	C	D

- **A** ⇨ Mechanical - SR - TWIN
- **B** ⇨ Pneumatic - SR - CENT/SING/TWIN
- **C** ⇨ - SR - CENT/SING
- **E** ⇨ Pneumatic - HR (Tractor 4x2)
- **E** ⇨ Pneumatic - HR - SR - STER (Chassis cab 6x2P)
- **F** ⇨ - SR - STER
- **G** ⇨ (*) - SR - SING
- **H** ⇨ (*) - SR - STER

* = Suspensions with 5886/D front axle
TWIN = Twin rear wheels
CENT = Middle axle (6x2C vehicles)
SING = Added axle with rear single wheels
STER = Added axle with rear steering single wheels
HR = Double reduction rear axle
SR = Simple reduction rear axle

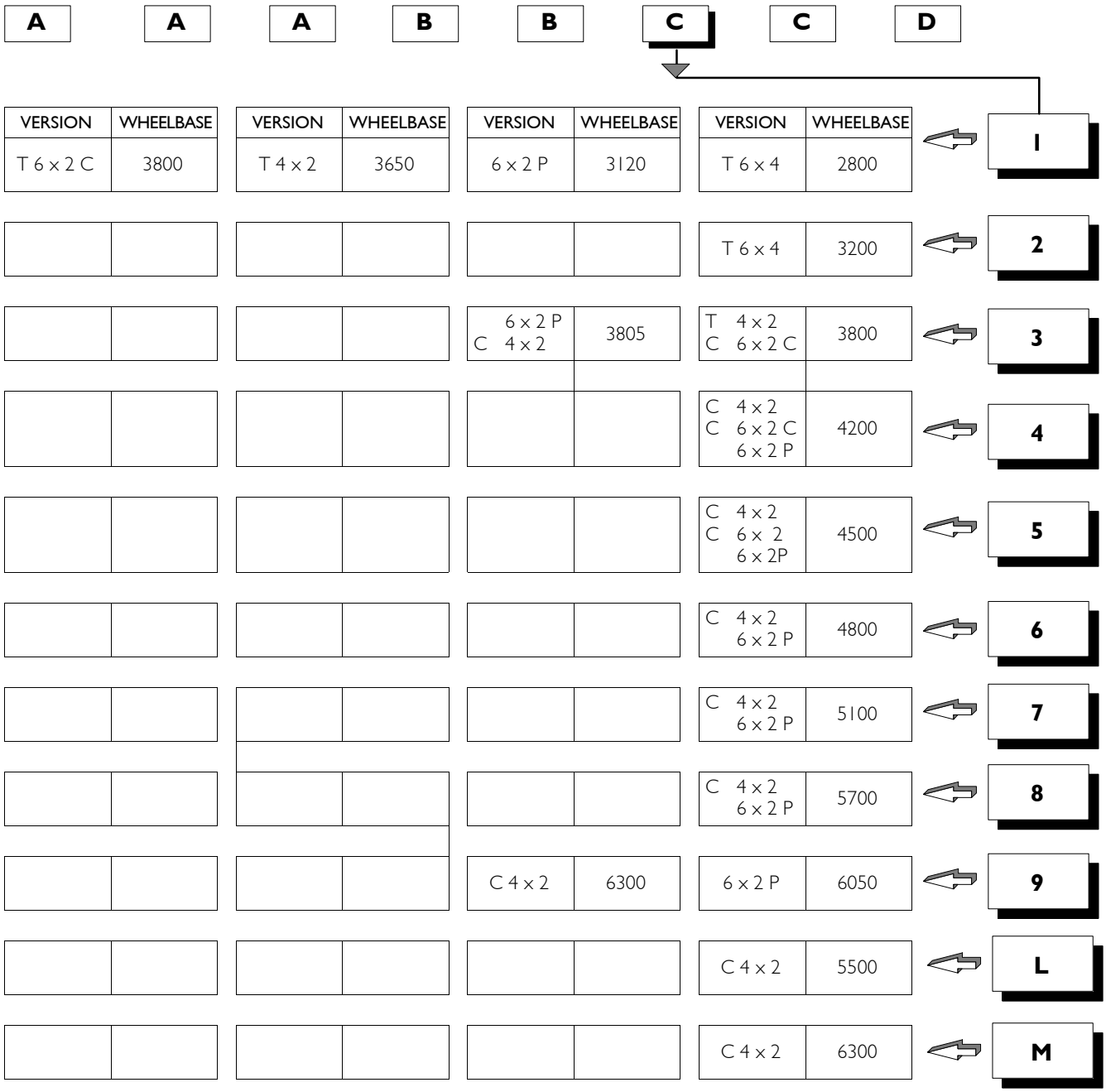
VERSION COMBINATION - USE

A	A	A	B	B	C	C	D

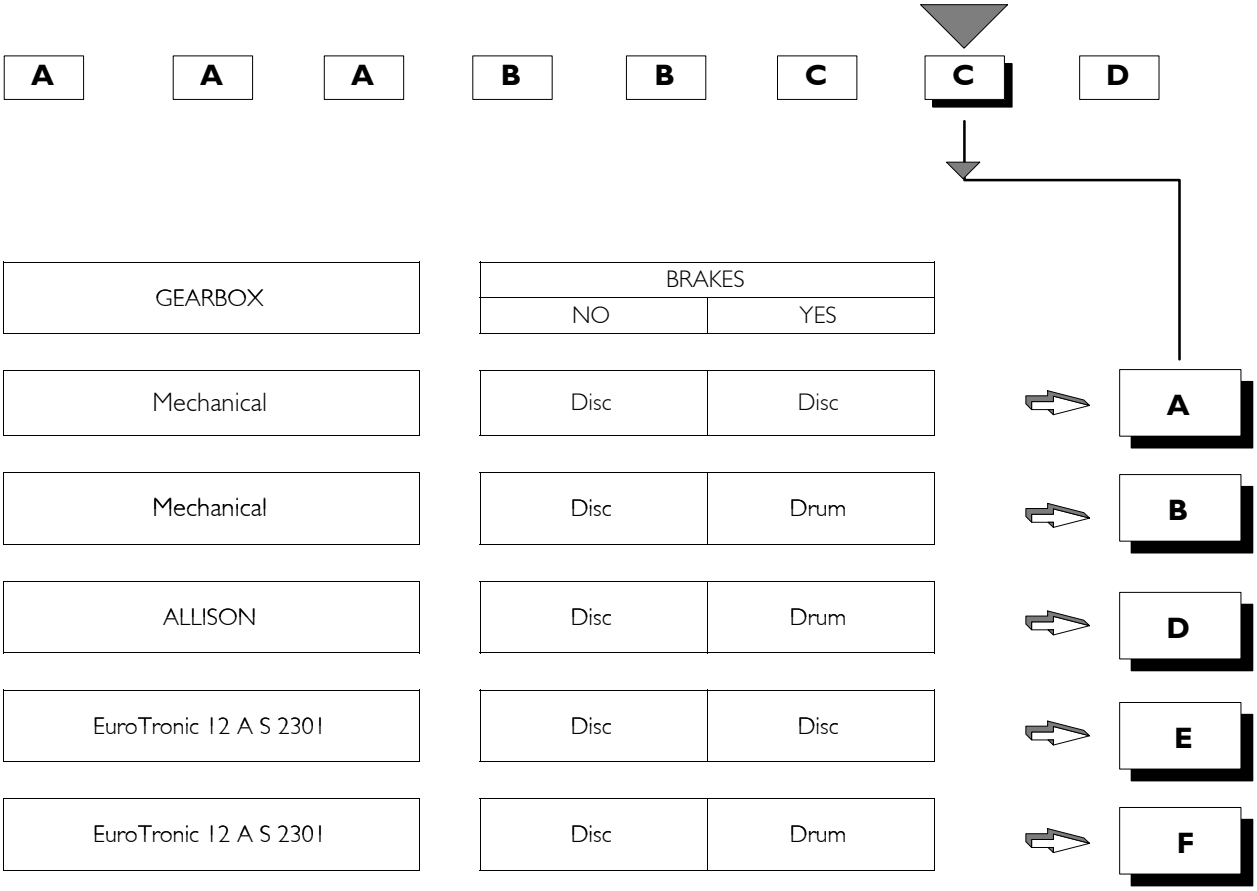
- **1** ⇨ = Chassis cab - STD
- **2** ⇨ = Tractor - STD
- **H** ⇨ = Tractor - GRAV
- **M** ⇨ = Cartran - STD -Tractor
- **N** ⇨ = Cartran - STD - Chassis cab
- **T** ⇨ = LOW TR - STD

Cartran = Car transport
LOW TR = Lowered tractor
STD = Standard use
GRAV = Heavy duty use

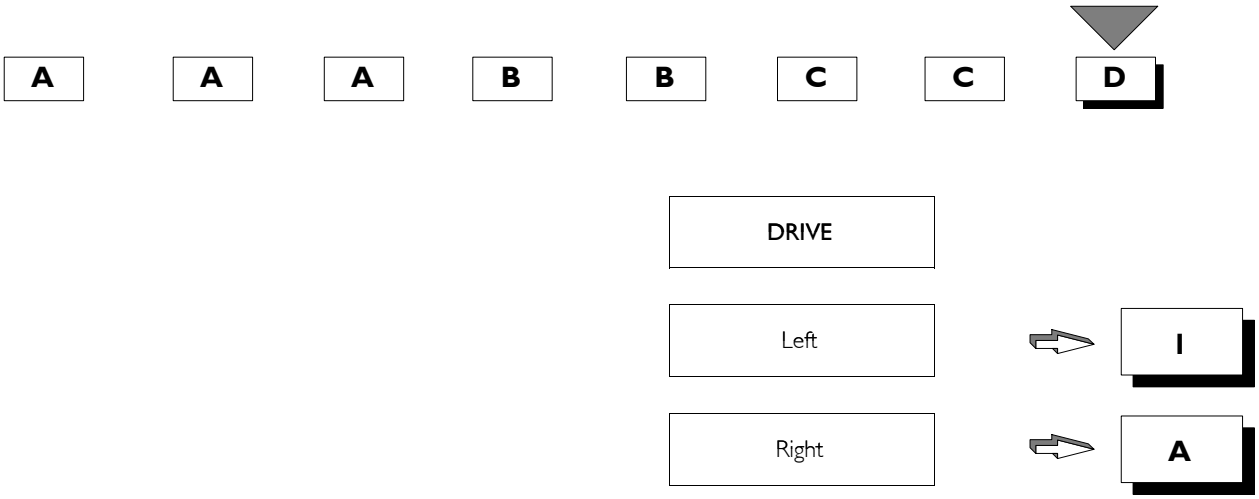
WHEELBASE


A
A
A
B
B
C
C
D
VERSION
WHEELBASE
T 6 x 2 C
3800
T 4 x 2
3650
6 x 2 P
3120
T 6 x 4
2800
1
T 6 x 4
3200
2
6 x 2 P
C 4 x 2
3805
T 4 x 2
C 6 x 2 C
3800
3
C 4 x 2
C 6 x 2 C
6 x 2 P
4200
4
C 4 x 2
C 6 x 2
6 x 2P
4500
5
C 4 x 2
6 x 2 P
4800
6
C 4 x 2
6 x 2 P
5100
7
C 4 x 2
6 x 2 P
5700
8
C 4 x 2
6300
6 x 2 P
6050
9
C 4 x 2
5500
L
C 4 x 2
6300
M

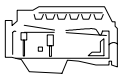
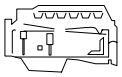
GEARBOX - BRAKES COMBINATION



CAB - DRIVE - BRAKES COMBINATION



REPLENISHING FLUIDS

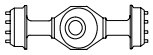
LUBRICANTS RECOMMENDED BY IVECO		PARTS TO BE FILLED UP	Quantity Litres	Quantity Kg
Urania FE 5W30(1) Urania LD5 Urania Turbo LD		Engine F2B		
		Total capacity for first filling	28	25,2
		Capacity:		
		- engine sump min level	12.5	11,2
		- engine sump max level	23	21
		- quantity in circulation that does not flow back to the engine sump	5	4.5
		- quantity contained in the cartridge filter (which has to be added to the cartridge filter refill)	2.5	2.3
Urania FE 5W30(1) Urania LD5 Urania Turbo LD		Engine F3A		
		Total capacity 1st filling	30	29.8
		Capacity:		
		- engine sump at minimum level	17	15.3
		- engine sump at maximum level	25	22.5
		- quantity in circulation that does not return to sump	7	6.3
		- quantity contained in cartridge filter (to add when changing the cartridge filter)	2.5	2.3
Tutela Truck FE-Gear1 Tutela ZC 90		Gearbox		
		ZF 9 S 109 *	8	7.2
		ZF 16 S 151 *	11	10
		ZF 16 S 151 + Intarder *	18.5	16.65
		ZF 16 S 181 *	13	12
		ZF 16 S 181 + Intarder*	21.5	19.35
		ZF 16 S 221 *	13	12
		ZF 16 S 221 + Intarder*	21.5	19.35
		EuroTronic automated 12 AS 2301*	12	11
		EuroTronic automated 12 AS 2301* + intarder	23	21
Tutela GI/A		Allison MD 3060 P - MD 3066 P	18	16
Tutela Truck FE-Gear1 Tutela ZC 90		Power take off (Multipower)	2.5	

* Quantity 1st filling

(1) IVECO recommends using these oils for reasons of fuel economy. IVECO provides new vehicles already with these types of lubricants. Also suited for cold climates (minimum temperature down to -30°C)

These quantities are not decisive. An exact check must be made by verifying the levels

REPLENISHING FLUIDS

LUBRICANTS RECOMMENDED BY IVECO		PARTS FOR REPLENISHING		Quantity Litres	Quantity kg
	Tutela Truck FE-Axle(2) Tutela W140/M-DA Tutela W90/M-DA3	Front hubs (single)			
		FRONT AXLE	5876/4-/5 (F8021)	0.35	0.32
		FRONT AXLE	5886/5	0.35	0.32
		ADDED AXLE::			
		Steering central	5876/4 (F 8021)	0.35	0.32
		Rigid rear	55080/D1 (N 8071)	0.35	0.32
		Rigid rear	56082/D1 (N 9171)	0.35	0.32
		Steering rear	57080/DI (N 8072)	0.35	0.32
	Tutela Truck FE-Axle(2) Tutela W140/M-DA Tutela W90/M-DA3 	Bridge Meritor MS 13-175/T - MS 13-175/D:			
		☐ (mechanical suspension)		18.5	16.5
		☐ (pneumatic suspension)		17	15.5
		Bridge 451391 HR		16	14.5
		Rear axle Meritor in tandem RT 160E/1			
		- middle		18.5	16.6
		- rear		16.5	14.8
	Tutela GI/A 	Power steering		2.7* 13.5**	2.4 12
		* Excluding vehicles with steering rear axle ** For vehicles with steering rear axle only			
	Tutela TRUCK DOT SPECIAL 	Clutch circuit (excluding vehicles with Euro Tronic gearbox)		0.5	0.45
	Water+Paraflu11	Cooling system			
		Engine F2B	Total capacity*	~34	~23.4
		Engine F2B with Intarder	Total capacity*	~50	~27
		Engine F3A	Total capacity*	~38	~39.6
		Engine F3A with Intarder	Total capacity*	~58	~57.6
		* = Protective anti-freeze (concentration 50% freezing point –35°C)			
	Tutela LHM 	Cab tilting system		0.6	0.54

(2) Only on axles with disc brakes, IVECO recommends using these oils for reasons of fuel economy. IVECO provides new vehicles already with these types of lubricants. Also suited for cold climates (minimum temperature down to -30°C)
(3) Specific for cold climates
These quantities are not decisive. An exact check must be made by verifying the levels

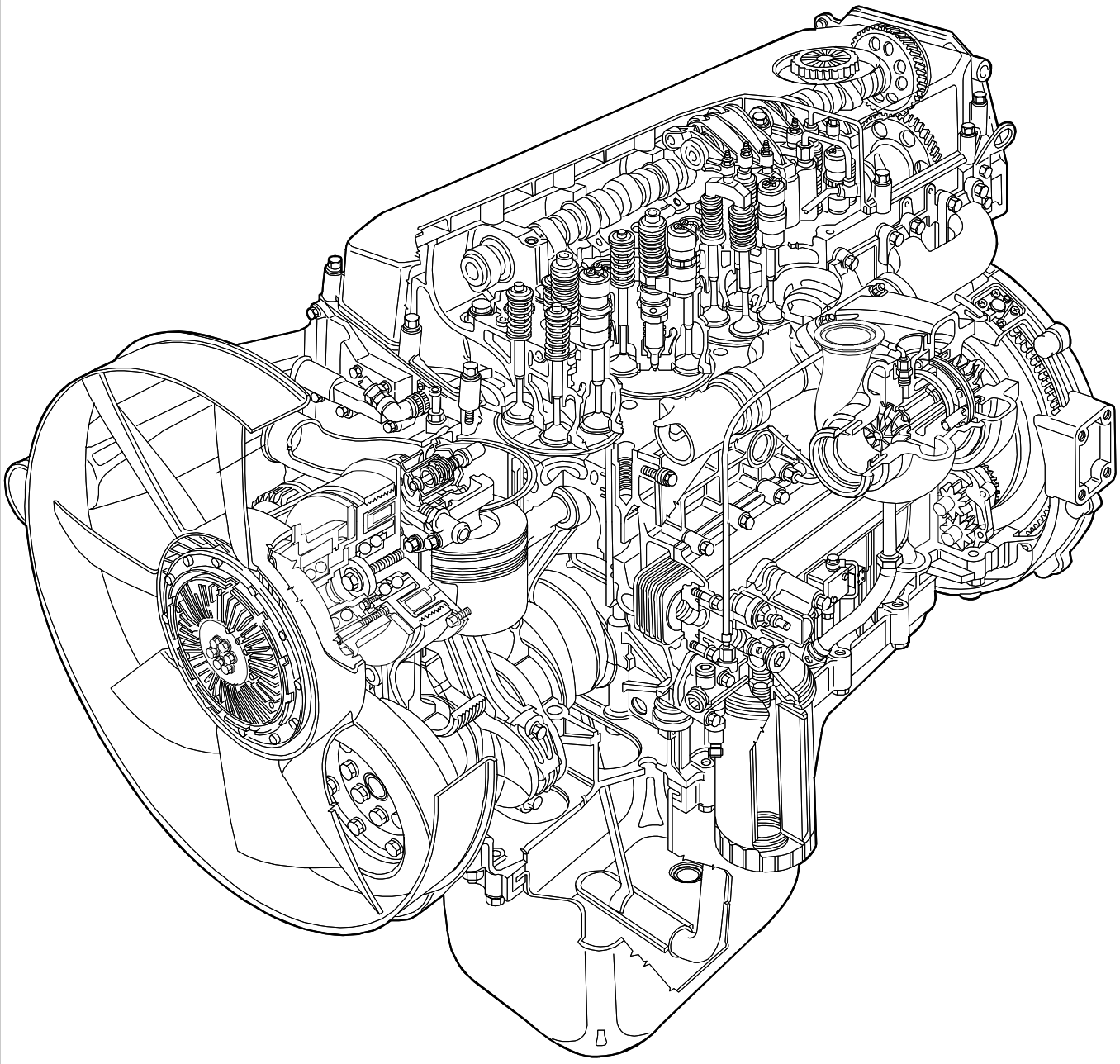
International lubricant designation		FL products
Engine oil Meets the specifications: **ACEA E4 with a totally synthetic base** ACEA E5 with a mineral base ACEA E3 with a mineral base	 **SAE 50W 30** SAE 15W 40 SAE 15W 40	 **URANIA FE 5W30** Urania LD5 Urania Turbo LD
Oil for differential gear and wheel hubs Meets the specifications: **API GL5, MT-1 with a totally synthetic base** API GL5 with a mineral base API GL5 with a mineral base	 **SAE 75W 90** SAE 85W 140 SAE 80W 90	 **Tutela Truck FE-Axle** Tutela W140/M-DA Tutela W90/M-DA
Oil for mechanical gearboxes Containing non-EP anti-wear additives Meets the specifications: **API GL4 with a totally synthetic base** API GL3 with a mineral base	 **SAE 75W 85** SAE 80W 90	 **Tutela Truck FE-Gear** Tutela ZC90
Oil for power steering and hydrostatic transmissions A.T.F. DEXRON II D		Tutela GI/A
Grease for general greasing based on lithium soaps, N.L.G.I. consistency no. 2		Tutela MR 2
Specific grease for bearings and wheel hubs based on lithium soaps, N.L.G.I. consistency no. 3		Tutela MR 3
Clutch drive fluid Conforming to N.H.T.S.A. standards 116, ISO 4925, Std. SAEJ 1703, IVECO STANDARD 18-1820		Tutela TRUCK DOT SPECIAL
Mineral oil for hydraulic circuits In compliance with IVE**CO STANDARD 18-1823**		Tutela LHM
Windscreen washer fluid, mixture of spirit, water and surfactants CUNA NC 956-11		Tutela PROFESSIONAL SC 35
Grease for central lubrication systems based on lithium soaps, with synthetic base, N.L.G.I. no. 2. Working temperatures: from –30°C to +140°C		Tutela COMAR 2
Concentrated protective fluid for radiators based on ethylene glycol containing corrosion inhibitors, conforming to the standard: IVECO-STANDARD 18-1830		Paraflu[11]

SECTION 2

Engine

F2B Engine

Figure 1



78840

F2B ENGINE

VIEWS OF THE ENGINE

ENGINE

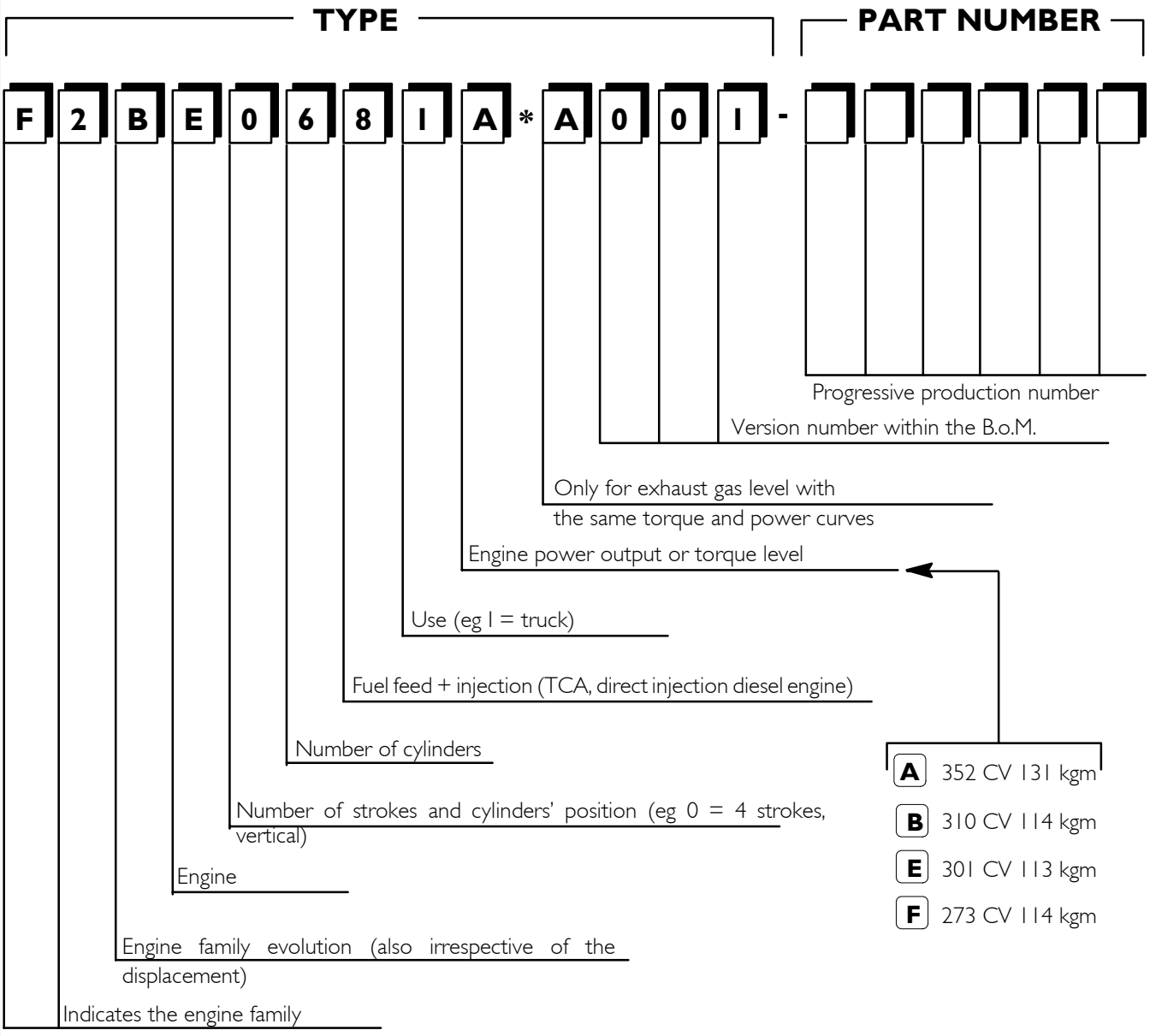
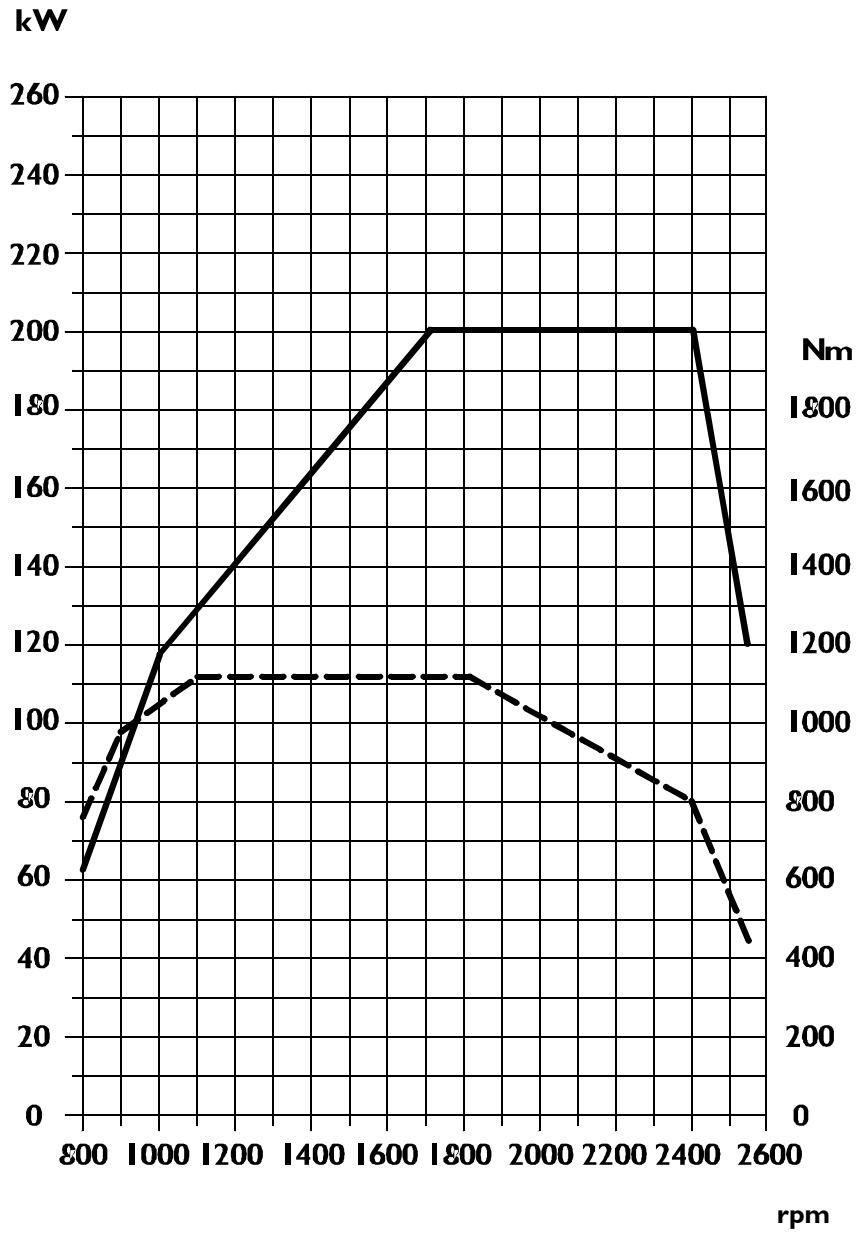


Figure 2



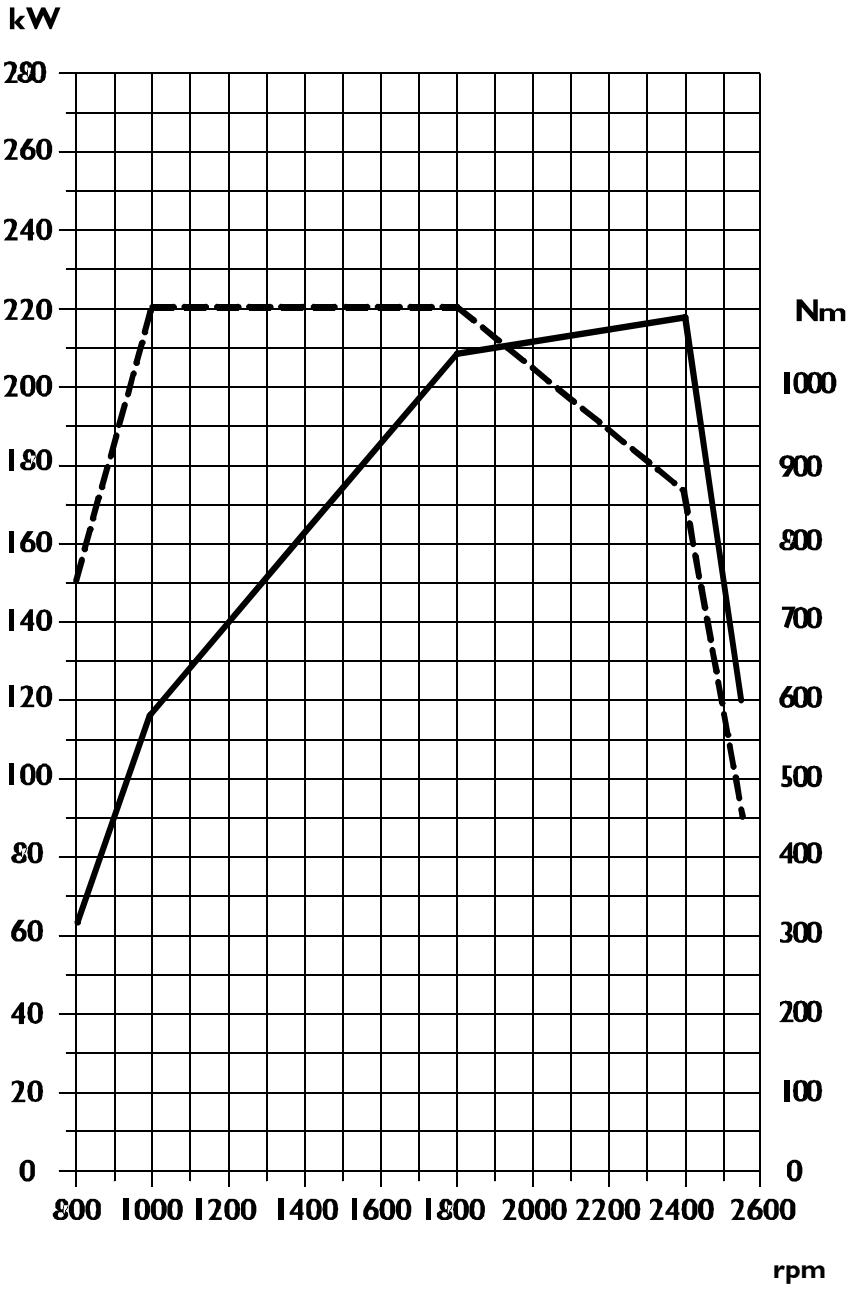
52244

F2BE0681F: POWER-TORQUE CURVES

Max OUTPUT 200 kW **273HP** **at 2400 rpm**

Max TORQUE 1115 Nm **114 kgm** **at 1000 to 1770 rpm**

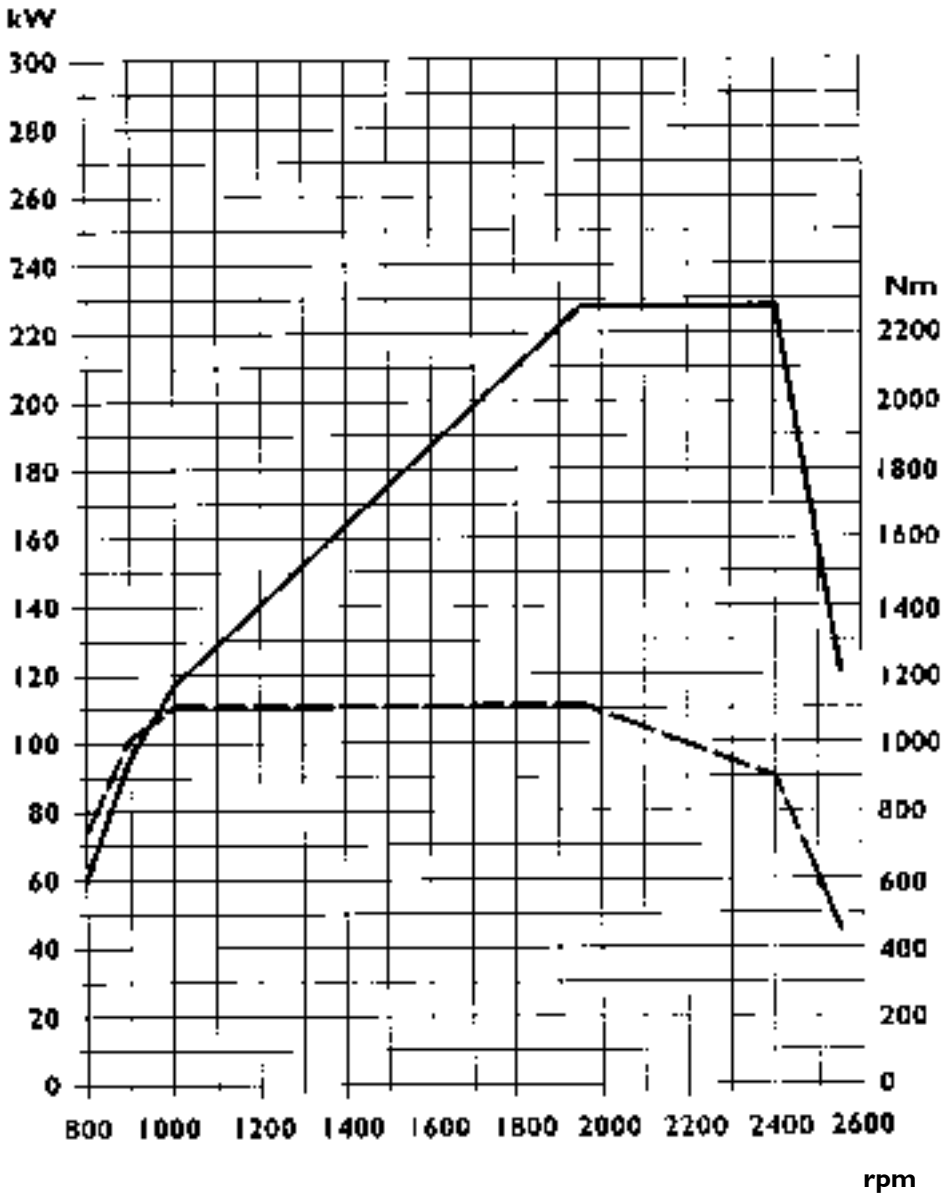
Figure 3



F2BE0681E: POWER-TORQUE CURVES

Max OUTPUT	**221 kW**	**301HP**	**at 2400 rpm**
Max TORQUE	**1110 Nm**	**113 kgm**	**at 1000 rpm**

Figure 4

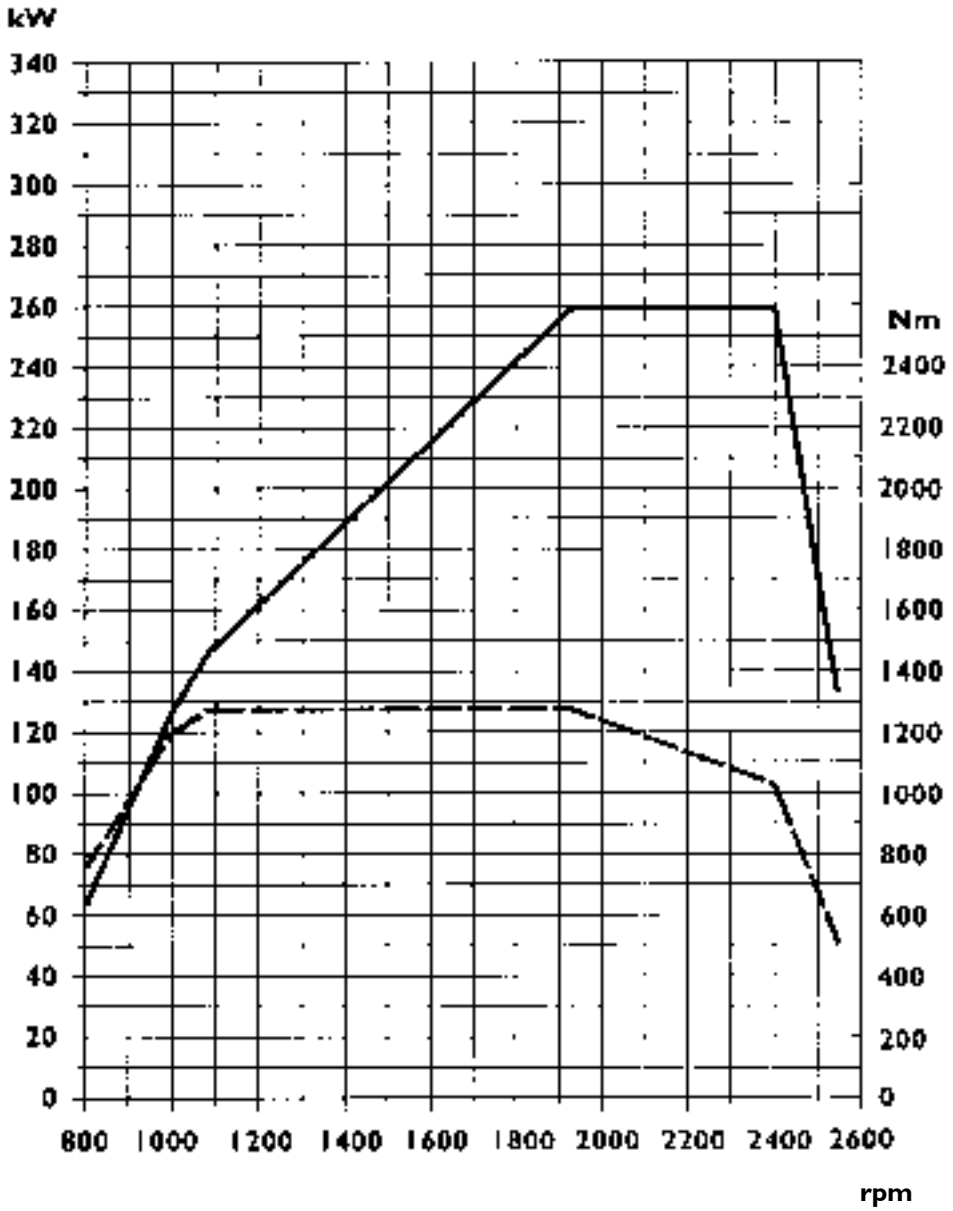


47531

F2BE0681B: POWER-TORQUE CURVES

Max OUTPUT	**228 kW**	**310HP**	**at 2400 rpm**
Max TORQUE	**1100 Nm**	**114 kgm**	**at 1000 to 1950 rpm**

Figure 5



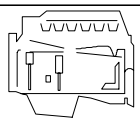
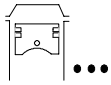
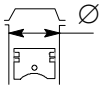
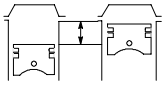
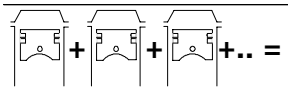
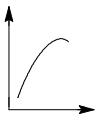
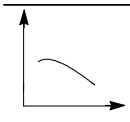
47532

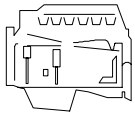
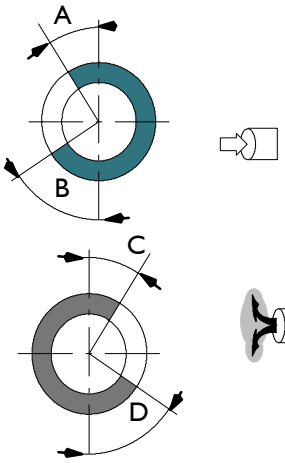
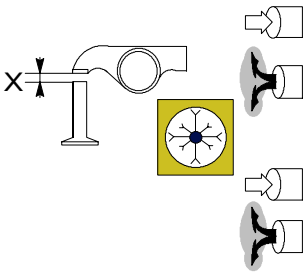
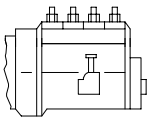
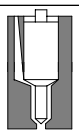
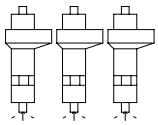
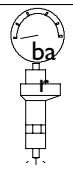
F2BE0681A: POWER-TORQUE CURVES

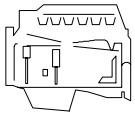
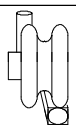
Max OUTPUT 259 kW **352HP** **at 2400 rpm**

Max TORQUE 1280 Nm **131 kgm** **at 1080 to 1930 rpm**

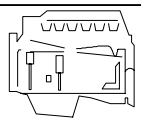
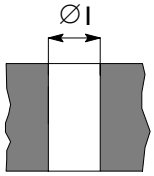
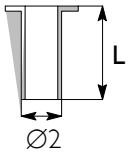
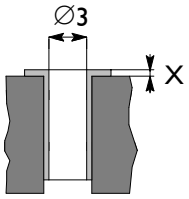
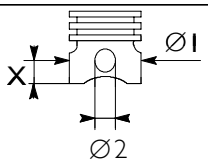
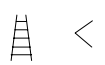
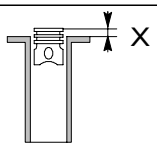
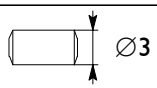
GENERAL CHARACTERISTICS

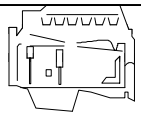
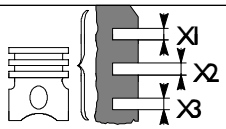
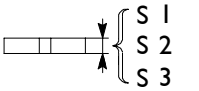
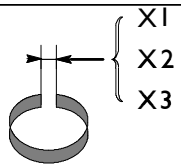
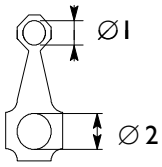
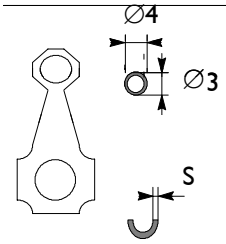
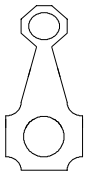
	Type		F2BE0681A	F2BE0681B	F2BE0681E	F2BE0681F
	Cycle		Diesel 4 strokes			
	Feeding		Turbocharged with aftercooler			
	Injection		Direct			
	N. of cylinders		6 on-line			
	Diameter	mm	115			
	Stroke	mm	125			
	Total displacement	cm^3	7790			
ϱ	Compression ratio		16 ± 0.8			
 	Max. power	KW (HP)	259 (352)	228 (310)	221 (301)	200 (273)
		rpm	2400	2400	2400	2400
 	Max. torque	Nm (Kgm)	1280 (131)	1115 (114)	1110 (113)	1115 (114)
		rpm	1080 to 1930	1000 to 1950	1000	1000 to 1770
	Engine idling speed, no load	rpm	525 ± 25			
	Maximum engine speed, no load	rpm	2760 ± 20			

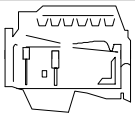
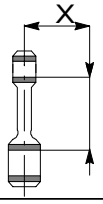
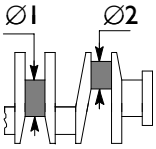
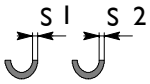
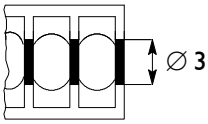
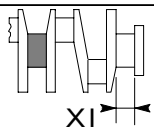
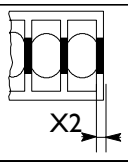
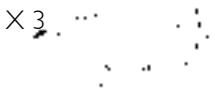
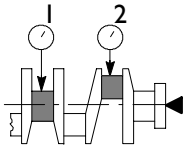
	Type	**F2B**
	VALVE TIMING	
	opens before T.D.C. A	17°
	closes after B.D.C. B	31°
	opens before B.D.C. D	48°
	closes after T.D.C. C	9°
	For timing check	
	X { mm	–
	mm	–
	Running	
	X { mm	0.35 to 0.45
	mm	0.35 to 0.45
	FEED	Through fuel pump - Filters
	Injection type Bosch	With electronically regulated injectors PDE 30 pump injectors controlled by overhead camshaft
	Nozzle type	–
	Injection order	1 - 4 - 2 - 6 - 3 - 5
	Injection pressure bar	1500
	Injector calibration bar	

	Type	**F2B**
	SUPERCHARGING Turbocharger type:	Holset, with variable geometry HY 40 V
	LUBRICATION	Forced by gear pump, pressure control valve, oil filter
 	Oil pressure, engine hot (100 °C ± 5 °C): at idling speed bar at maximum speed bar	 1.5 5
COOLING		By centrifugal pump, regulating thermostat, viscostatic fan, radiator and heat exchanger
	Water pump control	By belt
	Thermostat: starts to open: fully open:	N. 1 ~85 °C –
	OIL FILLING Total capacity at 1st filling liters kg	 28 25.5
 **Fiat lubricants Urania Turbo LD (according to E3-96 standard) Urania Turbo (according to E2-96 standard)**	Capacity: - engine sump min level liters kg - engine sump max level liters kg - quantity in circulation that does not flow back to the engine sump liters kg - quantity contained in the cartridge filter (which has to be added to the cartridge filter refill) liters kg	 12.5 11.2 23 21 5 2.5 2.3

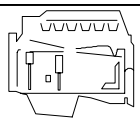
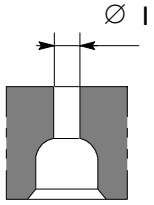
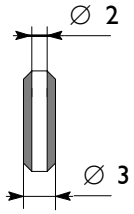
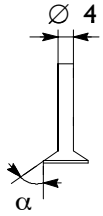
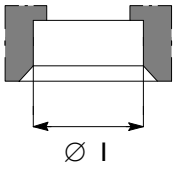
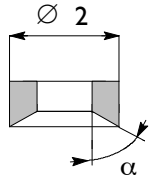
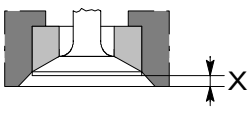
ASSEMBLY CLEARANCE DATA

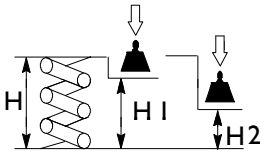
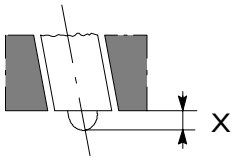
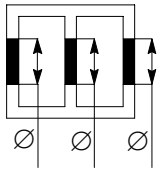
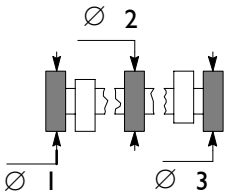
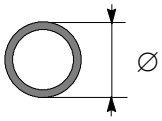
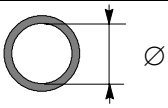
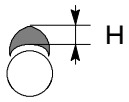
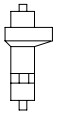
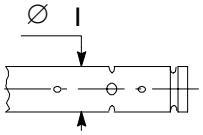
	Type	F2B
CYLINDER BLOCK AND CRANK MECHANISM COMPONENTS		mm
	Cylinder sleeve bore upper Ø 1 lower	 130.200 to 130.225 128.510 to 128.535
	Cylinder liners: outer diameter: upper Ø 2 lower length L	 130.161 to 130.186 128.475 to 128.500
	Cylinder sleeve - crankcase bore upper lower	 0.014 to 0.064 0.010 to 0.060
IVECO PARTS 	Outside diameter Ø 2	
	Cylinder sleeve inside diameter Ø 3 Protrusion X	 A* 115.000 to 115.012 B* 115.010 to 115.022 0.035 to 0.065
* Available dia. class		
	Pistons: measuring dimension X outside diameter Ø 1 A• outside diameter Ø 1 B•• outside diameter Ø 2	 18 114.888 to 114.900 114.898 to 114.910 46.010 to 46.018 114.898 to 114.910
• Class A pistons supplied as spares. •• Class B pistons are fitted in production only and are not supplied as spares.		
	Piston - cylinder sleeve	0.100 to 0.124
IVECO PARTS 	Piston diameter Ø 1	–
	Pistons protrusion X	0.32 to 0.99
	Gudgeon pin Ø 3	45.994 to 46.000
	Gudgeon pin - pin housing	0.010 to 0.024

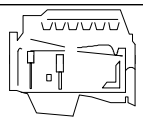
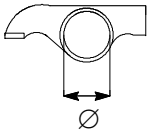
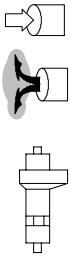
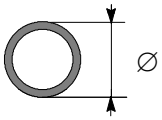
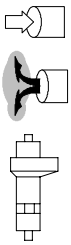
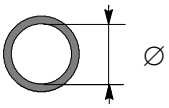
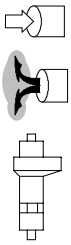
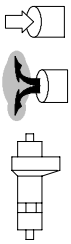
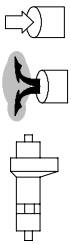
	Type		F2B mm
	Piston ring grooves *measured on Ø of 112 mm	X1* X 2 X3	2.71 to 2.74 2.55 to 2.57 4.02 to 4.04
	Piston rings: trapezoidal seal lune seal milled scraper ring with slits and internal spring *measured on Ø of 112 mm	S1* S2 S3	2.575 to 2.595 2.470 to 2.490 3.975 to 3.990
	Piston rings - grooves	1 2 3	0.115 to 0.165 0.060 to 0.100 0.030 to 0.065
IVECO PARTS 	Piston rings		–
	Piston ring end gap in cylinder liners: X1 X2 X3		0.35 to 0.50 0.70 to 0.96 0.30 to 0.60
	Small end bush housing Ø 1 Big end bearing housing Ø2 Selection classes Ø2	1 2 3	49.975 to 50.000 Rated value 77.000 to 77.030 77.000 to 77.010 77.010 to 77.020 77.020 to 77.030
	Small end bush diameter outside Ø4 inside Ø 3 Big end bearing shell S Red Green Yellow		50.055 to 50.080 46.015 to 46.030 2.000 to 2.010 2.011 to 2.020 2.021 to 2.030
	Small end bush - housing		0.055 to 0.105
	Piston pin - bush		0.015 to 0.036
IVECO PARTS 	Big end bearing shells		0.127 - 0.254 - 0.508
	Connecting rod weight Class	A B C	g. 2890 to 2920 g. 2921 to 2950 g. 2951 to 2980

		F2B	
	Type		mm
	Measuring dimension X		125
	Max. connecting rod axis misalignment tolerance ⫻		0.08
	Main journals Ø 1	Rated value	82.910 to 82.940
	Selection class 1		82.910 to 82.919
	Selection class 2		82.920 to 82.929
	Selection class 3		82.930 to 82.940
	Crankpins Ø 2	Rated value	72.915 to 72.945
	Selection class 1		72.915 to 72.924
	Selection class 2		72.925 to 72.934
	Selection class 3		72.935 to 72.945
	Main bearing shells S1		
	Red		3.000 to 3.010
	Green		3.011 to 3.020
	Yellow ●		3.021 to 3.030
	Big end bearing shells S2		
	Red		2.000 to 2.010
	Green		2.011 to 2.020
	Yellow ●		2.021 to 2.030
	Main bearing housings Ø 3	Rated value	89.000 to 89.030
	Selection class 1		89.000 to 89.009
	Selection class 2		89.010 to 89.019
	Selection class 3		89.020 to 89.030
	Bearing shells - main journals		0.040 to 0.080
	Bearing shells - big ends		0.035 to 0.075
	Main bearing shells		0.127 - 0.254 - 0.508
	Big end bearing shells		0.127 - 0.254 - 0.508
	Main journal, thrust bearing X1		39.96 to 40.00
	Main bearing housing, thrust bearing X2		32.94 to 32.99
	Thrust washer halves X3		3.38 to 3.43
	Driving shaft shoulder		0.11 to 0.30
	Alignment ⫻ 1		≤ 0.05
	Ovality ⬭ 2		
	Taper ⟍ 1 - 2		0.010
	Taper ⟋ 1 - 2		0.010

● Fitted in production only and not supplied as spares

	Type	**F2B**
CYLINDER HEADS - VALVE TRAIN		mm
	Valve guide housings in cylinder head Ø1	12.980 to 12.997
	Valve guide Ø 2 Ø 3	8.023 to 8.038 13.012 to 13.025
	Valve guides - housings in the cylinder heads	0.015 to 0.045
IVECO PARTS	Valve guide	–
	Valves: Ø 4 α Ø 4 α	7.985 to 8.000 60° 30′ ± 7′ 30″ 7.985 to 8.000 45° + 15′
	Valve stem and its guide	0.023 to 0.053
	Housing in head for valve seat Ø1 Ø1	41.985 to 42.020 40.985 to 41.020
	Outside diameter of valve seat; angle of valve seat in cylinder head: Ø 2 α Ø 2 α	42.060 to 42.075 60° - 30' 41.060 to 41.075 45° - 30′
	Recessing of valve X	0.5 to 0.8 1.6 to 1.9
	Between valve seat and head	0.040 to 0.090

	Type	F2B
		mm
	Valve outside spring height: free height H under a load of: N 454 ± 22 H1 N 840 ± 42 H2	 62.6 48.5 36.5
	Injector protrusion X	0.7
	Camshaft bush housing fitted in the cylinder head: 1 ⇒ 7 Ø	80.000 to 80.030
	Camshaft journal diameter: 1 ⇒ 7 Ø	75.924 to 75.940
	Camshaft bushing outer diameter: Ø	80.090 to 80.115
	Camshaft bushing inner diameter: Ø	75.990 to 76.045
	Bushings and housings in engine block	0.060 to 0.115
	Bushings and journals	0.050 to 0.121
	Cam lift:   	 8.07 7.63 8.80 to 8.82
	Rocker shaft Ø 1	37.984 to 38.000

	Type	F2B
		mm
	Bushing housing in rocker arms 	41.000 to 41.016 53.000 to 53.019 42.000 to 42.016
	Bushing outer diameter for rocker arms: 	41.097 to 41.135 53.105 to 53.156 42.066 to 42.091
	Bushing inner diameter for rocker arms: 	38.025 to 38.041 50.025 to 50.041 38.015 to 38.071
	Between bushings and housings 	0.081 to 0.135 0.086 to 0.156 0.050 to 0.091
	Between rocker arms and shaft 	0.025 to 0.057 0.225 to 0.057 0.015 to 0.087
TURBOCHARGER		
Type		HOLSET, variable geometry
End float		–
Radial play		–

TIGHTENING TORQUES

PART			TORQUE	
			Nm	kgm
Under-basement fastening screws to cylinder block (see Figure 6) ♦				
Outer screws	First stage : pre-tightening	M10x1.25	25	2.5
Inner screws	Second stage : pre-tightening	M16x2	140	14
Inner screws	Third stage : angle closing	M16x2	60°	
Inner screws	Fourth stage : angle closing	M16x2	60°	
Outer screws	Fifth stage : angle closing	M10x1,5	90°	
Pipe union for piston cooling nozzle		M12X1.5	35 ± 2	3.5 ± 0.2
Intercooler fastening screws to cylinder block ♦ (see Figure 10)				
pre-tightening			11.5 ± 3.5	1.15 ± 0.35
tightening			19 ± 3	1.9 ± 0.3
Plug			125 ± 15	12.5 ± 1.5
Spacer and oil sump fastening screws (see Figure 11)			41.5 ± 3.5	4.1 ± 0.3
Gearcase fastening screws to cylinder block			41.5 ± 3.5	4.1 ± 0.3
			63 ± 7	6.3 ± 0.7
			9 ± 3	1.9 ± 0.3
Cylinder head fastening screw: (see Figure 7) ♦				
First stage	pre-tightening		50	5
Second stage	pre-tightening		100	10
Third stage	angle closing		90°	
Fourth stage	angle closing		75°	
Rocker arm shaft fastening screw ♦				
First stage	pre-tightening		40	4
Second stage	pre-tightening		60°	
Locknut for rocker arm adjusting screw ♦			39 ± 5	3.9 ± 5
Screws for injector fastening brackets ♦			36.5	3.65
Shoulder plate fastening screws to head ♦			23.5	2.35
Engine support bracket fastening screws to cylinder head			74 ± 8	7.4 ± 0.8
Gear fastening screws to camshaft: ♦				
First stage	pre-tightening		50	5
Second stage	pre-tightening		50°	
Phonic wheel fastening screws to distribution gear			8.5 ± 1.5	0.8 ± 0.1
Exhaust pipe fastening screws • (see Figure 8)				
pre-tightening			32.5 ± 7.5	3.2 ± 0.7
tightening			47 ± 2.5	4.7 ± 0.2
Engine brake actuator cylinder fastening screws			24.5 ± 2.5	2.4 ± 0.2
Connecting rod cap fastening screws: ♦				
First stage	pre-tightening		50	5
Second stage	pre-tightening		40°	
Engine flywheel fastening screws: ♦		M16x1.5x58		
First stage	pre-tightening		100	10
Second stage	pre-tightening		60°	
Engine flywheel fastening screws: ♦		M16x1.5x110		
First stage	pre-tightening		100	10
Second stage	pre-tightening		120°	
Flywheel pulley fastening screws to crankshaft : ♦				
First stage	pre-tightening		70	7
Second stage	pre-tightening		50°	

♦ Lubricate with oil MOLYKOTE before assembly
• Lubricate with graphitized oil before assembly

TIGHTENING TORQUES

PART		TORQUE	
		Nm	kgm
Damper flywheel fastening screws: ♦		115 ± 15	11.5 ± 1.5
Idler gear pin fastening screws: ♦			
First stage	pre-tightening	30	3
Second stage	pre-tightening	90°	
Idle gear link rod fastening screw		24.5 ± 2.5	2.4 ± 0.2
Oil pump fastening screw		24.5 ± 2.5	2.4 ± 0.2
Oil pump suction rose fastening screw		24.5 ± 2.5	2.4 ± 0.2
Front cover fastening screw to cylinder block ♦		19 ± 3	1.9 ± 0.3
Control unit fastening screw to cylinder block ♦		19 ± 3	1.9 ± 0.3
Supply pump fastening screw to gearcase ♦		19 ± 3	1.9 ± 0.3
Fuel filter support fastening screw to cylinder head ♦		37 ± 3	3.7 ± 0.3
Turbo-compressor fastening screws and nuts • (see Figure 9)			
pre-tightening		32.5 ± 7.5	3.2 ± 0.7
tightening		46 ± 2	4.6 ± 0.2
Water pump fastening screw to cylinder block		24.5 ± 2.5	2.4 ± 0.2
Pulley fastening screw to hub		55 ± 5	5.5 ± 0.5
Rocker arm cover fastening screws (see Figure 12)		9	0.9
Thermostat box fastening screws to cylinder head		24.5 ± 2.5	2.4 ± 0.2
Automatic tightener fastening screws to cylinder block		45 ± 5	4.5 ± 0.5
Fixed tightener fastening screws to cylinder block		105 ± 5	10.5 ± 0.5
Fan support fastening screws to cylinder block		24.5 ± 2.5	2.4 ± 0.2
Starter fastening screws		44 ± 4	4 ± 0.4
Air heater on cylinder head		30 ± 3	3 ± 0.3
Air compressor fastening screw to cylinder head		74 ± 8	7.4 ± 0.8
Air compressor control gear fastening nut		170	17 ± 1
Hydraulic power steering pump gear fastening nut		46.5 ± 4.5	4.6 ± 0.4
Air conditioner compressor fastening screw to support		24.5 ± 2.5	2.4 ± 2.5
Air conditioner compressor support fastening screw to cylinder block		44 ± 4	4.4 ± 0.4
Alternator support fastening screw to cylinder block		44 ± 4	4.4 ± 0.4
Alternator bracket fastening screw to cylinder block		24.5 ± 2.5	2.4 ± 0.2
Water pipe unions		35	3.5
Water temperature sensor		32.5 ± 2.5	3.2 ± 0.2

♦ Lubricate with oil MOLYKOTE before assembly
• Lubricate with graphitized oil before assembly

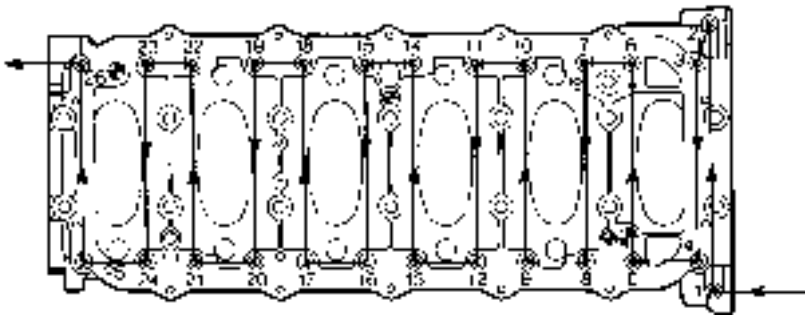
TIGHTENING TORQUES

PART	TORQUE	
	Nm	kgm
Engine brake solenoid valve fastening screws	32.5 ± 2.5	3.2 ± 0.2
Flywheel rev sensor fastening screw	8 ± 4	0.8 ± 0.2
Camshaft rev sensor fastening screw	8 ± 2	0.8 ± 0.2
P.D.E solenoid connector fastening screw	1.62 ± 0.3	0.1 ± 0.3
Overboost pressure sensor fastening screw	8 ± 2	0.8 ± 0.2
Absolute pressure sensor fastening screw	22.5 ± 2.5	2.2 ± 0.2
P.W.M. control valve fastening screw/nut	8 ± 2	0.8 ± 0.2
Fuel/coolant temperature sensor	35	3.5
Coolant temperature indicator	23.5 ± 2.5	2.3 ± 0.2
Filter clogging sensor	10	1
Oil temperature switch	25 ± 1	2.5 ± 0.1
Oil pressure sensor	25 ± 1	2.5 ± 0.1
Oil clogging sensor	55 ± 5	5.5 ± 0.5
Electric wire fastening screw	8 ± 2	0.8 ± 0.2
Heater fastening screw	12.5 ± 2.5	1.2 ± 0.2

UNDERBLOCK FIXING SCREWS TIGHTENING SEQUENCE

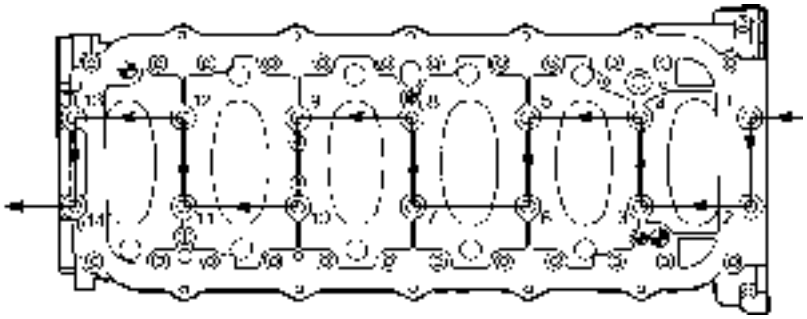
Figure 6

FRONT SIDE



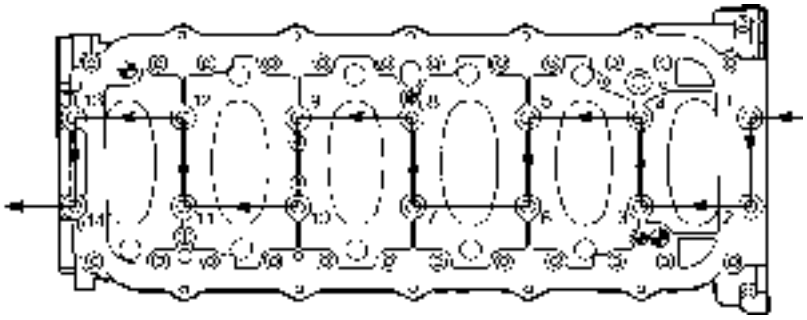
First phase:
preliminary tightening
of outer screws
(25 Nm)

FRONT SIDE



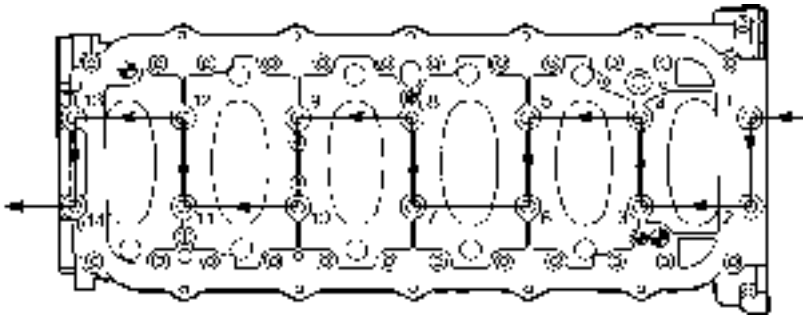
Second phase:
preliminary
tightening of
inner screws
(140 Nm)

FRONT SIDE



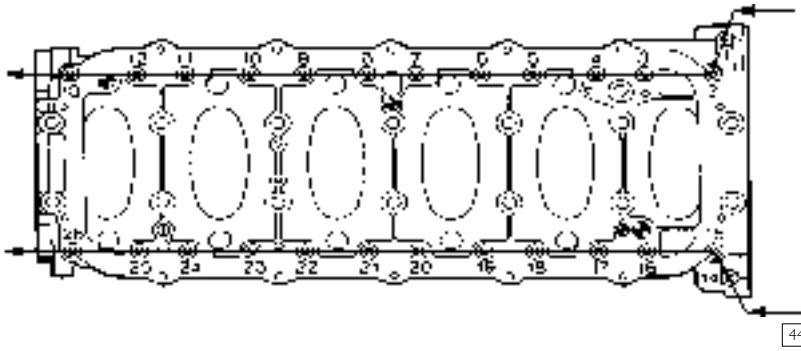
Third phase:
angle tightening
of inner screws
60°

FRONT SIDE



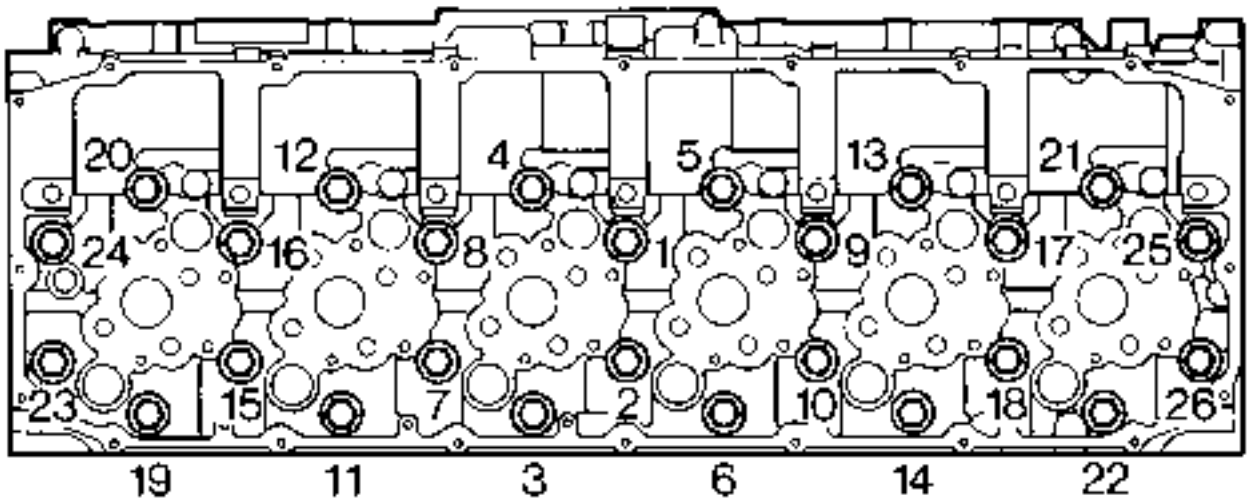
Front phase:
angle tightening
of inner screws
60°

FRONT SIDE



Fifth phase:
angle tightening
of outer screws
90°

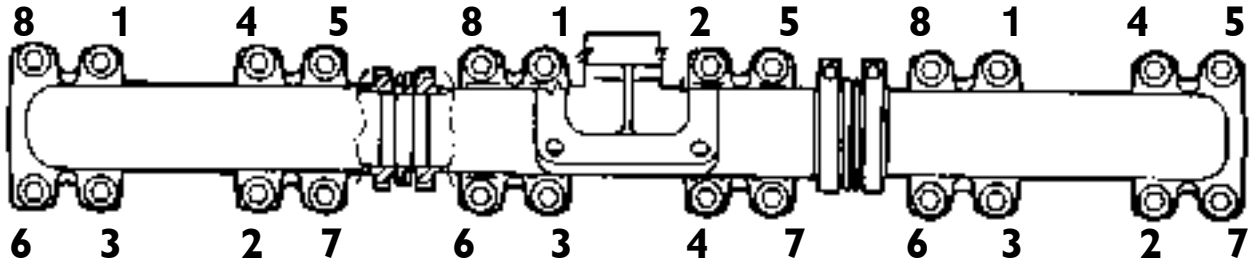
Figure 7



44900

DIAGRAM OF CYLINDER HEAD FIXING SCREWS TIGHTENING SEQUENCE

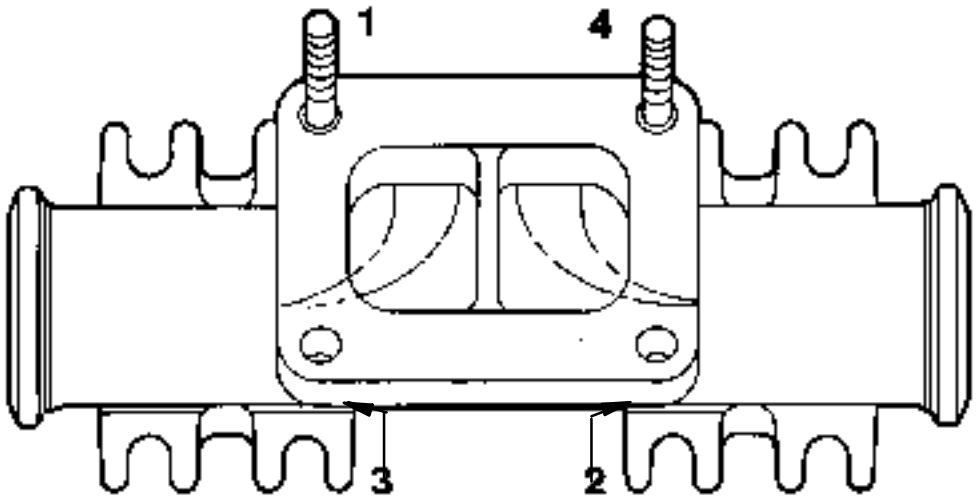
Figure 8



45359

DIAGRAM OF EXHAUST MANIFOLD FIXING SCREWS TIGHTENING SEQUENCE

Figure 9

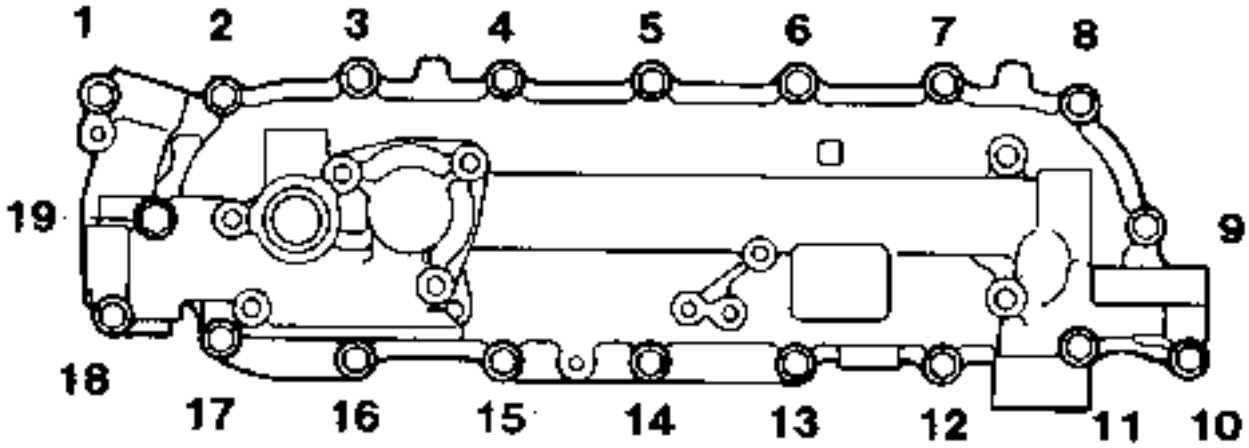


45360

DIAGRAM OF TURBOCHARGER FIXING SCREWS AND NUTS TIGHTENING SEQUENCE

SEQUENCE:	Preliminary tightening	4 - 3 - 1 - 2
	Tightening	1 - 4 - 2 - 3

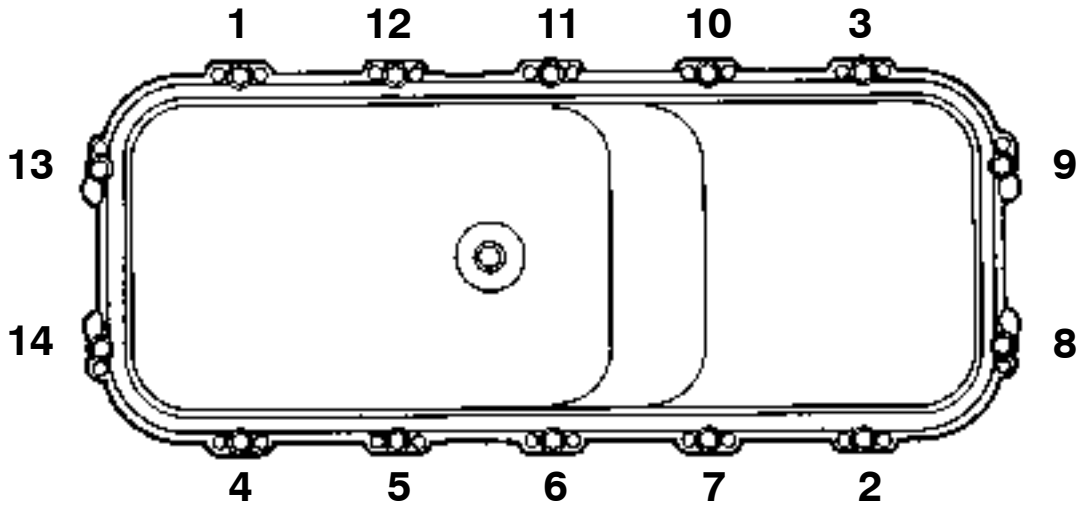
Figure 10



455361

DIAGRAM OF HEAT EXCHANGER FIXING SCREWS TIGHTENING SEQUENCE

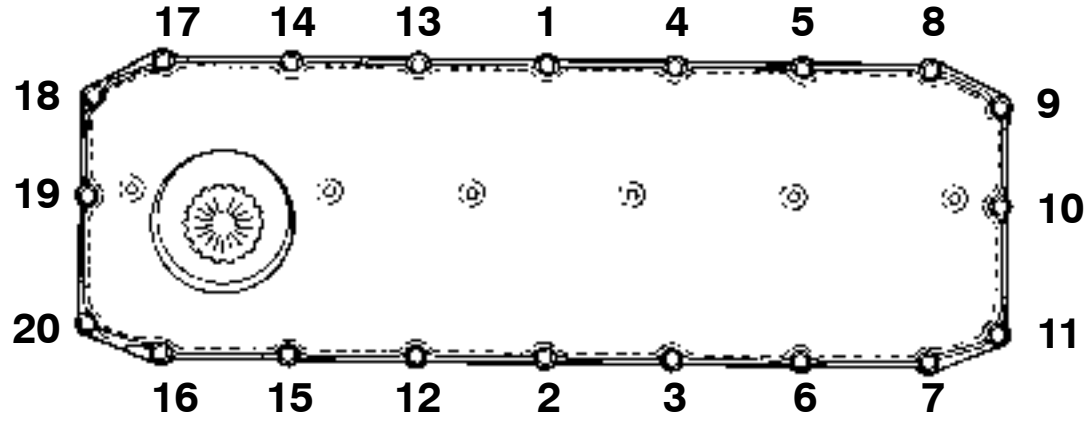
Figure 11



45362

DIAGRAM OF ENGINE OIL SUMP FIXING SCREWS TIGHTENING SEQUENCE

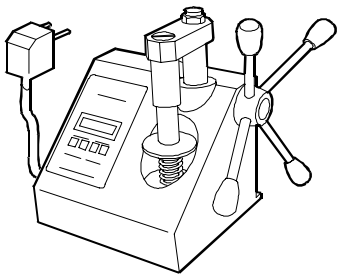
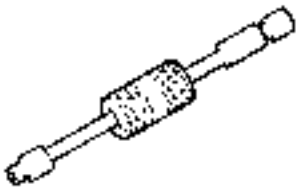
Figure 12



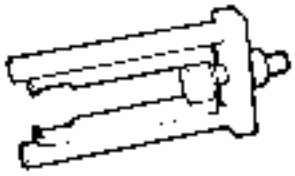
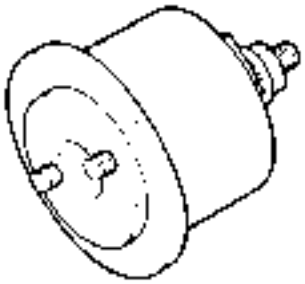
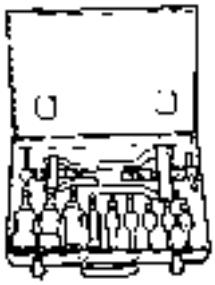
45363

DIAGRAM OF ROCKER ARM CAP FIXING SCREWS TIGHTENING SEQUENCE

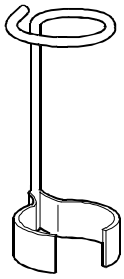
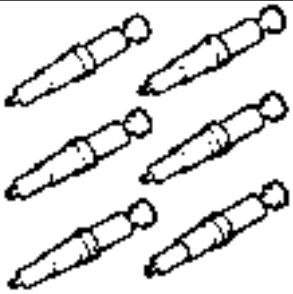
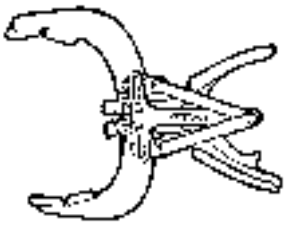
TOOLS

TOOL NO.		DESCRIPTION
99305019		Full-optional tool-kit to rectify valve seat
99305047		Equipment for spring load check
99322230		Rotary telescopic stand
99340051		Extractor for crankshaft front gasket
99340052		Extractor for crankshaft rear gasket
99340205		Percussion extractor

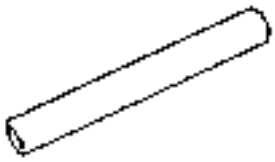
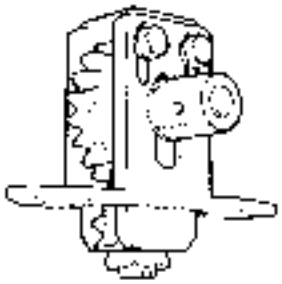
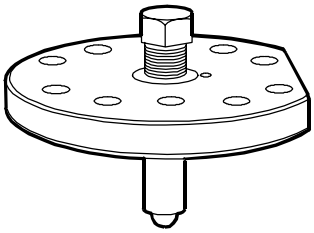
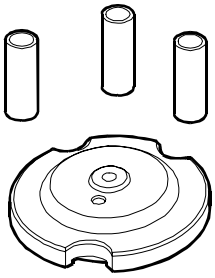
TOOLS

TOOL NO.		DESCRIPTION
99342148		Injector extractor
99342149		Extractor for injector-holder
99346245		Tool to install the crankshaft front gasket
99346246		Tool to install the crankshaft rear gasket
99348004		Universal extractor for 5 to 70 mm internal components
99350072		Box wrench for transmission gear support fixing screws

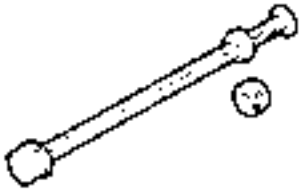
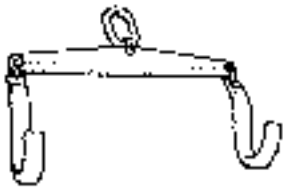
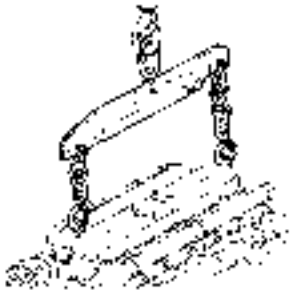
TOOLS

TOOL NO.		DESCRIPTION
99350074		Box wrench for block junction bolts to the underblock
99360144		Skid retaining tools (12+6) for rocker arm adjusting screws during rocker arm shaft removal/ refitting
99360177		Injector housing plug
99360184		Pincers for removing and refitting circlips and pistons (105-160 mm)
99360264		Tool to take down-fit engine valves
99360288		Tool to remove valve guide

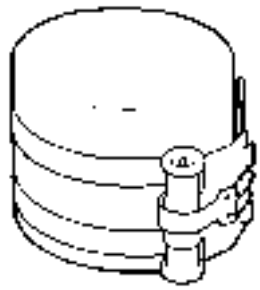
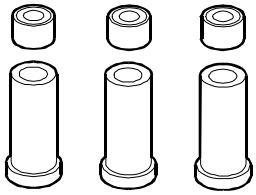
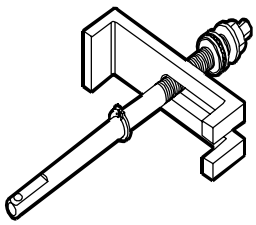
TOOLS

TOOL NO.		DESCRIPTION
99360292		Tool to install gasket on valve guide
99360294		Tool to drive valve guide
99360314		Tool to remove cartridge filters
99360321		Tool to rotate engine flywheel
99360334		Tool for checking cylinder barrel projection.
99360335		Cylinder barrel compression cap (to be used with 99360334)

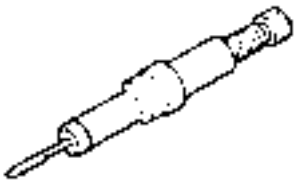
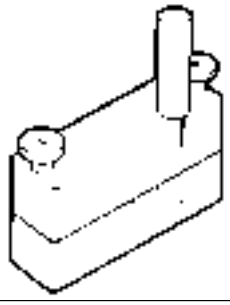
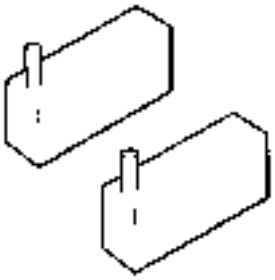
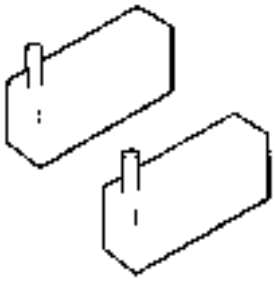
TOOLS

TOOL NO.		DESCRIPTION
99360351		Tool to stop engine flywheel
99360487		Tool to take down and fit back camshaft bushes
99360500		Tool to lift crankshaft
99360551		Bracket to take down and fit engine flywheel
99360558		Tool to lift and transport rocker shaft
99360585		Balance for lifting and handling engine

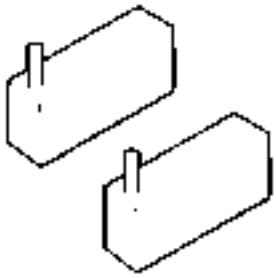
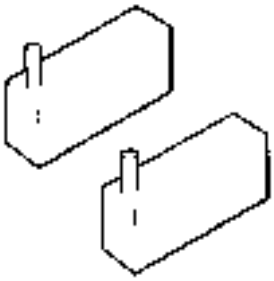
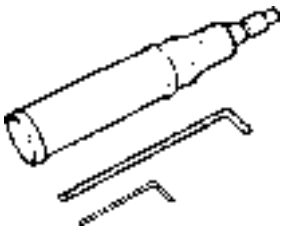
TOOLS

TOOL NO.		DESCRIPTION
99360605		Belt to insert piston in cylinder liner (60 - 125 mm)
99360612		Engine flywheel timing pin
99360613		Tool for timing of phonic wheel on timing gear
99360703		Tool to stop cylinder liners
99360706		Tool to extract cylinder liners
99360724		Tool to extract the cylinder liners (to be used with 99360723)

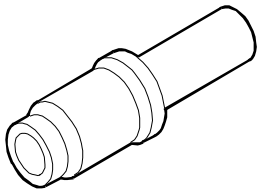
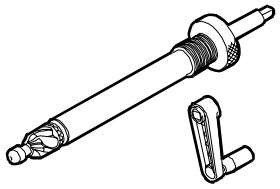
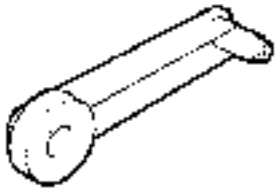
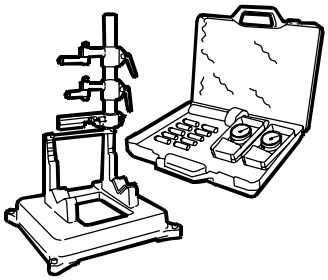
TOOLS

TOOL NO.		DESCRIPTION
99361035		Brackets fixing the engine to rotary stand 99322230
99365054		Tool for injector holder heading
99370415		Tool to detect cylinder liner projections (use with 99395603)
99378100		Tool for printing engine identification plates (to be used with special punches)
99378101		Punches (A) for printing engine identification plates (to be used with 99378100)
99378102		Punches (B) for printing engine identification plates (to be used with 99378100)

TOOLS

TOOL NO.		DESCRIPTION
99378105		Punches (E) for printing engine identification plates (to be used with 99378100)
99378106		Punches (F) for printing engine identification plates (to be used with 99378100)
99389834		Dynamometric screwdriver to calibrate screws for injector solenoid valve
99390310		Valve guide sleeker
99390772		Tool to remove residues from injector holder
99390804		Tool to thread injector holders to be extracted

TOOLS

TOOL NO.		DESCRIPTION
99394014		Guide bush (to be used with 99394041 or 99394043)
99394041		Cutter to rectify injector holder housing (to be used with 99394015)
99394043		Reamer to rectify injector holder lower side (to be used with 99394015)
99395215		Gauge for centre distance check between camshaft and idle gear
99395216		Measuring pair for angular tightening with 1/2" and 3/4" square couplings
99395363		Complete square to check connecting rod squaring

TOOLS

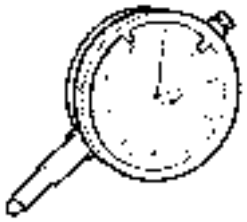
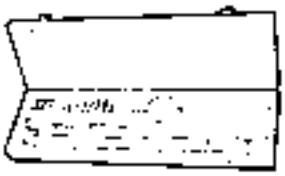
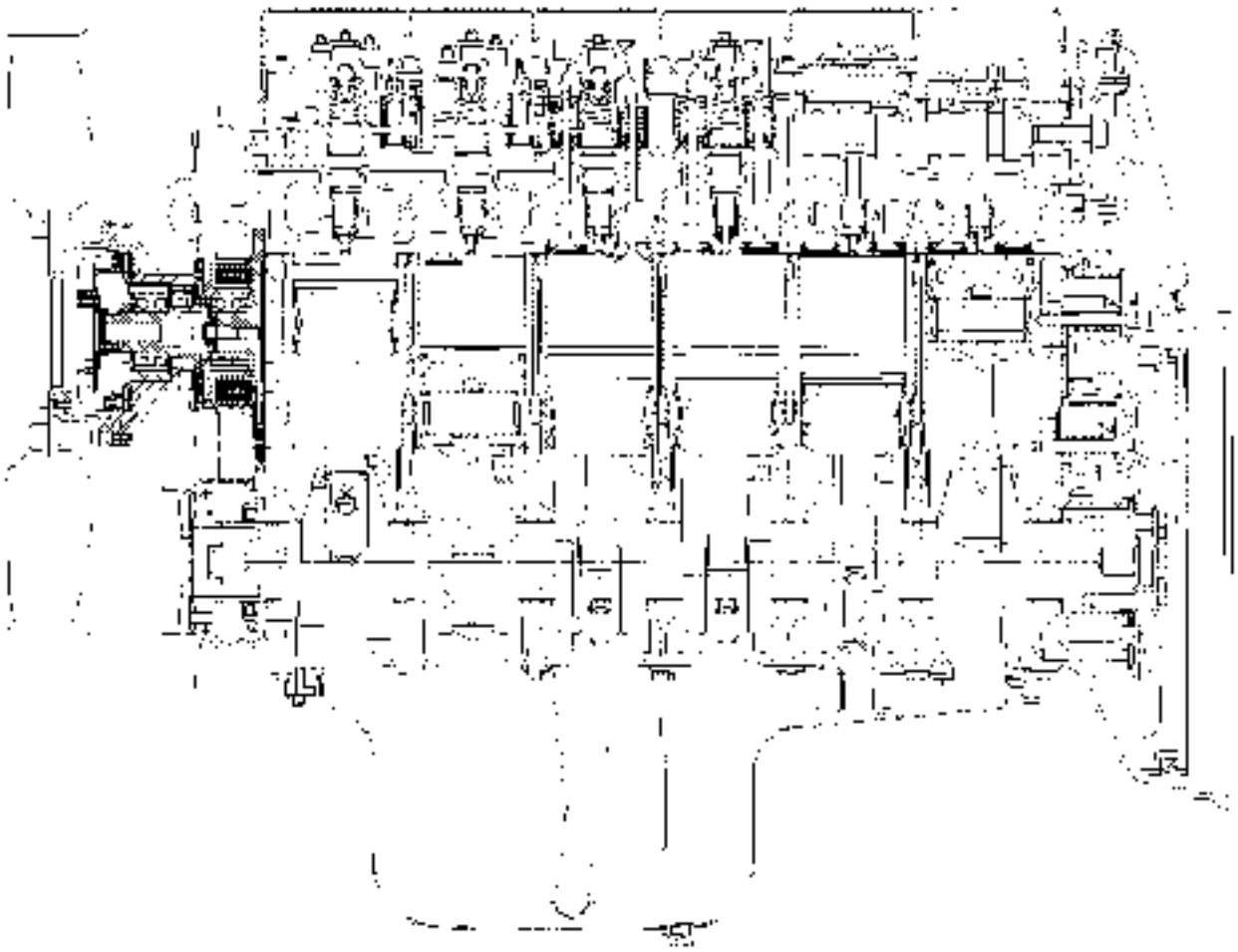
TOOL NO.		DESCRIPTION
99395603		Dial gauge (0 - 5 mm)
99395687		Reaming gauge (50-178 mm)
99396033		Centering ring of crankshaft front cap

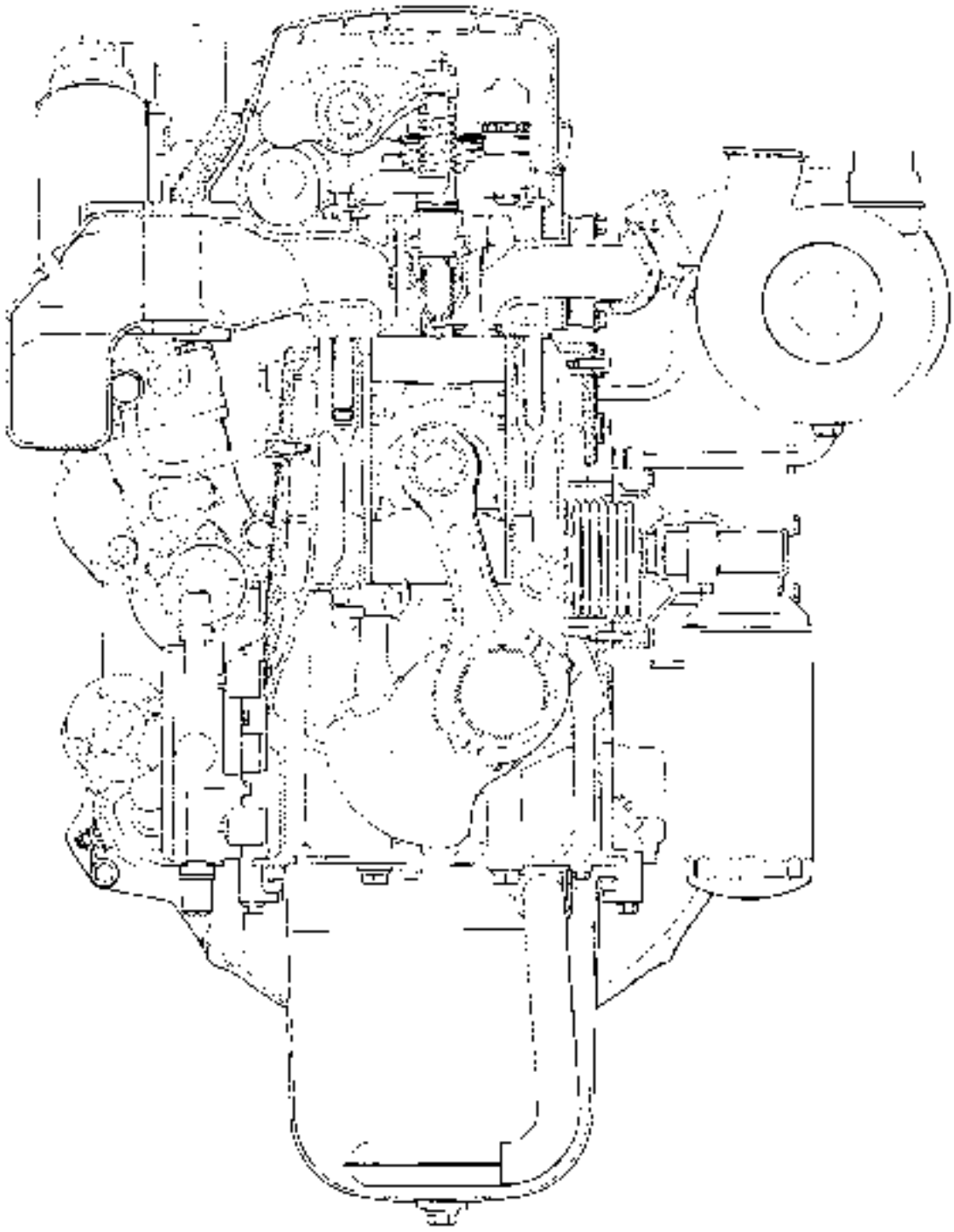
Figure 13



78839

ENGINE - LONGITUDINAL SECTION

Figure 14

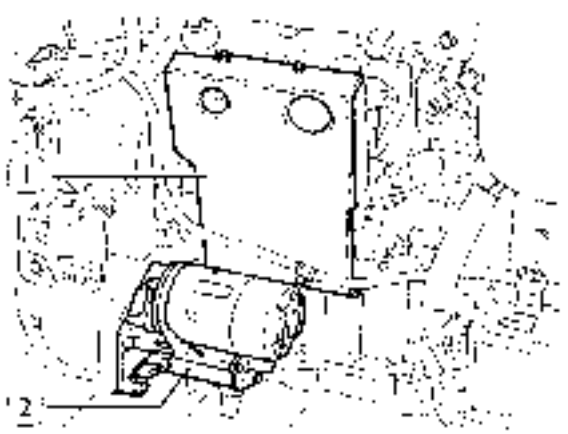


78841

ENGINE - CROSS SECTION

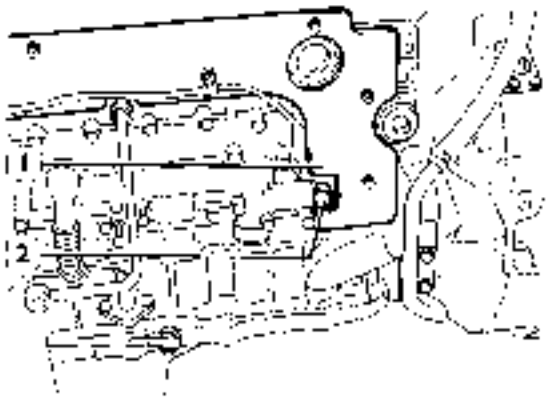
54010 DISMANTLING THE ENGINE ON THE BENCH

Figure 15



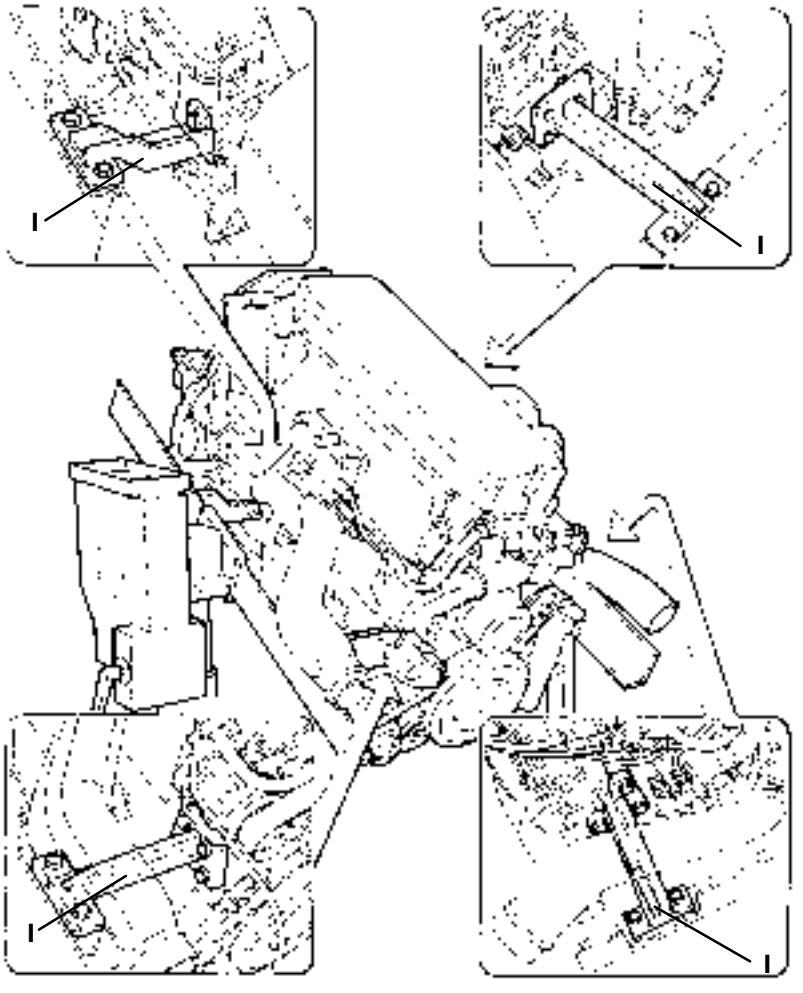
Before dismantling the engine on the rotary stand 99322230, remove the following components:
- starter (2)
- turbocharger soundproofing shield (1)

Figure 16



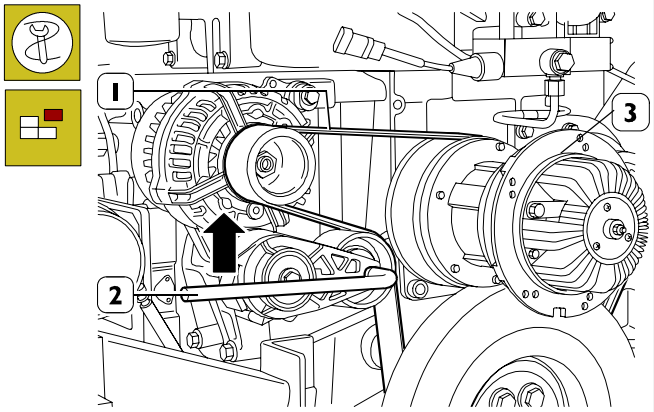
Remove the soundproofing shield (1) and plug (2)

Figure 17



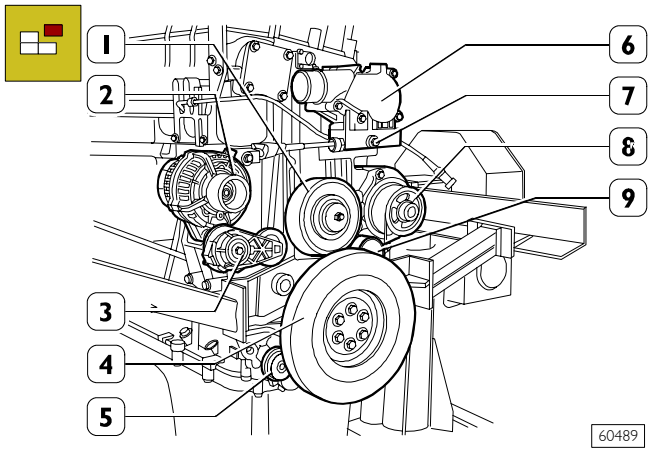
Fix the engine to the rotary stand 99322230, by means of brackets 99361035 (1), remove the fan.

Figure 18



Using an appropriate tool (2), operate in the direction of the arrow, and remove the belt (1) driving the water pump, alternator and fan.
Take out the screws and remove the electromagnetic coupling (3).

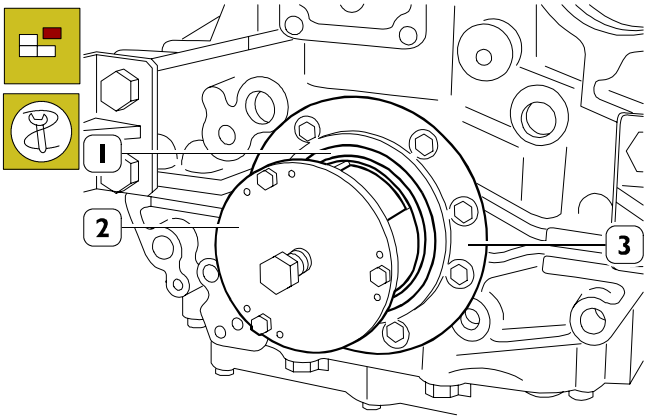
Figure 19



Remove the following components:

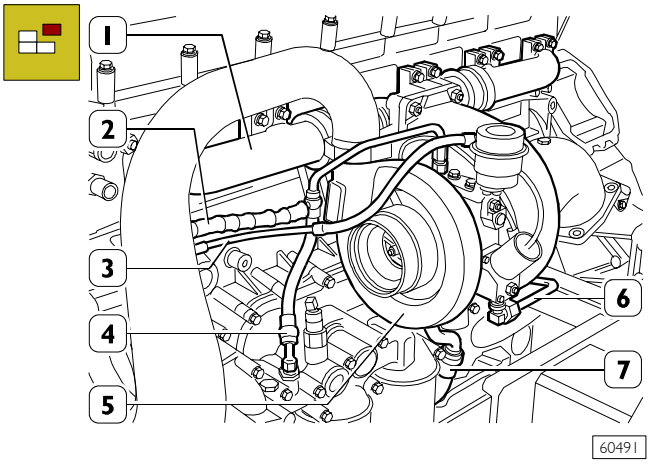
- thermostat unit (6) fitted with turbine actuator pressure sensor (7);
- alternator (2);
- pulley support (1);
- water pump (8) and piping;
- automatic belt tightener support (3);
- fixed belt tightener (9);
- damping flywheel (4) and pulley underneath it;
- automatic belt tightener (5);
- disconnect all the electric connections and the sensors.

Figure 20



Fit the extractor 99340053 (2) and remove the engine crankshaft seal gasket (1), remove the cover (3).

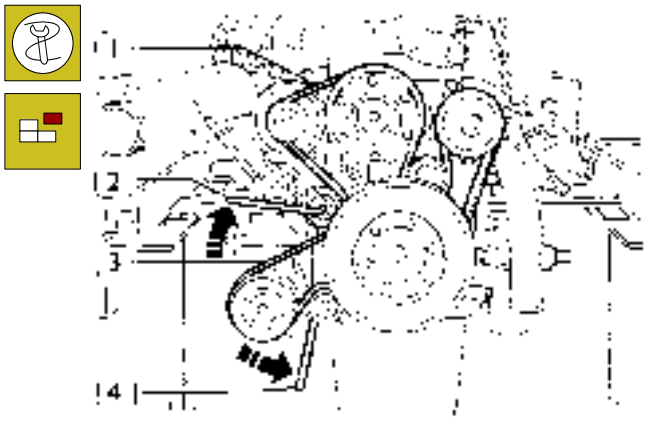
Figure 21



Remove the following components:

- water outlet line (2);
- oil delivery line (4);
- actuator air line (3);
- water delivery line (6);
- oil return line (7);
- turbocharger (5);
- exhaust manifold (1).

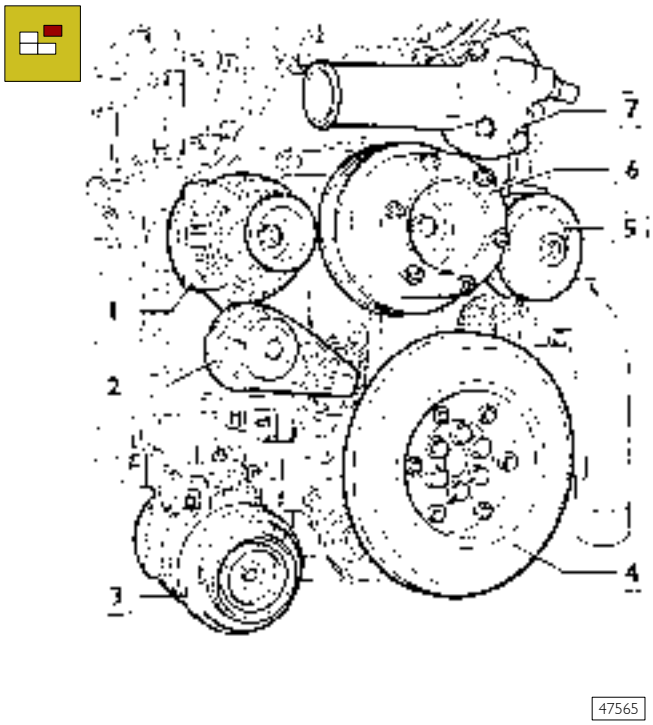
Figure 22



47564

Load the belt tensioner spring by tool (4), acting in the direction shown by the arrow, on the head of the screw fixing the roller. The screw cannot be untightened as the thread is counterclock-wise. Remove the belt (3). By tool (2), act in the direction shown by the arrow and remove the fan, alternator and water pump control belt (1).

Figure 23

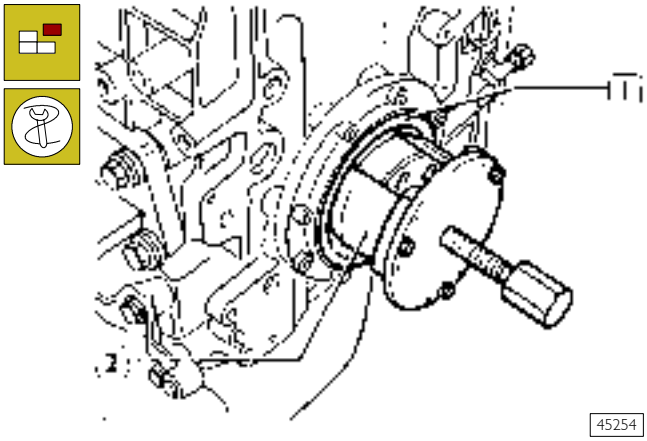


47565

Remove the following components:

- alternator (1);
- belt tightener support (2);
- air conditioner compressor (3);
- flywheell (4);
- water pump and piping (5);
- fan pulley spacer (6);
- thermostat unit (7).

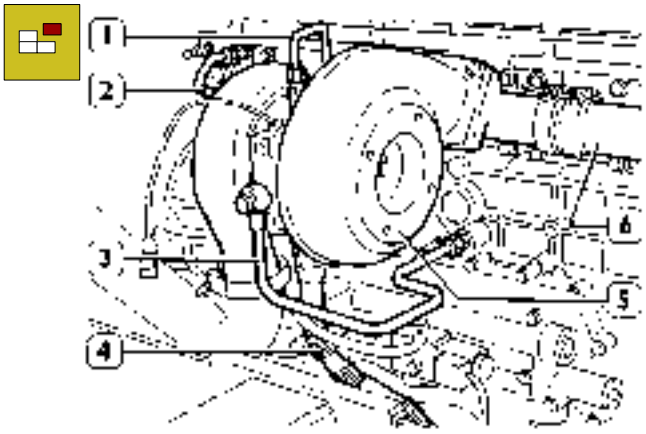
Figure 24



45254

Install extractor 99340051 (2) and remove the seal gaskets (1). Unscrew the screws and remove the cover.
Disconnect all electric connections and sensors.

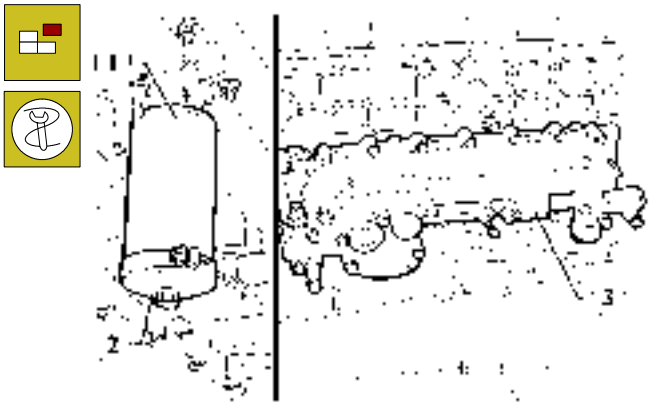
Figure 25



47566

Remove the following components: oil supply lines (1); water cooling supply lines (3); water discharge lines (2); oil return lines (4); turbocharger (5); exhaust manifold (6).

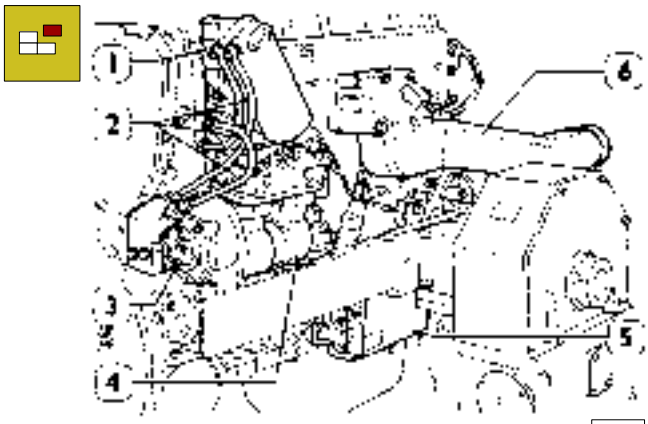
Figure 26



47567

Unscrew the oil filter (1) by tool 99360314 (2).
Unscrew the screws and remove the entire heat exchanger (3).

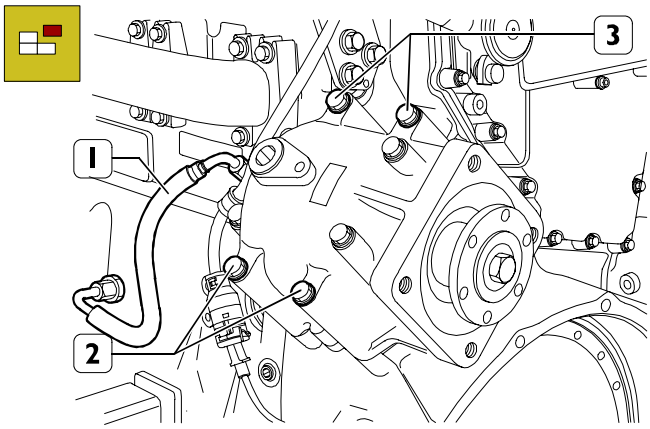
Figure 27



47587

Remove the following components: intake manifold (6); support for fuel filter (1); fuel lines (2); fuel pump (3);compressor (4); control unit (5).

Figure 28

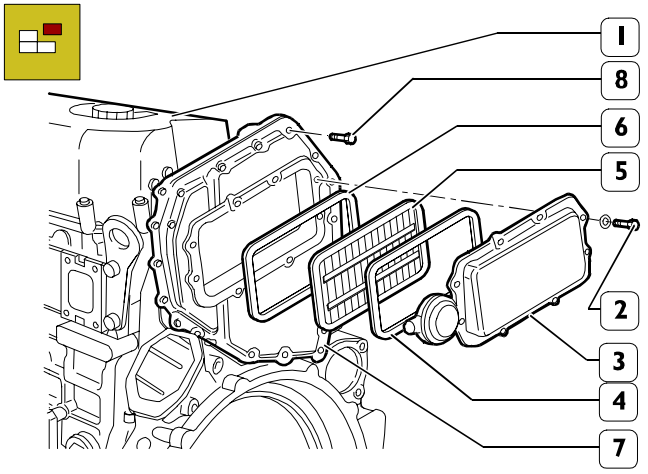


70708

To remove the P.T.O. (if applicable):

- ❑ Disconnect the oil pipe (1).
- ❑ Unscrew the 4 screws (2) and (3).

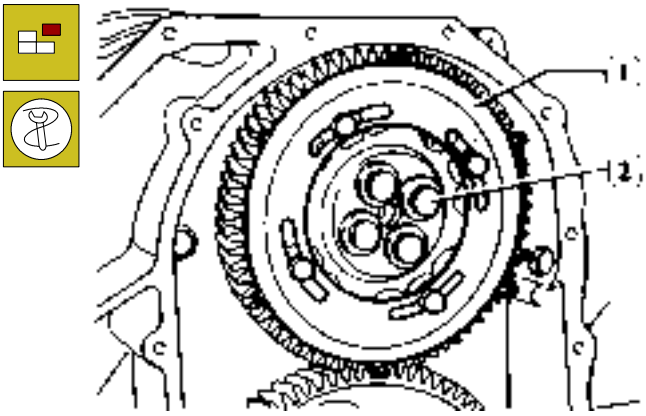
Figure 29



84377

Remove the rocker arm cover (1), take off the screws (2) and remove: the cover (3), the filter (5) and the gaskets (4 and 6). Take off the screws (8) and remove the blow-by case (7).

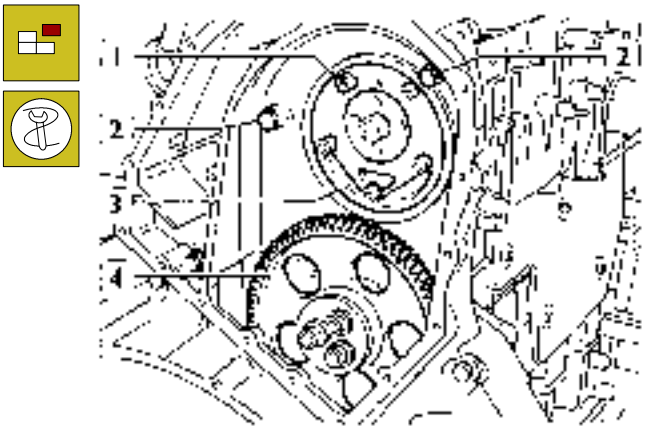
Figure 30



45661

Unscrew the screws (2), by using the proper wrench and remove the gear (1) with the phonic wheel.

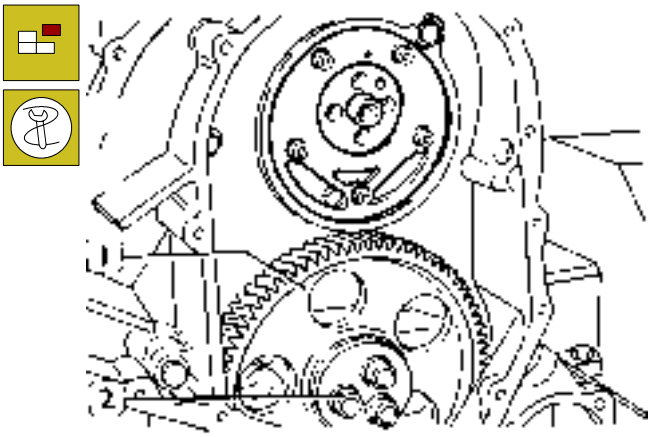
Figure 31



45265

Unscrew the screws (1); tighten a screw in a reaction hole and remove the shoulder plate (3), remove the sheet gasket.

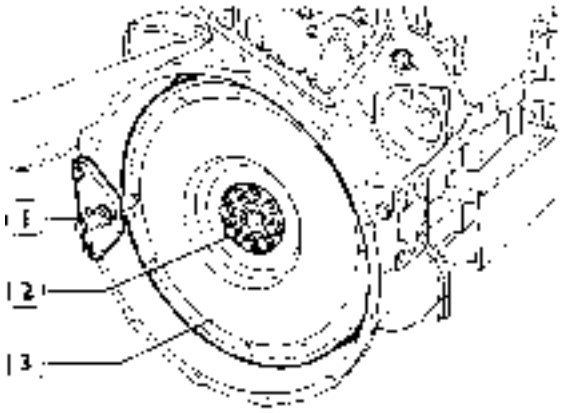
Figure 32



47568

By means of a properly splined wrench, untighten screws (2) and remove the transmission gear (1)

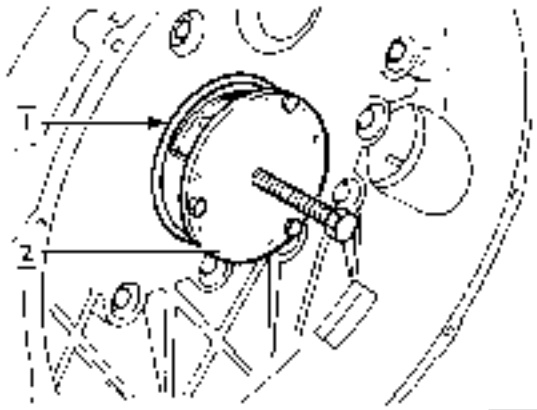
Figure 33



47568

Stop the engine flywheel (3) rotation by means of tool 99360351 (1), untighten the fixing screws (2) and remove the engine flywheel.

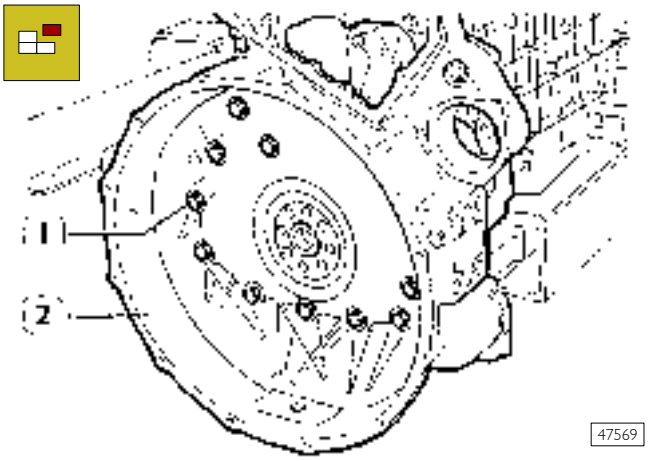
Figure 34



45257

Apply extractor 99340052 (2) and pull out the seal gasket (1).

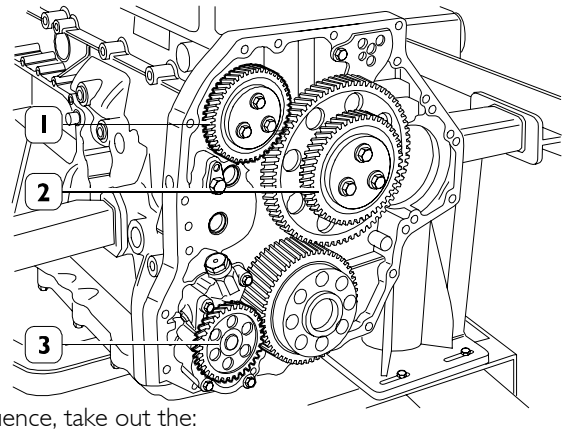
Figure 35



47569

Untighten the screws (1) and take down the gear box (2).

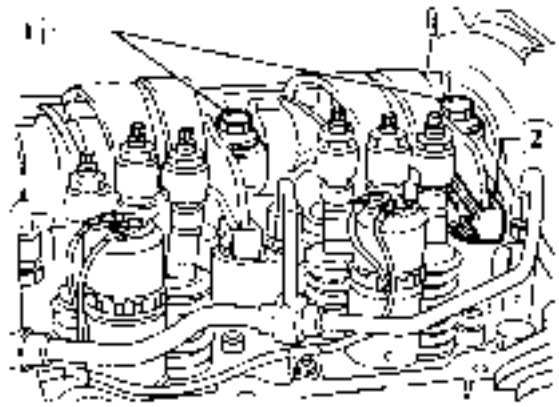
Figure 36



In sequence, take out the:

- ❑ if the P.T.O. control gear (1) is present;
- ❑ idle gear (2);
- ❑ oil pump gear (3).

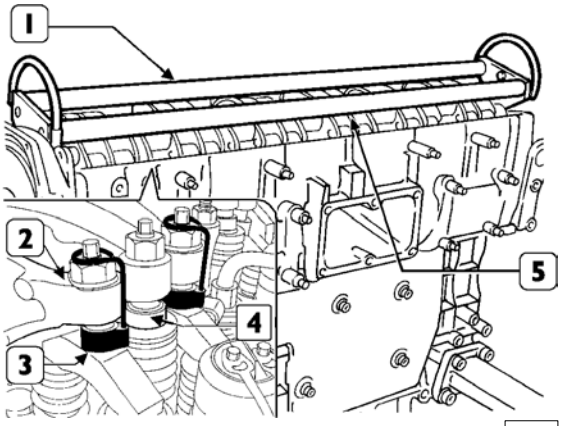
Figure 37



45259

- ❑ Remove the check springs (2) of the exhaust brake lever;
- ❑ Untighten the fixing screws (1) of rocker arm shaft.

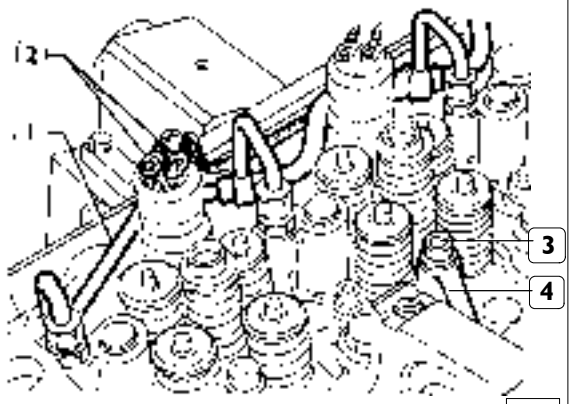
Figure 38



73533

- ❑ Using tool 99360144 (3), constrain the blocks (4) to the rockers (2).
- ❑ Apply tool 99360553 (1) to the rocker holder shaft (5) and remove the shaft (5) from the cylinder head.

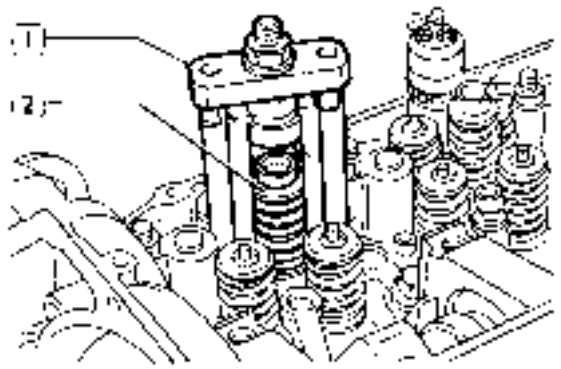
Figure 39



45262

- ❑ Remove the piping (1) for exhaust brake pins;
- ❑ Untighten screws and remove electric connections (2) from solenoid valves;
- ❑ Untighten fixing screws (3) of injector brackets (4).

Figure 40

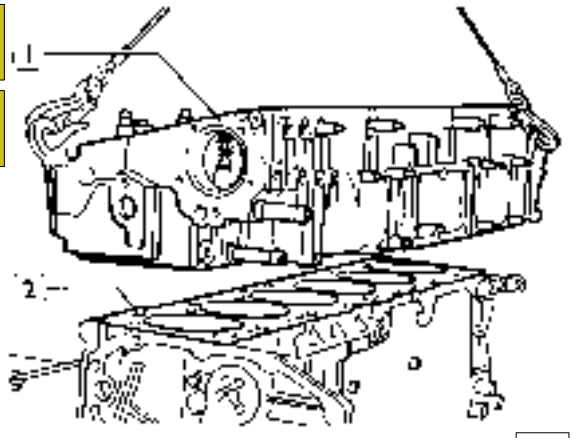


45263

- ❑ Remove injectors (2)

If this operations is difficult, use extractor 99342148 (1). Install plugs 99360177 instead of injectors.

Figure 41

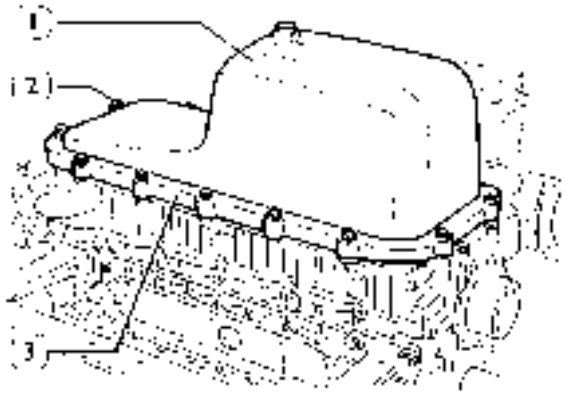


45266

Remove the camshaft and the fixing screws on cylinder heads

- ❑ By means of wire ropes, lift the cylinder head (1) and remove seals (2).

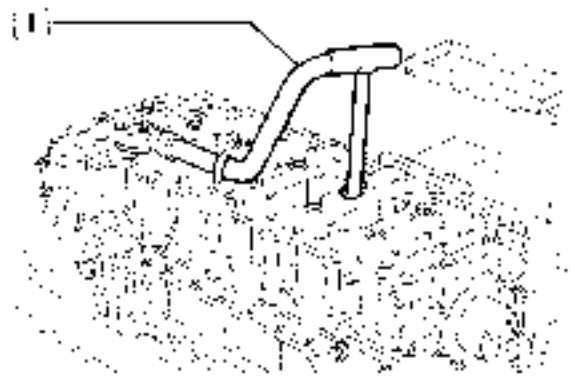
Figure 42



47573

Untighten screws (2) and remove the engine oil sump (1) with spacer (3) and seal .

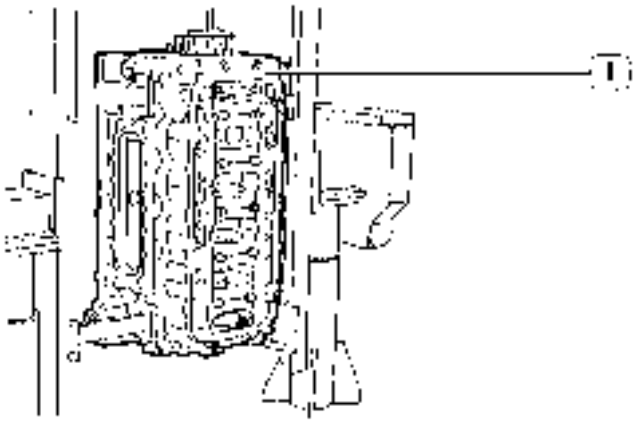
Figure 43



47572

Untighten screws and remove suction rose (1).

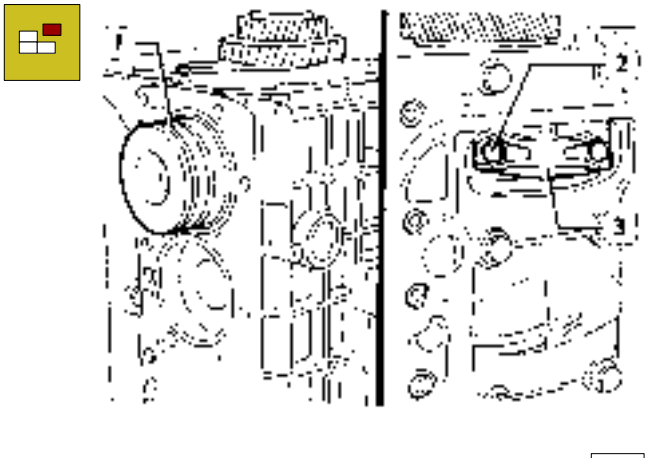
Figure 44



47574

Rotate the block (1) to the vertical position.

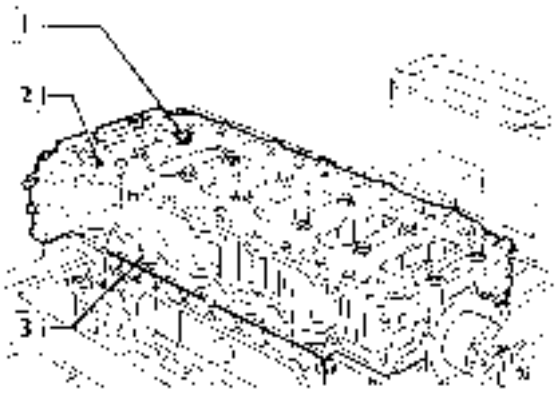
Figure 45



47575

Untighten screws (2) fixing the connecting rod cap (3) and remove it. Remove the connecting rod-piston assembly from the upper side. Repeat these operations for the other pistons.

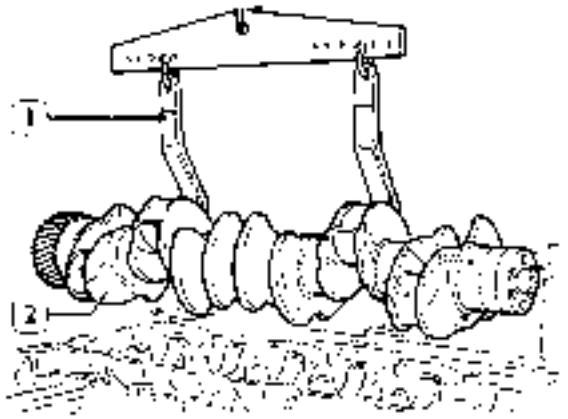
Figure 46



47576

By means of proper and splined wrenches, untighten the screws (1) and (2) and remove the under-block (3).

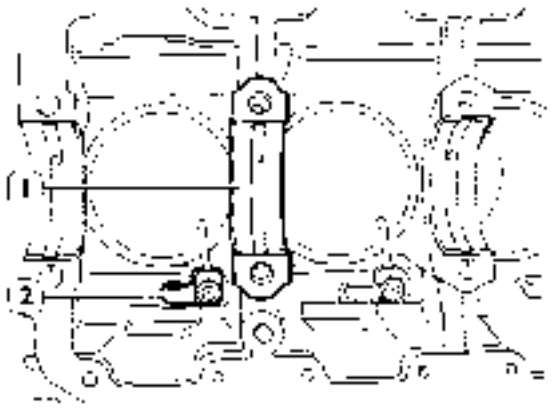
Figure 47



47570

Remove the crankshaft (2) with tool 99360500 (1).

Figure 48



47571

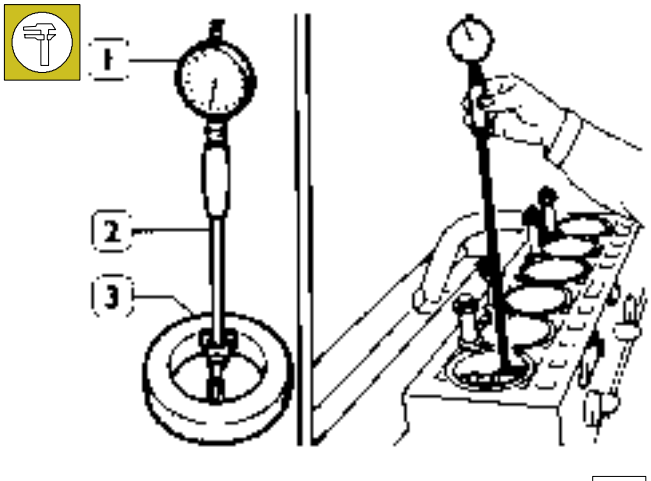
Remove the crankshaft half-bearings (1), untighten the screws and remove oil spray nozzles (2).
Take down cylinder liners as specified in the relative paragraph on page 49.

After disassembling the engine, thoroughly clean disassembled parts and check their integrity.
Instructions for main checks and measures are given in the following pages, in order to determine whether the parts can be re-used.

REPAIR OPERATIONS

540410 CYLINDER BLOCK
540420 Checks and measurements

Figure 49 (Demonstration)

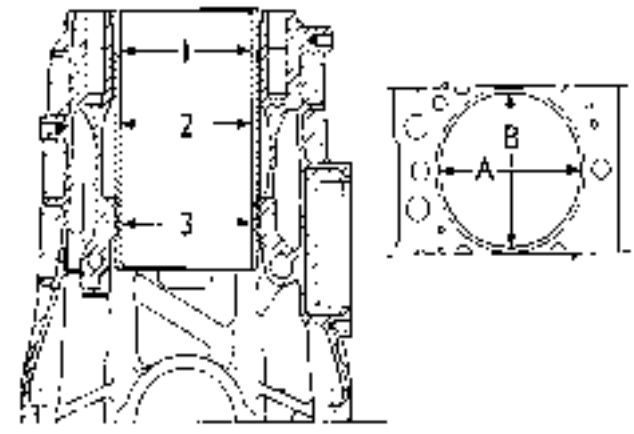


34994

Internal diameter of the cylinder liners is checked for ovalization, taper and wear, using a bore dial (1) centesimal gauge 99395687 (2) previously reset to ring gauge (3), diameter 115 mm.

If a 115 ring gauge is not available use a micrometer caliper.

Figure 50

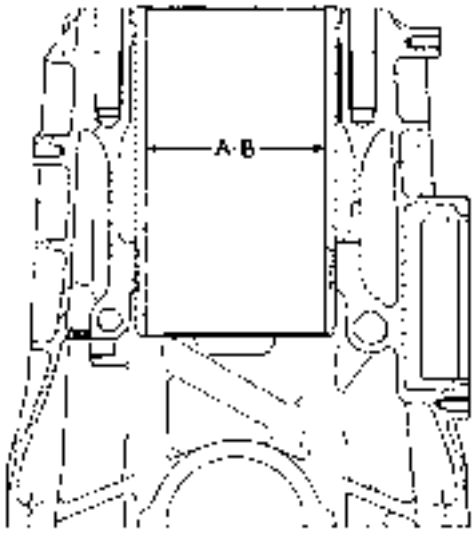


47439

1 = 1st measuring
2 = 2nd measuring
3 = 3rd measuring

Carry out measurings on each cylinder liner at three different levels and on two (A-B) surfaces, to one another perpendicular, as shown in Figure 50.

Figure 51



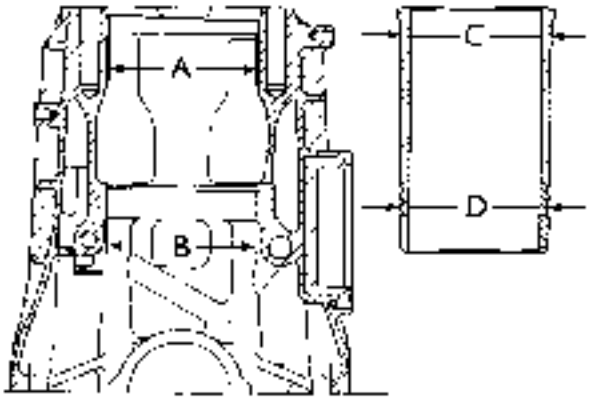
47440

A = Selection class Ø 115 to 115.012 mm
B = Selection class Ø 115.010 to 115.022 mm

In case of maximum wear max 0.150 mm or maximum ovalization max 0.100 mm compared to the values indicated in the figure, the liners must be replaced as they cannot be ground, lapped or trued.

Cylinder liners are equipped with spare parts with "A" selection class.

Figure 52



47441

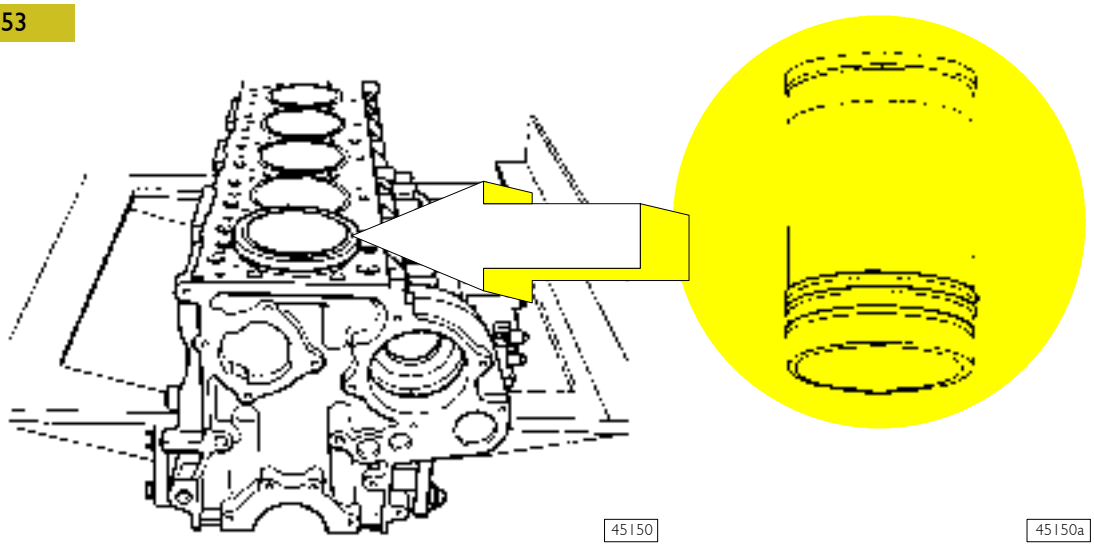
A = Ø 130.200 to 130.225 mm
B = Ø 128.510 to 128.535 mm
C = Ø 130.161 to 130.186
D = Ø 128.475 to 128.500 mm

The figure shows the outer diameters of the cylinder liners and the relative seat inner diameters.

The cylinder liners can be extracted and installed several times in different seats, if necessary.

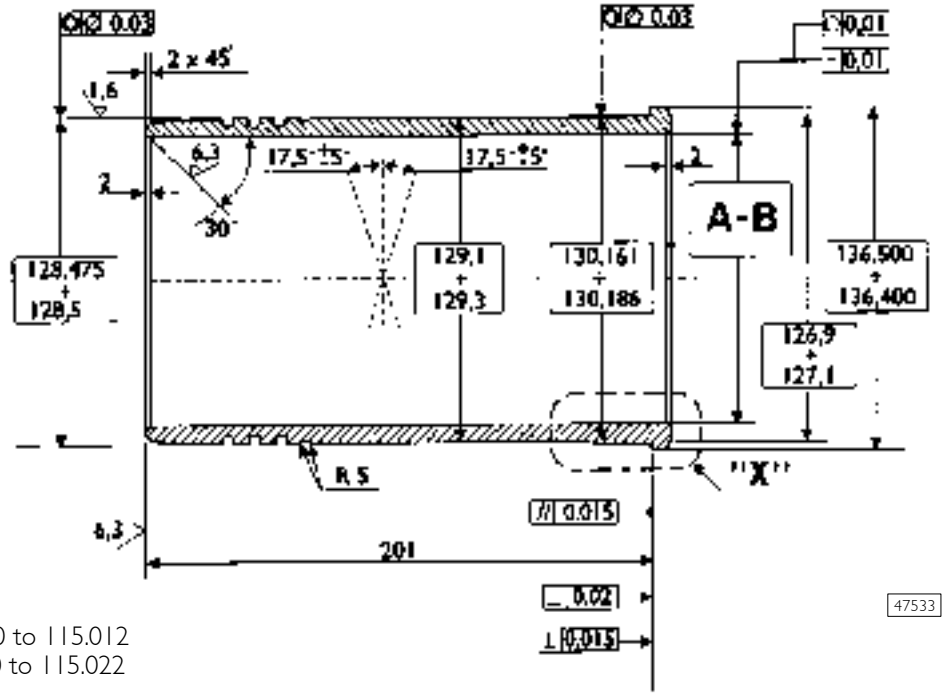
CYLINDER LINERS

Figure 53



BLOCK WITH CYLINDER LINERS

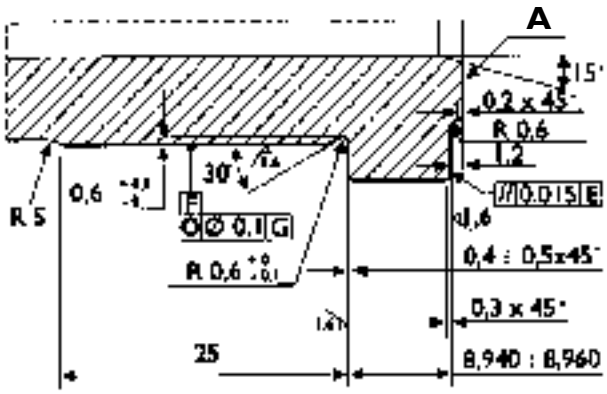
Figure 54



Selection class
- A mm 115.000 to 115.012
- B mm 115.010 to 115.022

CYLINDER LINERS MAIN DATA

Figure 55

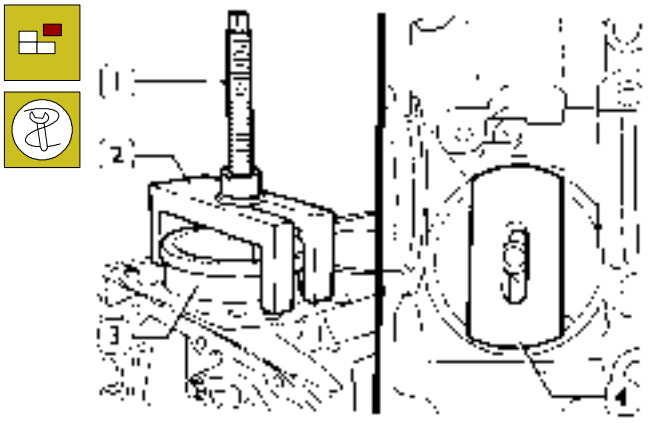


DETAIL "X"
"A" = Selection class marking area

540420 Replacing cylinder liners

Removal

Figure 56

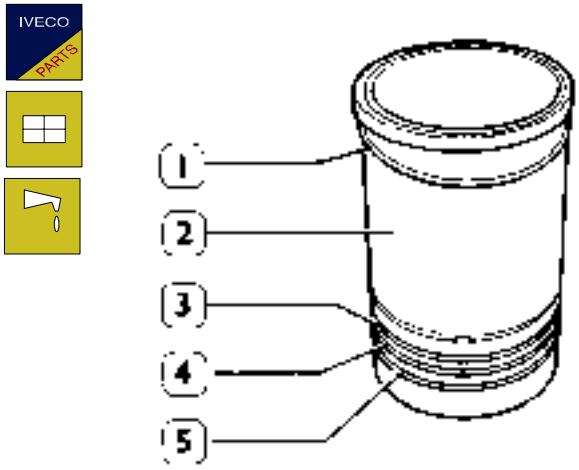


47577

Place details 99360706 (1 and 2) and plate 99360724 (4) as shown in the figure, by making sure that the plate (4) is properly placed on the cylinder liners.
Tighten the screw nut (1) and remove the cylinder liner (3) from the block.

Fitting and checking protrusion

Figure 57

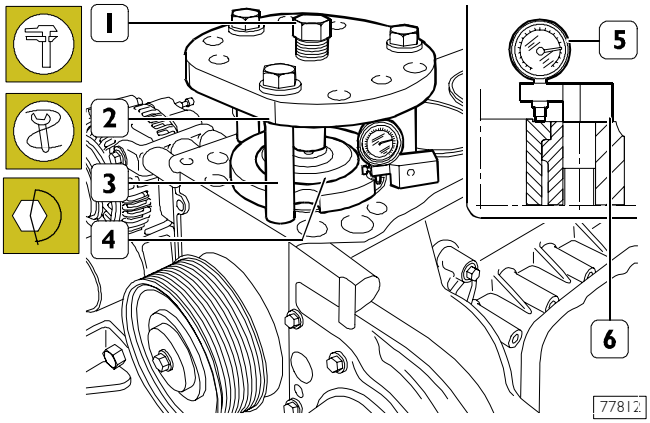


16798

Always replace water sealing rings (3, 4 and 5).
Install the adjustment ring (1) on the cylinder liner (2); lubricate lower part of liner and install it in the cylinder unit using the proper tool.

The adjustment ring (1) is supplied as spare parts in the following thicknesses: 0.08 mm - 0.10 mm - 0.12 mm.

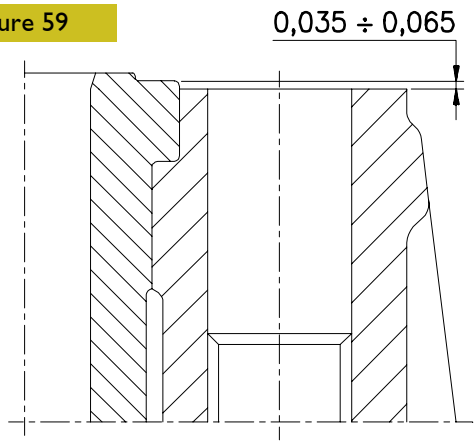
Figure 58



77812

Check cylinder barrel protrusion with tool 99360334 (1-2-3-4) and tighten screw (1) to 170 Nm.
With dial gauge 99395603 (5) placed on base 99370415 (6). Measure the cylinder barrel protrusion compared to the cylinder head supporting plane, it must be 0,035 to 0,065 mm (Figure 59); otherwise replace the adjusting ring (1, Figure 57) fitted with spare parts having different thickness.

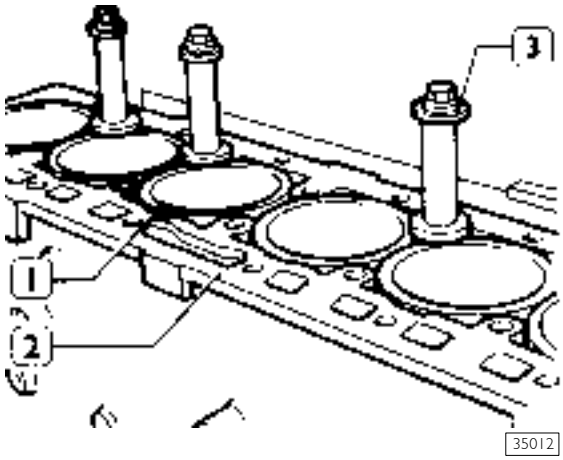
Figure 59



49017

CYLINDER LINER PROTRUSION

Figure 60 (Demonstration)

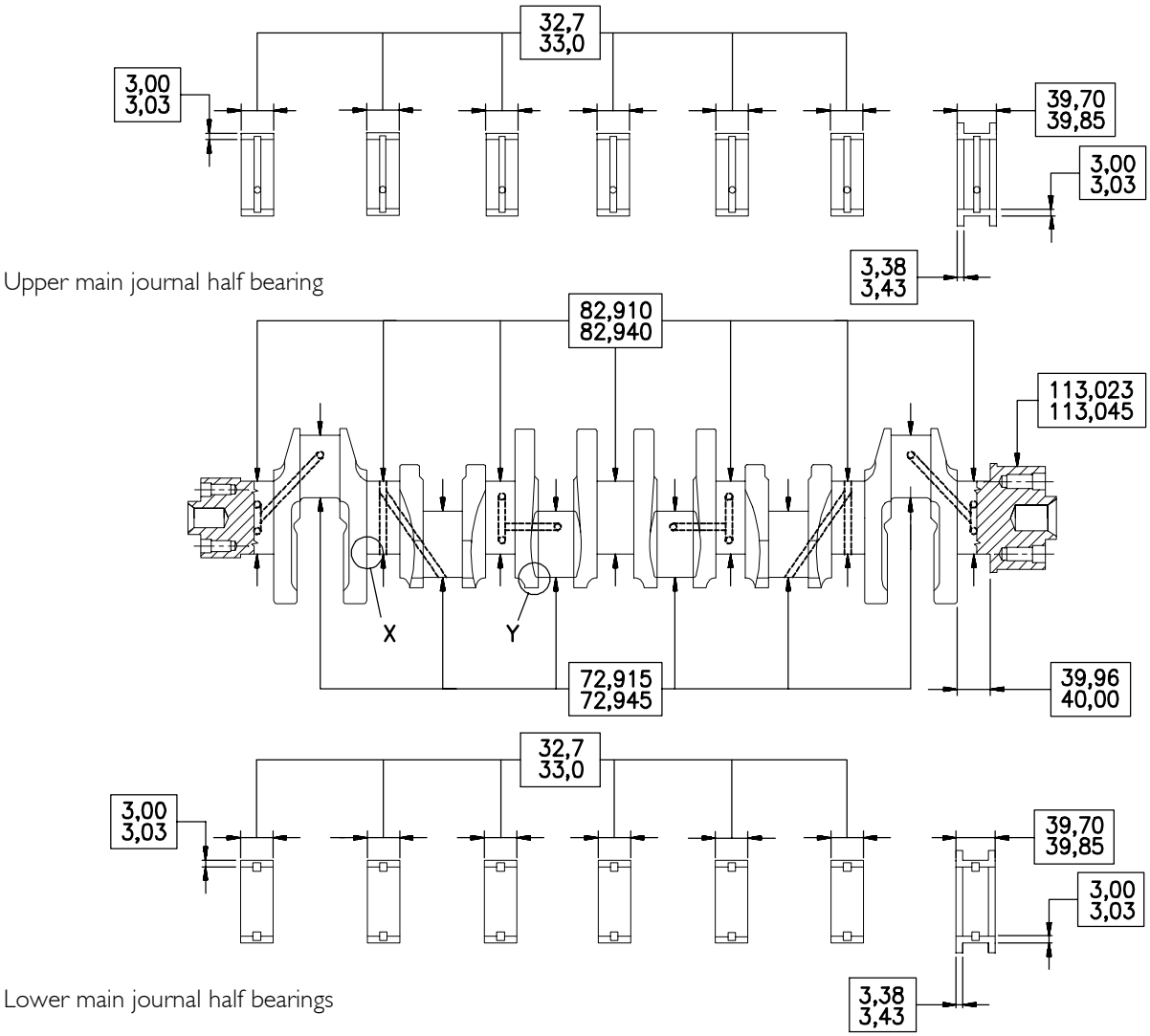


35012

When the installation is completed, block the cylinder liners (1) to the block (2) with studs 99360703 (3).

5408 CRANKSHAFT

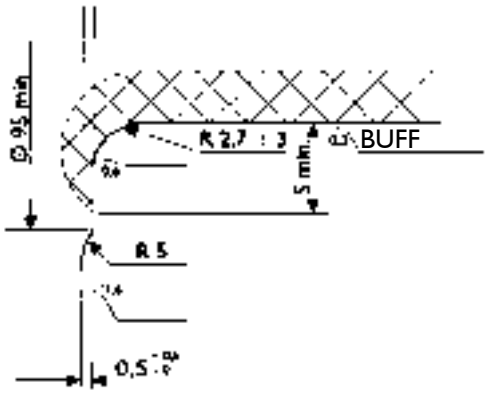
Figure 61



MAIN DATA FOR THE CRANK SHAFT PINS AND THE HALF BEARINGS

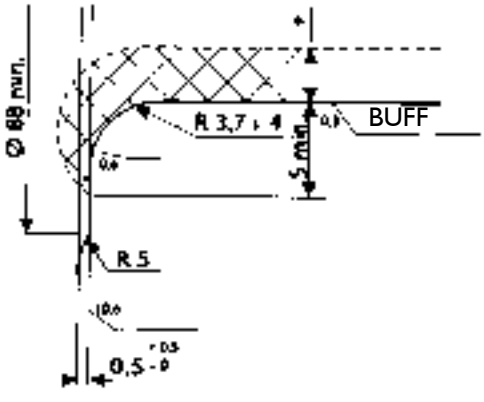
Check the condition of the journals and the big end pins; there must no be signs of scoring, ovalization or excessive wear.
The data given refer to the normal diameter of the pins.

Figure 62



X. Detail of main journals connections

Figure 63

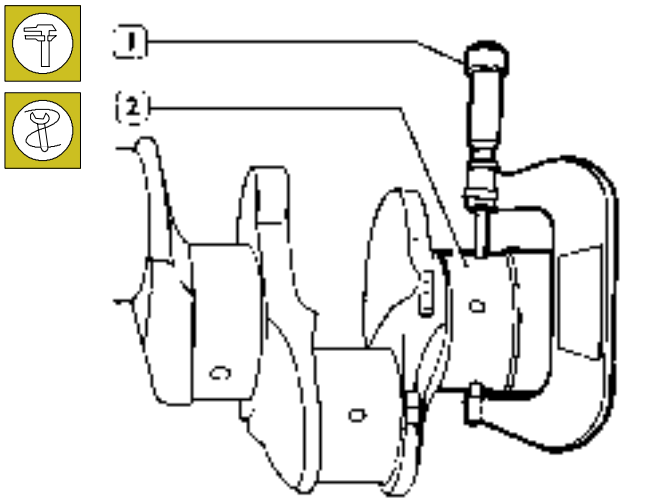


Y. Detail of crank pins connections

540812 Measuring main journals and crank pins

Before grinding the crank pins using a micrometer (1), measure the main journals and the crank pins (2) and decide, on the basis of the undersizing of the bearings, the final diameter to which the pins are to be ground.

Figure 64

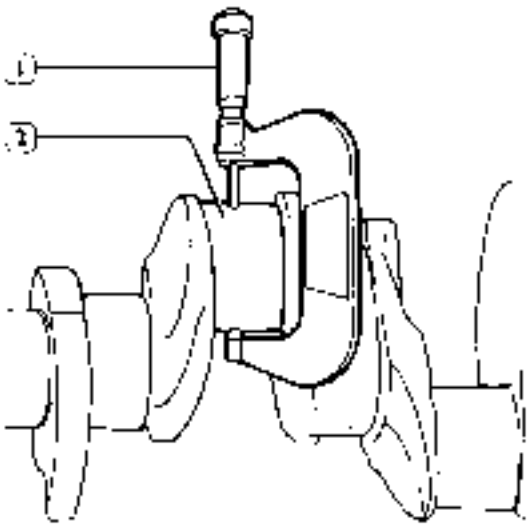


47535

MEASURING THE MAIN JOURNALS

It is advisable to enter the values found in a table (Figure 66).

Figure 65



47536

MEASURING CRANK PINS

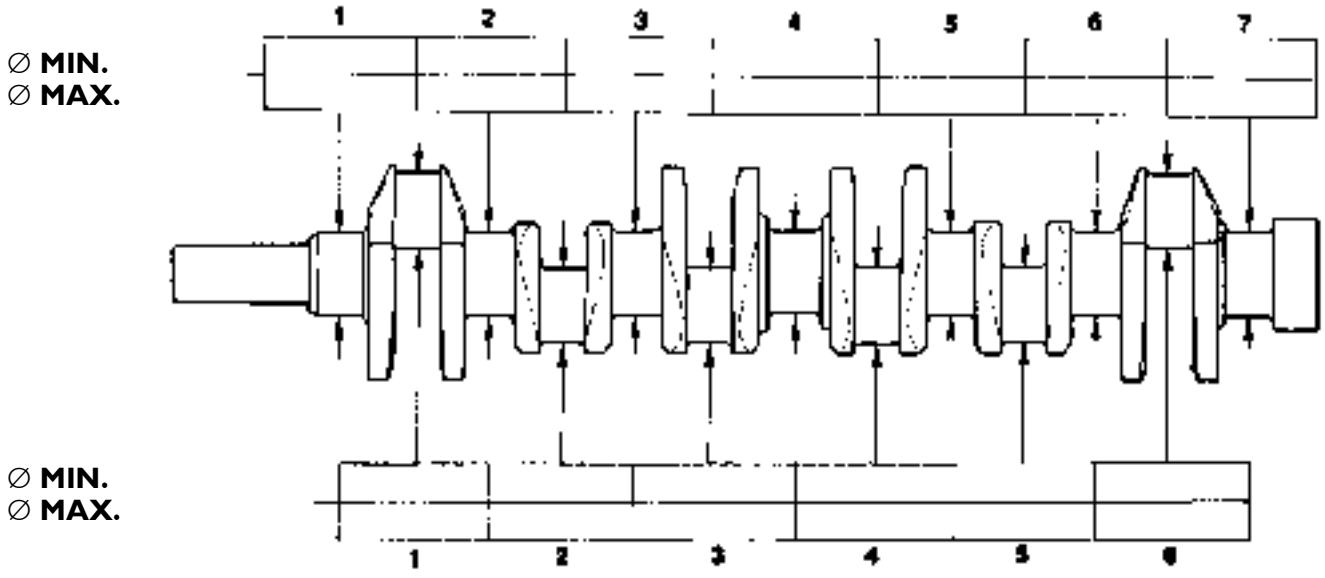
During grinding, pay attention to journal and crank pins values specified in figures 62 and 63.

All journals and crank pins must also be ground to the same undersizing class, in order to avoid any alteration to shaft balance.

Figure 66

Fill in this table with the measurements of the main journals and the crank pins.

MAIN JOURNALS



CRANK PINS

36061

PRELIMINARY MEASUREMENT OF MAIN AND BIG END BEARING SHELL SELECTION DATA

For each of the journals of the crankshaft, it is necessary to carry out the following operations:

MAIN JOURNALS:

- ❑ Determine the class of diameter of the seat in the crankcase.
- ❑ Determine the class of diameter of the main journal.
- ❑ Select the class of the bearing shells to mount.

CRANKPINS:

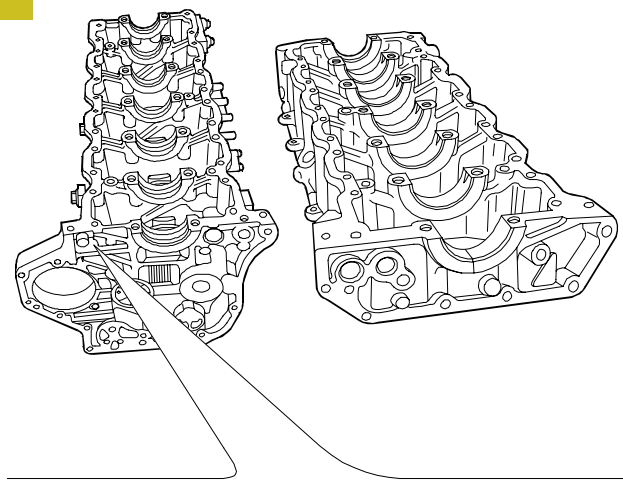
- ❑ Determine the class of diameter of the seat in the connecting rod.
- ❑ Determine the class of diameter of the crankpin.
- ❑ Select the class of the bearing shells to mount.

DEFINING THE CLASS OF DIAMETER OF THE SEATS FOR BEARING SHELLS ON THE CRANKCASE

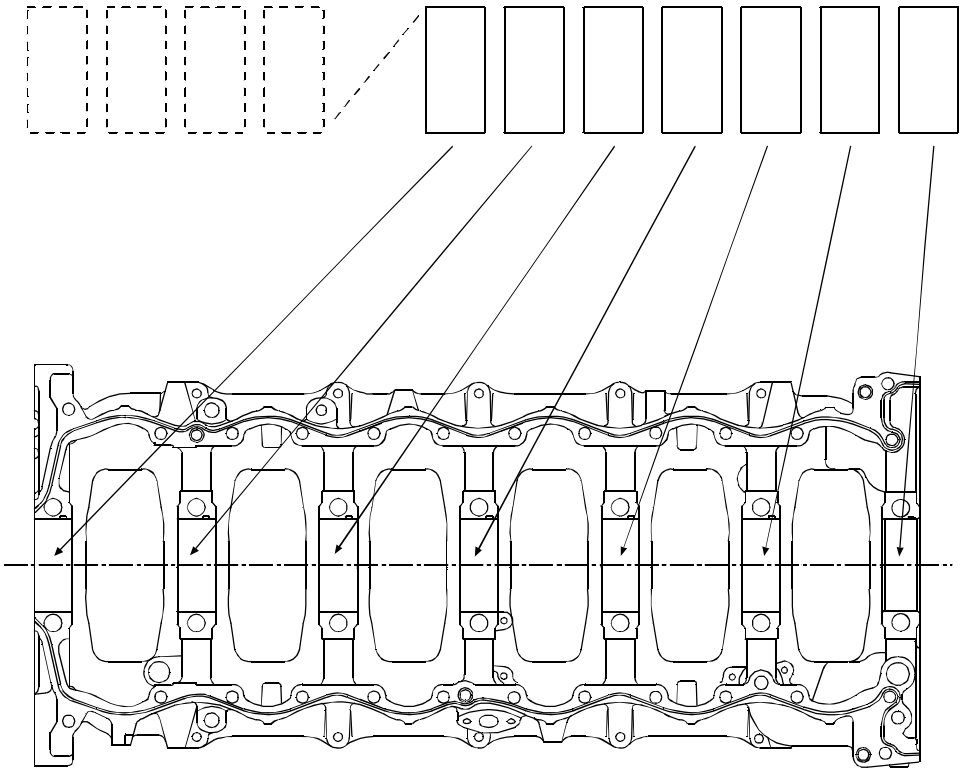
On the front of the crankcase, two sets of numbers are marked in the position shown (Figure 67 at top).

- ❑ The first set of digits (four) is the coupling number of the crankcase with its base.
- ❑ The following seven digits, taken singly, are the class of diameter of each of the seats referred to (Figure 67 at bottom).
- ❑ Each of these digits may be **1**, **2** or **3**.

Figure 67



CLASS	MAIN BEARING HOUSING NOMINAL DIAMETER
1	89.000 to 89.009
2	89.010 to 89.019
3	89.020 to 89.030



47535

Selecting the main and big end bearing shells

To obtain the required assembly clearances, the main and big end bearing shells need to be selected as described hereunder.

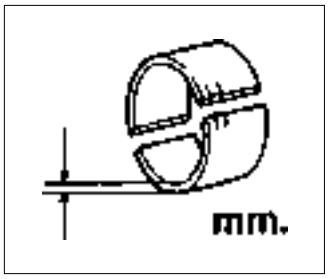
This operation makes it possible to identify the most suitable bearing shells for each of the journals (the bearing shells, if necessary, can have different classes from one journal to another).

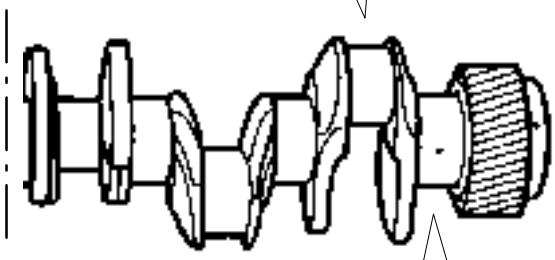
Depending on the thickness, the bearing shells are selected in classes of tolerance marked by a coloured sign (red-green – red/black – green/black).

The following tables give the specifications of the main and big end bearing shells available as spares in the standard sizes (STD) and in the permissible oversizes (+0.127, +0.254, +0.508).

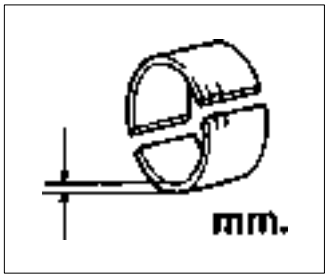
Figure 68

	STD	+0.127	+0.254	+0.508
red	2.000 to 2.010		2.127 to 2.137	2.254 to 2.264
red/black		2.063 to 2.073		
green	2.011 to 2.020		2.138 to 2.147	2.265 to 2.274
green/black		2.074 to 2.083		
yellow*	2.021 to 2.030			
yellow/black*		2.084 to 2.093		





	STD	+0.127	+0.254	+0.508
red	3.000 to 3.010		3.127 to 3.137	2.254 to 3.264
red/black		3.063 to 3.073		
green	3.011 to 3.020			
green/black		3.074 to 3.083		
yellow*	3.021 to 3.030			
yellow/black*		3.084 to 3.093		



* Fitted in production only and not supplied as spares

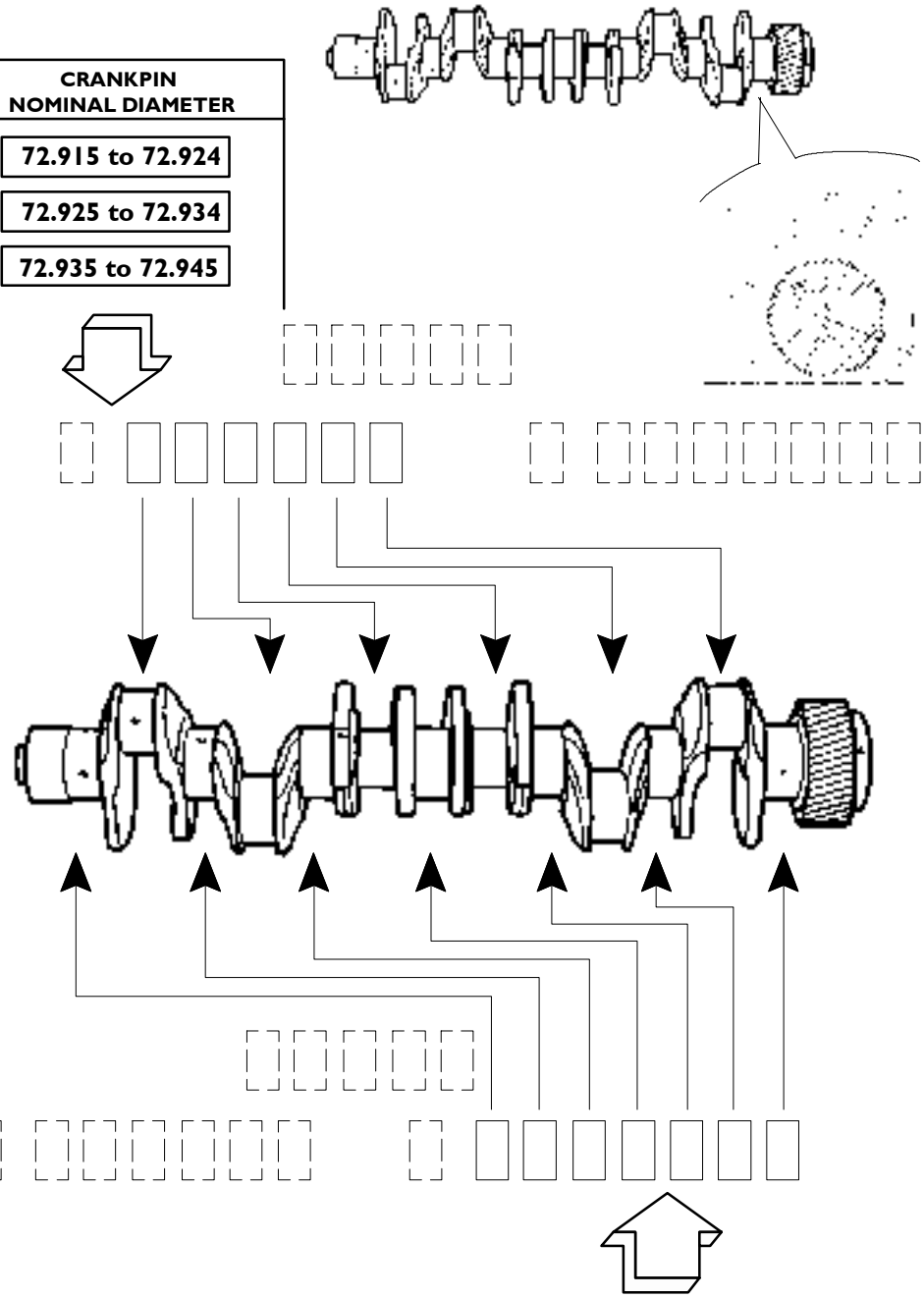
DEFINING THE CLASS OF DIAMETER OF THE MAIN JOURNALS AND CRANKPINS (Journals with nominal diameter)

Main journals and crankpins: determining the class of diameter of the journals.
Three sets of numbers are marked on the crankshaft in the position shown by the arrow (Figure 69 at top):

- The first number, of five digits, is the part number of the shaft.
- Under this number, on the left, a set of six digits refers to the crankpins and is preceded by a single digit showing the status of the journals (1 = STD, 2 = -0.127), the other six digits, taken singly, give the class of diameter of each of the crankpins they refer to (Figure 69 at top).
- The set of seven digits, on the right, refers to the main journals and is preceded by a single digit: the single digit shows the status of the journals (1 = STD, 2 = -0.127), the other seven digits, taken singly, give the class of diameter of each of the main journals they refer to (Figure 69 at bottom).

Figure 69

CLASS	CRANKPIN NOMINAL DIAMETER
1	72.915 to 72.924
2	72.925 to 72.934
3	72.935 to 72.945



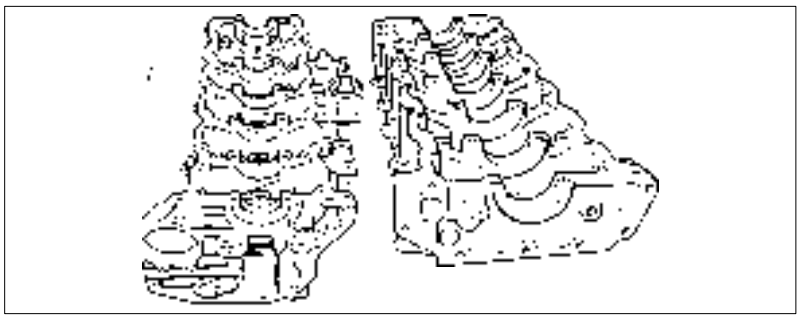
CLASS	MAIN JOURNALS NOMINAL DIAMETER
1	82.910 to 82.919
2	82.920 to 82.929
3	82.930 to 82.940

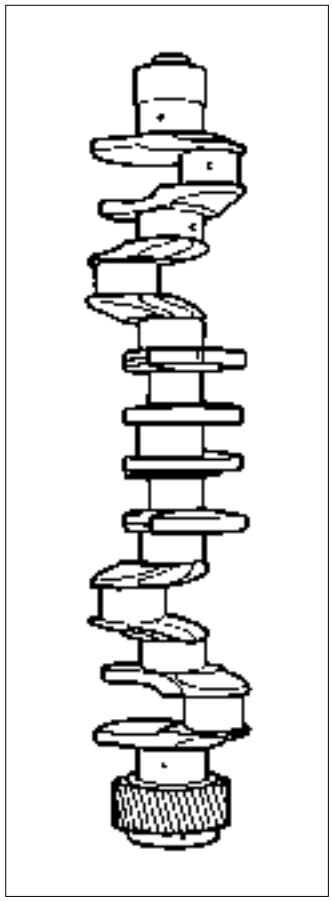
Selection of main half-bearings (nominal diameter pins)

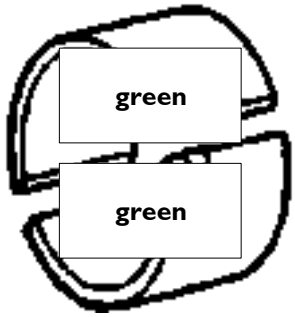
After detecting, for each journal, the necessary data on block and crankshaft, select the type of half-bearings to be used, in compliance with the following table:

Figure 70

STD.



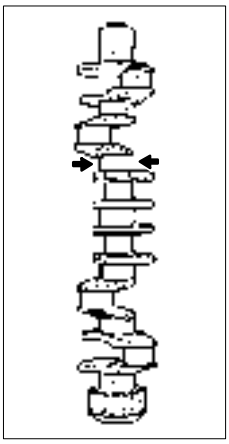
	1	2	3
	1	green green	green green	green green
	2	red red	green green	green green
	3	red red	red red	red red

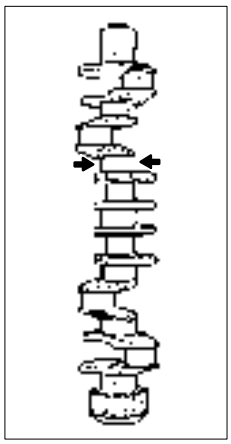


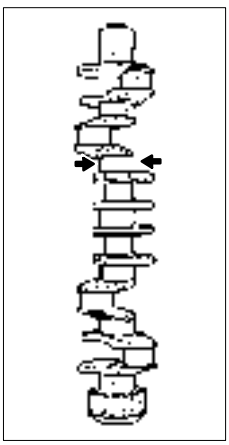
Selection of main half-bearings (rectified pins)

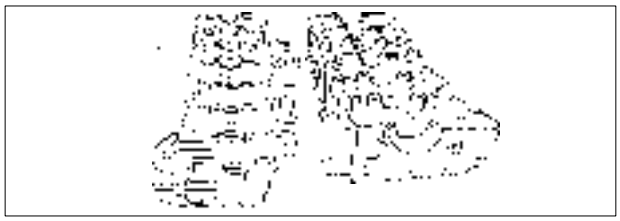
If the journals have been rectified, the procedure described cannot be applied.
In this case, make sure that the new diameter of the journals is as specified on the table and install the only half-bearing type required for this undersizing.

Figure 71









			1	2	3
-0.127	82.784 82.793	1	green/black green/black	green/black green/black	green/black green/black
	82.794 82.803	2	red/black red/black	green/black green/black	green/black green/black
	82.804 82.814	3	red/black red/black	red/black red/black	red/black red/black

red/black = mm 3.063 to 3.073

green/black = mm 3.063 to 3.073

			1	2	3
-0.254	82,666 82,686		red red	red red	red red

red = mm 3.127 to 3.137

			1	2	3
-0.508	82.412 82.432		red red	red red	red red

red = mm 3.254 to 3.264

SELECTING THE BIG END BEARING SHELLS (JOURNALS WITH NOMINAL DIAMETER)

There are three markings on the body of the connecting rod in the position shown in the view from "A":

1 Letter indicating the class of weight:

A = 2890 to 2920 g.
B = 2921 to 2950 g.
C = 2951 to 2980 g.

2 Number indicating the selection of the diameter of the big end bearing seat:

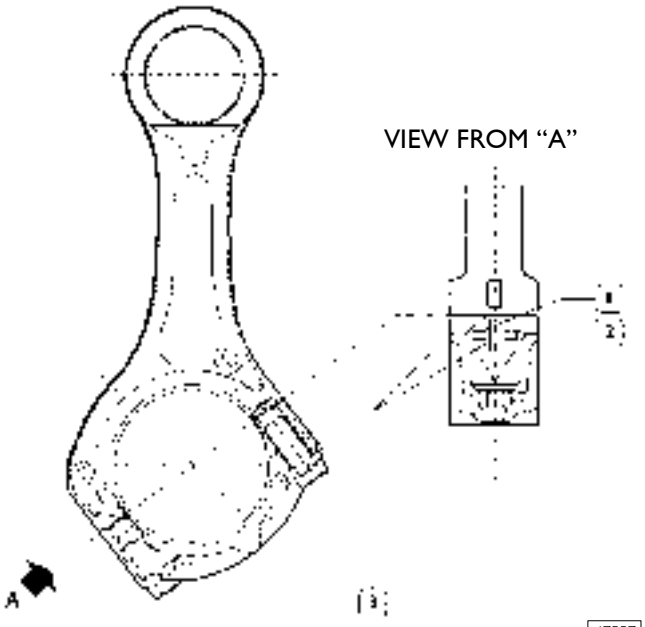
1 = 77.000 to 77.010 mm
2 = 77.011 to 77.020 mm
3 = 77.021 to 77.030 mm

3 Numbers identifying the cap-connecting rod coupling.

The number, indicating the class of diameter of the bearing shell seat may be **1**, **2** o **3**.

Determine the type of big end bearing to fit on each journal by following the indications in the table (Figure 73).

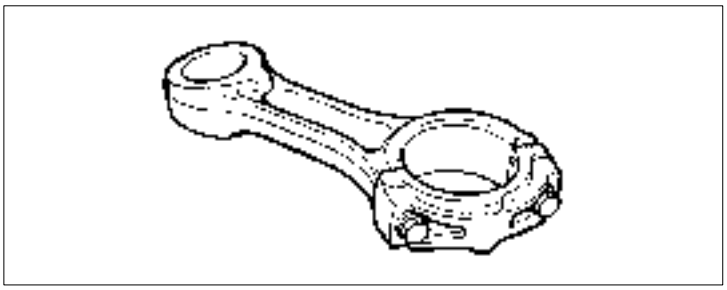
Figure 72

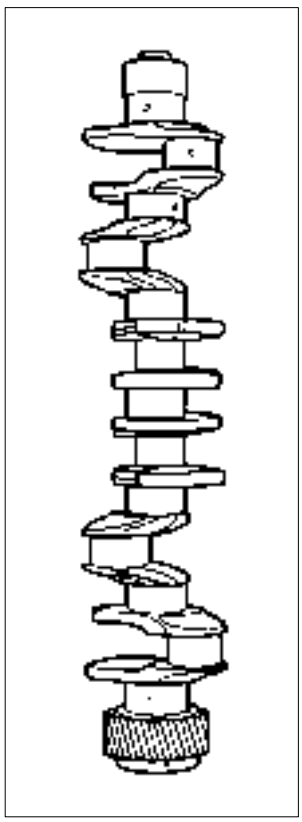


47557

Figure 73

STD.



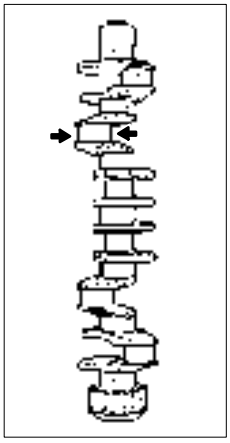


Class	1	2	3
1	green green	green green	green green
2	red red	green green	green green
3	red red	red red	red red

Selection of connecting rod half-bearings (rectified pins)

If pins have been rectified, the procedure described must be applied.
In this case, (for each undersizing) determine the tolerance field the new big end pins belong to, and install the half-bearings identified according to the relative table.

Figure 74

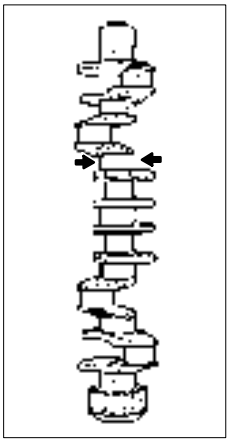


red/black = mm 2.074 to 2.083

green/black = mm 2.063 to 2.073

-0.127

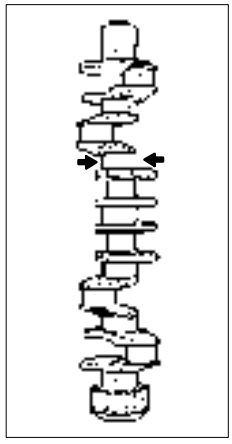
		1	2	3
72.789 72.798	1	green/black	green/black	green/black
		green/black	green/black	green/black
72.799 72.808	2	red/black	green/black	green/black
		red/black	green/black	green/black
72.809 72.818	3	red/black	red/black	green/black
		red/black	red/black	green/black



-0.254

red mm 2.127 to 2.137
green = mm 2.138 to 2.147

	1	2	3
72.671 72.680	red	green	green
	red	green	green
72.681 72.691	red	red	green
	red	red	green



-0.508

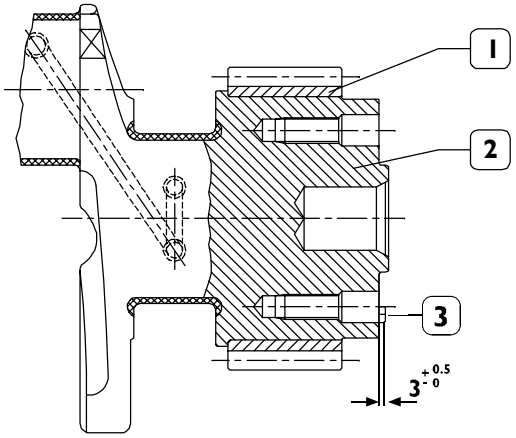
red = mm 2.254 to 2.264
green = mm 2.265 to 2.274

	1	2	3
72.417 72.426	red	green	green
	red	green	green
72.427 72.437	red	red	green
	red	red	green

540815 Replacing the timing control gear and the oil pump

Check that the teeth of the gears are not damaged or worn, otherwise remove them using the appropriate extractor.

Figure 75



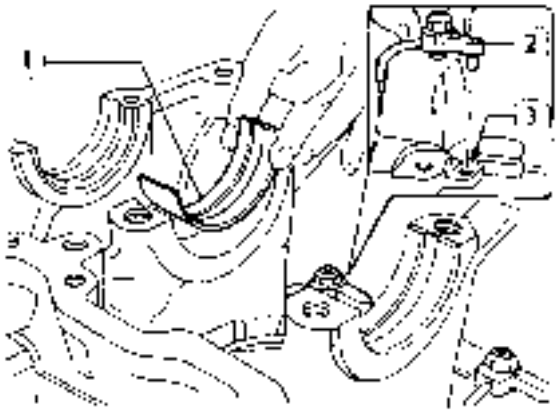
49020

After fitting the gear (1) on the crankshaft (2), heat it for ~15 minutes in an oven at temperature not higher than 180°C.
Let them cool down after the installation.

If changing the pin (3), after fitting it on, check it protrudes from the crankshaft as shown in the figure.

540811 Checking main journal installation clearance

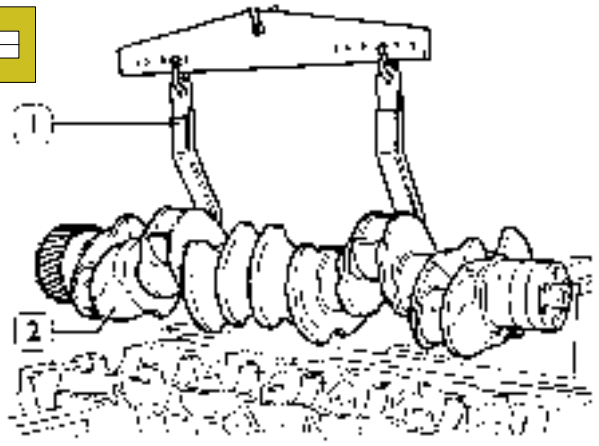
Figure 76



47579

Install the oil spray nozzles (2) and have the dowel coincide with the block hole (3).
Install the half-bearings (1) on the main bearings.

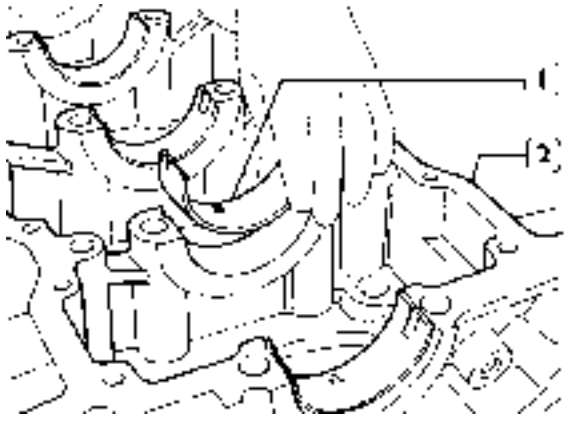
Figure 77



47578

Using the hoist and hook 99360500 (1) mount the driving shaft (2).

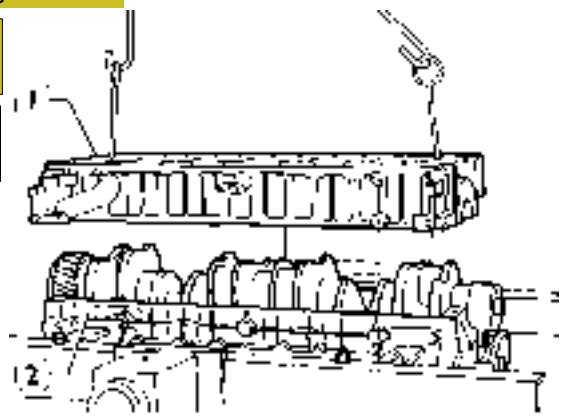
Figure 78



49021

Install the half-bearings (1) on the main bearings in the underblock (2).
Check the installation clearance between the main journals and the relative bearings as follows:

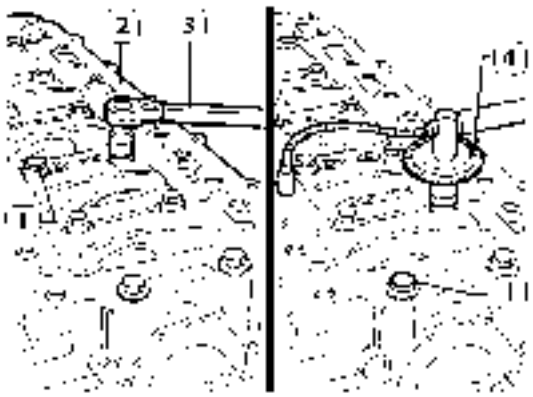
Figure 79



49022

Place a piece of calibrated wire on the journal of the crankshaft (2), parallel to the longitudinal axis; install the underblock (1), by hoist and appropriate hooks.

Figure 80

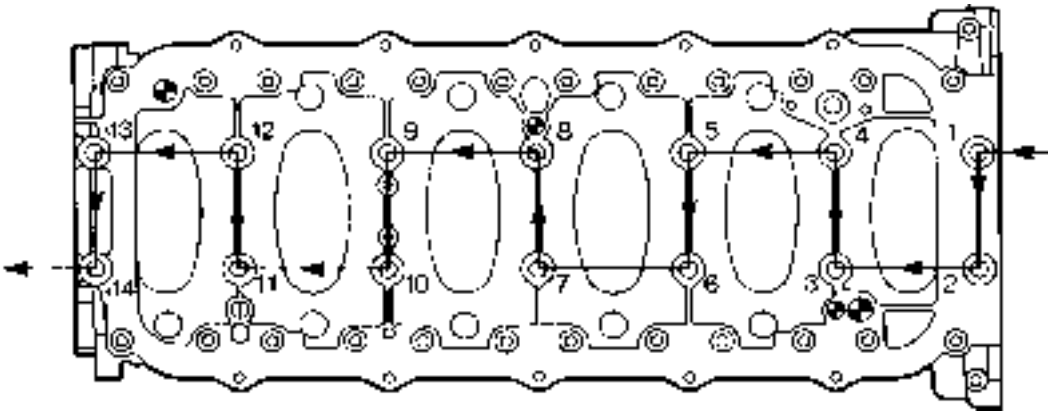


47578

❑ Lubricate inside screws (1) con UTDM oil, and tighten them by dynamometric wrench to 140 Nm torque, thus with 60° angle closing, following the diagram in Figure 81.

Figure 81

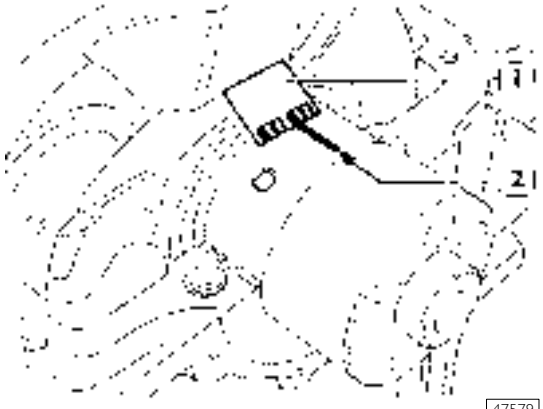
FRONT SIDE



44898

Diagram showing the tightening order of the screws fixing the lower under-block to the block

Figure 82



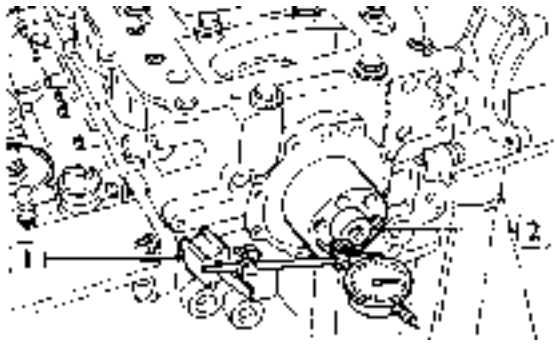
47579

❑ Remove the under-block

The clearance between the main bearings and the journals is obtained by comparing the calibrated wire length (2) at the maximum deflection point, with the calibrated scale on the coating (1) containing the calibrated wire (1).
Numbers shown on the scale specify the clearance in coupling millimeters. If the clearance obtained is different from the clearance required, replace the half-bearings and repeat this check.

Checking crankshaft end float

Figure 83

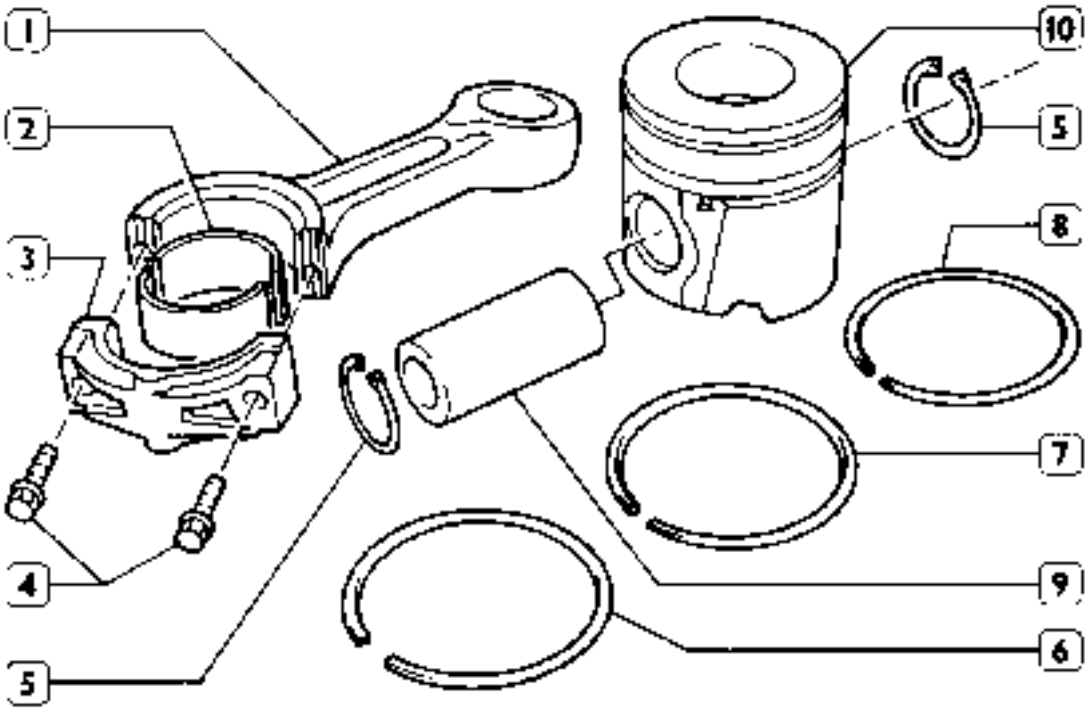


47588

End float is checked by placing a magnetic dial gauge (1) on the crankshaft (2), as shown in the figure. If the value obtained is higher than specified, replace the rear thrust half-bearings and repeat this check.

5408 PISTON-CONNECTING ROD ASSEMBLY

Figure 84



PISTON CONNECTING ROD ASSEMBLY

1. Connecting rod body - 2. Half bearings - 3. Connecting rod cap - 4. Cap fastening screws - 5. Split ring - 6. Scraper ring with spiral spring - 7. Bevel cut sealing ring - 8. Trapezoidal sealing ring - 9. Piston pin - 10. Piston

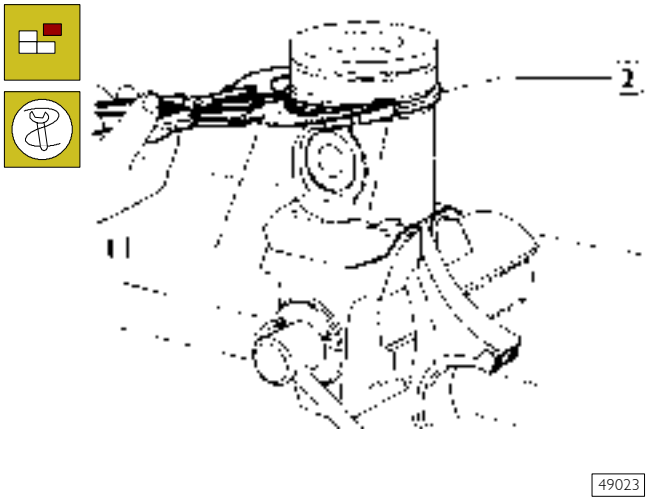
Make sure the piston does show any trace of seizing, scoring, cracking; replace as necessary.

Pistons are equipped with three elastic rings: a sealing ring, a trapezoidal ring and a scraper ring.

Pistons are grouped into classes A and B for diameter.

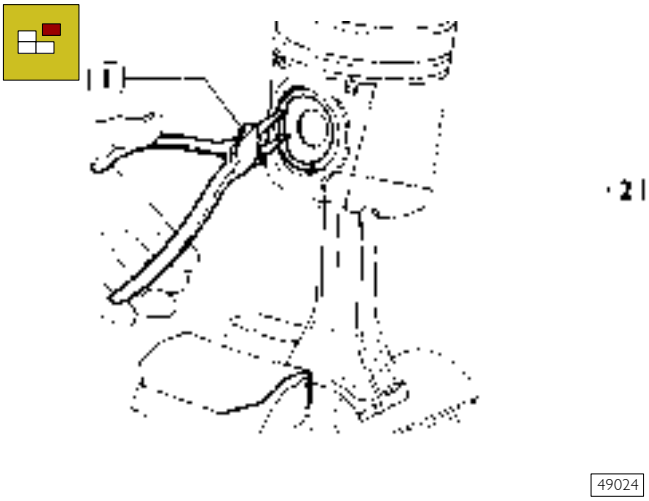
Removal

Figure 85



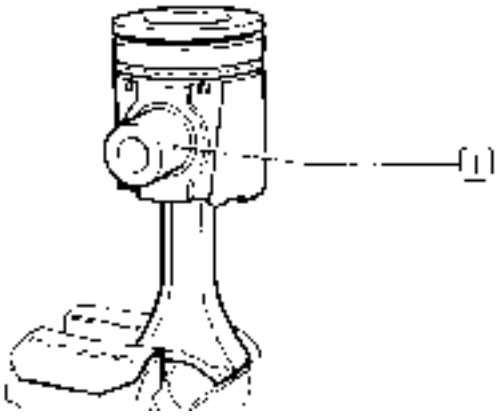
Removal of the piston split rings (2) using the pliers 99360184 (1).

Figure 86



Remove the piston pin split rings (2) using the round tipped pliers (1).

Figure 87

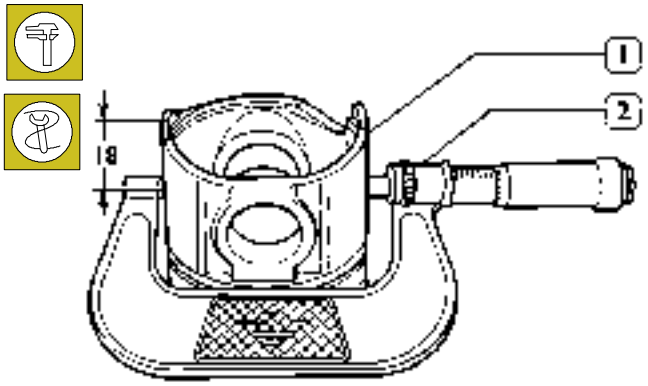


49025

Remove the piston pin (1).
If removal is difficult use the appropriate beater.

Measuring the diameter of the pistons

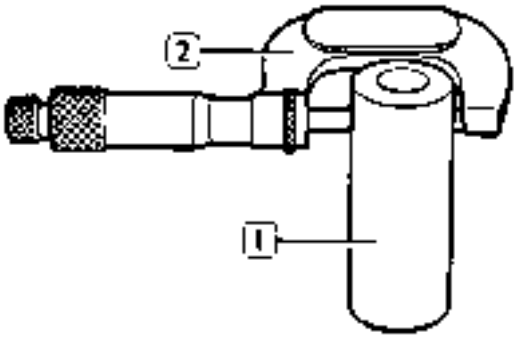
Figure 88



47584

Using a micrometer (2), measure the diameter of the piston (1) to determine the assembly clearance; the diameter should be measured at the specified value.

Figure 89

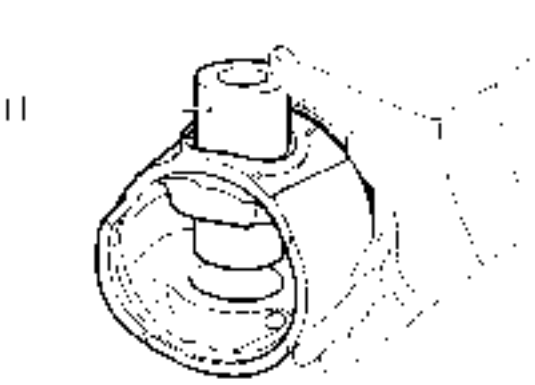


32618

Measuring the gudgeon pin diameter (1) with a micrometer (2).

Conditions for correct gudgeon pin-piston coupling

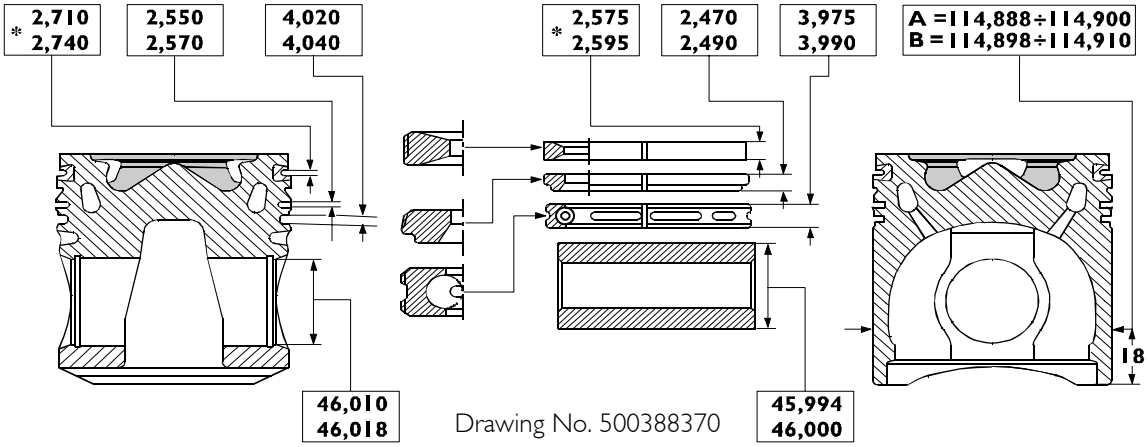
Figure 90



49026

Lubricate the pin (1) and the relevant housing on the piston hubs with engine oil; piston must be inserted with a slight finger pressure and it should not come out by gravity.

Figure 91



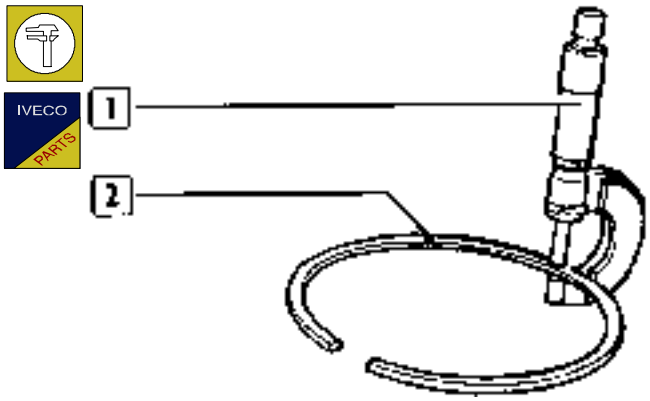
77816

MAIN DATA ON PISTONS, AND PISTONS RINGS

* Values are determined on ∅ of 112 mm.

540842 Piston rings

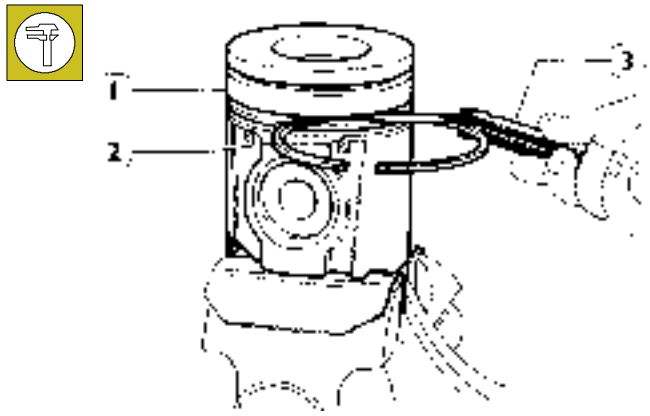
Figure 92



16552

Check the thickness of the piston ring (2) using a micrometer (1).

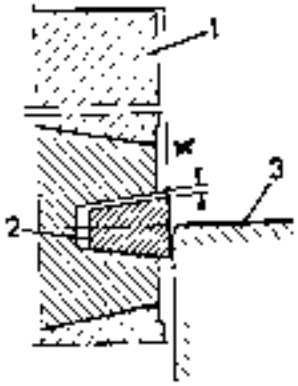
Figure 93



16552

Check the clearance between the sealing rings (2) and the relative piston housings (1) using a thikness gauge (3).

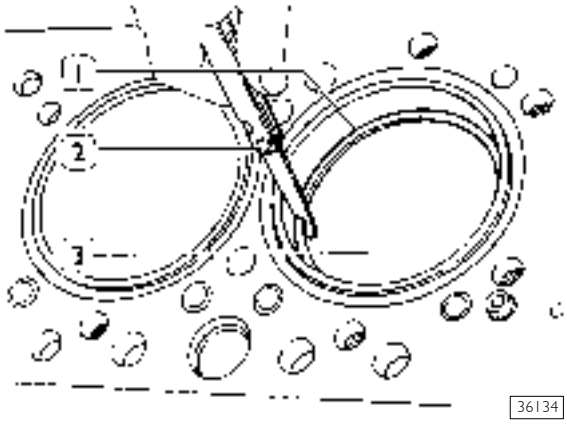
Figure 94



3513

The sealing ring (2) of the 1° cavity is trapezoidal. Clearance "X" between the sealing ring and its housing is measured by placing the piston (1) with its ring in the cylinder barrel (3), so that the sealing ring is half-projected out of the cylinder barrel.

Figure 95



36134

Check the opening between the ends of the sealing rings (1), using a thickness gauge (2), entered in the cylinder barrel (3). If the distance between ends is lower or higher than the value required, replace split rings.

540830 CONNECTING ROD

Figure 96

Data concerning the class section of connecting rod housing and weight are stamped on the big end.

When installing connecting rods, make sure they all belong to the same weight class.

DIAGRAM CONNECTING ROD MARKS

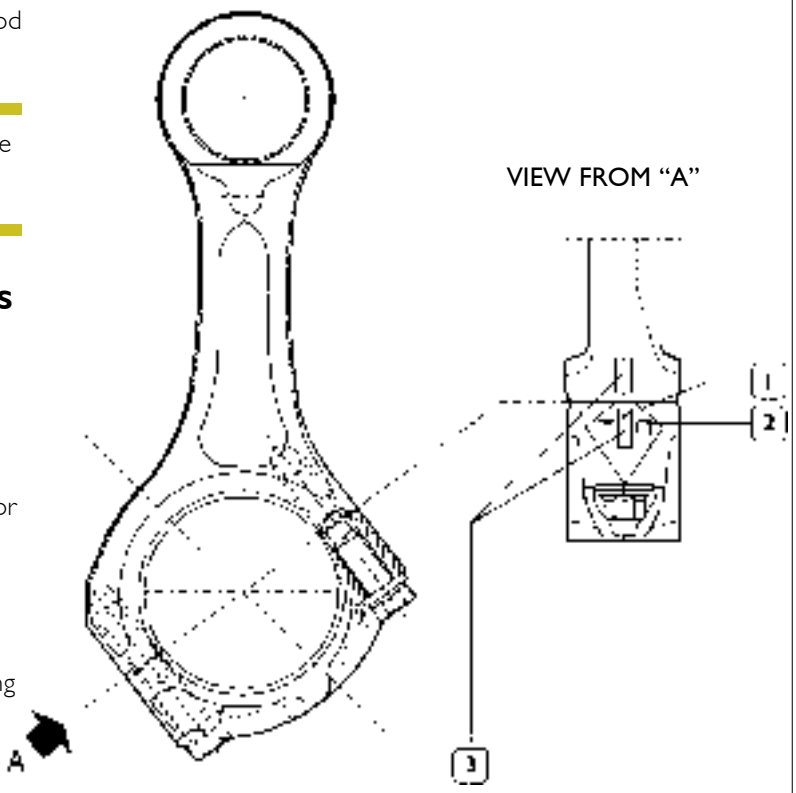
1 Letter indicating the weight class:

A = 2890 to 2920 g.
B = 2921 to 2950 g.
C = 2951 to 2980 g.

2 Number indicating the selection of diameter for the big end bearing housing:

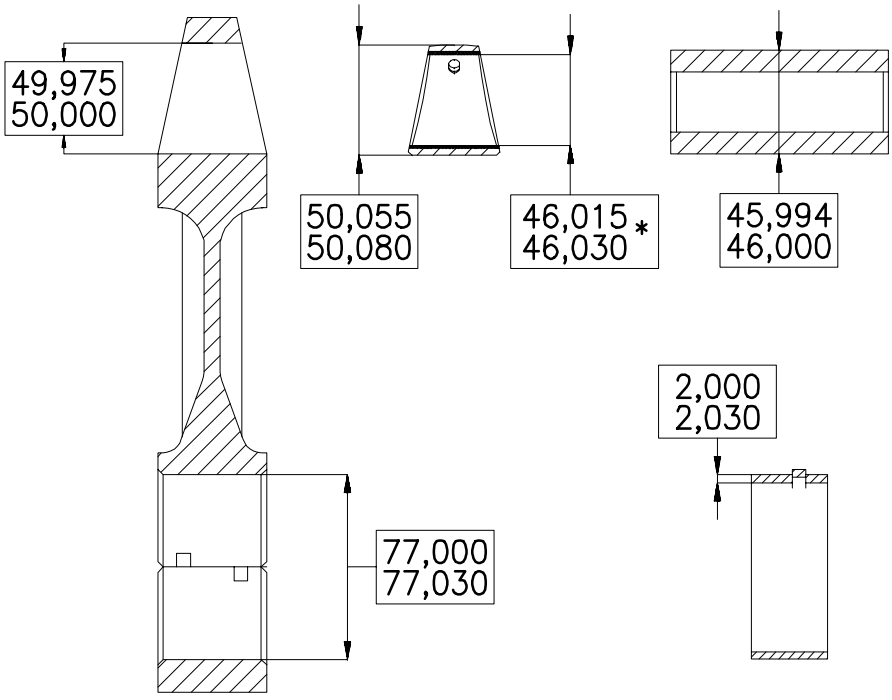
1 = 77.000 to 77.010 mm
2 = 77.011 to 77.020 mm
3 = 77.021 to 77.030 mm

3 Numbers identifying cap-connecting rod coupling



47557

Figure 97

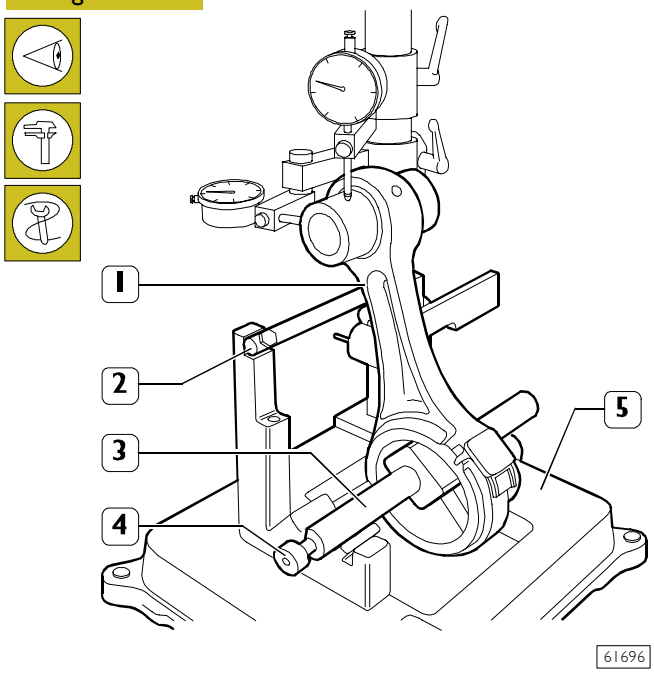


44927

MAIN DATA - BUSH, CONNECTING ROD, PIN AND HALF-BEARINGS
* Values to be obtained after installing the bush

Checking connecting rod alignment

Figure 98



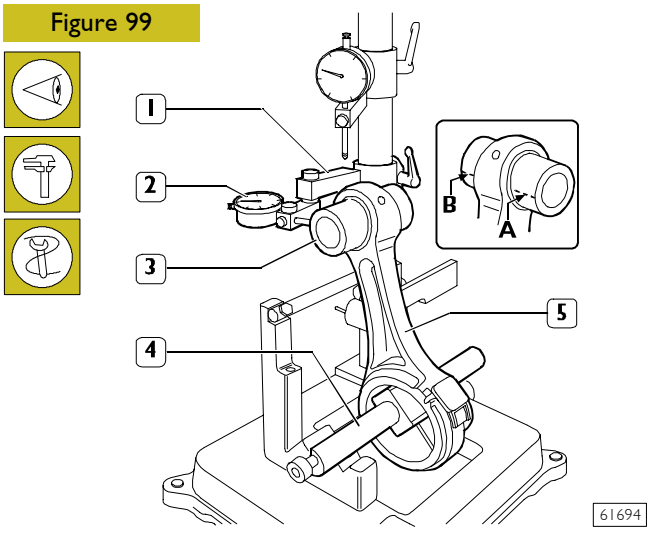
Checking axis alignment

Check the alignment of the axes of the connecting rods (1) with device 99395363 (5), proceeding as follows:

- ❑ Fit the connecting rod (1) on the spindle of the tool 99395363 (5) and lock it with the screw (4).
- ❑ Set the spindle (3) on the V-prisms, resting the connecting rod (1) on the stop bar (2).

Checking torsion

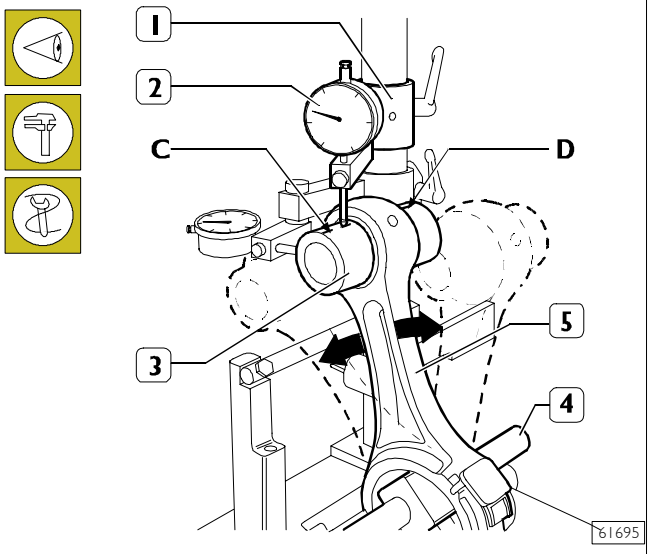
Figure 99



Check the torsion of the connecting rod (5) by comparing two points (**A** and **B**) of the pin (3) on the horizontal plane of the axis of the connecting rod.
Position the mount (1) of the dial gauge (2) so that this pre-loads by approx. 0.5 mm on the pin (3) at point **A** and zero the dial gauge (2). Shift the spindle (4) with the connecting rod (5) and compare any deviation on the opposite side **B** of the pin (3): the difference between **A** and **B** must be no greater than 0.08 mm.

Checking bending

Figure 100



Check the bending of the connecting rod (5) by comparing two points **C** and **D** of the pin (3) on the vertical plane of the axis of the connecting rod.
Position the vertical mount (1) of the dial gauge (2) so that this rests on the pin (3) at point **C**.
Swing the connecting rod backwards and forwards seeking the highest position of the pin and in this condition zero the dial gauge (2).
Shift the spindle (4) with the connecting rod (5) and repeat the check on the highest point on the opposite side **D** of the pin (3). The difference between point **C** and point **D** must be no greater than 0.08 mm.

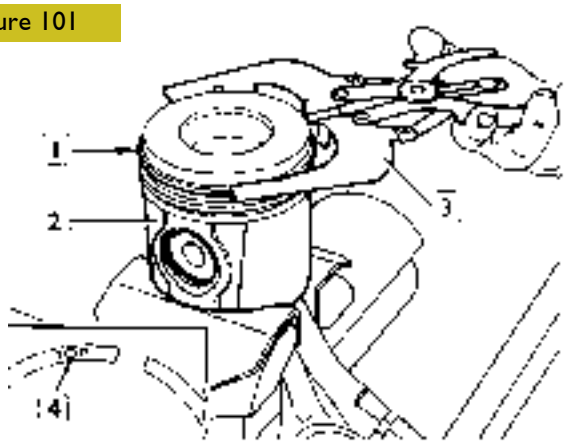
Mounting the connecting rod - piston assembly

Carry out the steps for removal described on page 61 in reverse order.

The connecting rod screws can be reused as long as the diameter of the thread is not less than 13.4 mm.

Mounting the piston rings

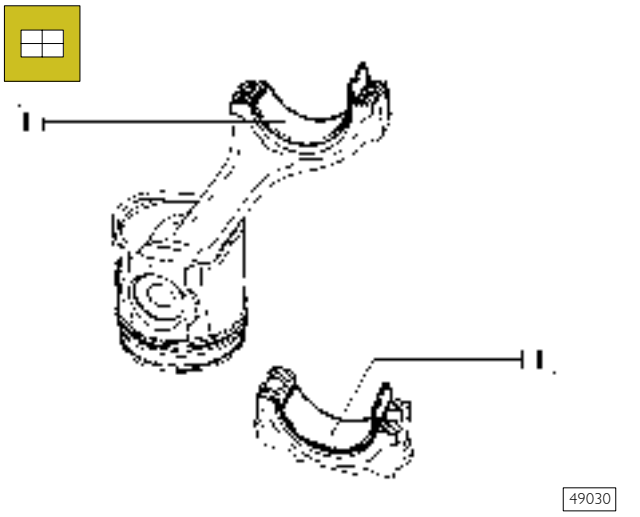
Figure 101



To fit the piston rings (1) on the piston (2) use the pliers 99360184 (3).
The rings need to be mounted with the word "TOP" (4) facing upwards. Direct the ring openings so they are staggered 120° apart.

Fitting the connecting rod-piston assembly into the piston liners

Figure 102



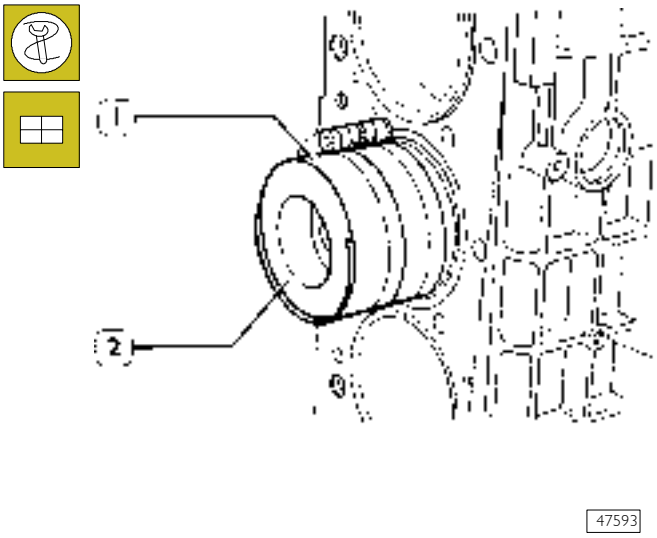
Install half-bearings (1), selected as specified on page 66, on both the connecting rod and the cap.

As spares, class A pistons are provided and can be fitted also to cylinder barrels belonging to class B.

Fit the connecting rod-piston assemblies (1) into the piston liners (2) using band 99360605 (1, Figure 104). Check the following:

- ❑ the openings of the split rings are offset by 120°;
- ❑ all pistons belong to the same class, A or B;
- ❑ ideogram stamped on the piston crown is placed toward the engine flywheel, or the cavity, on the piston cover, corresponds to the position of the oil spray nozzles.

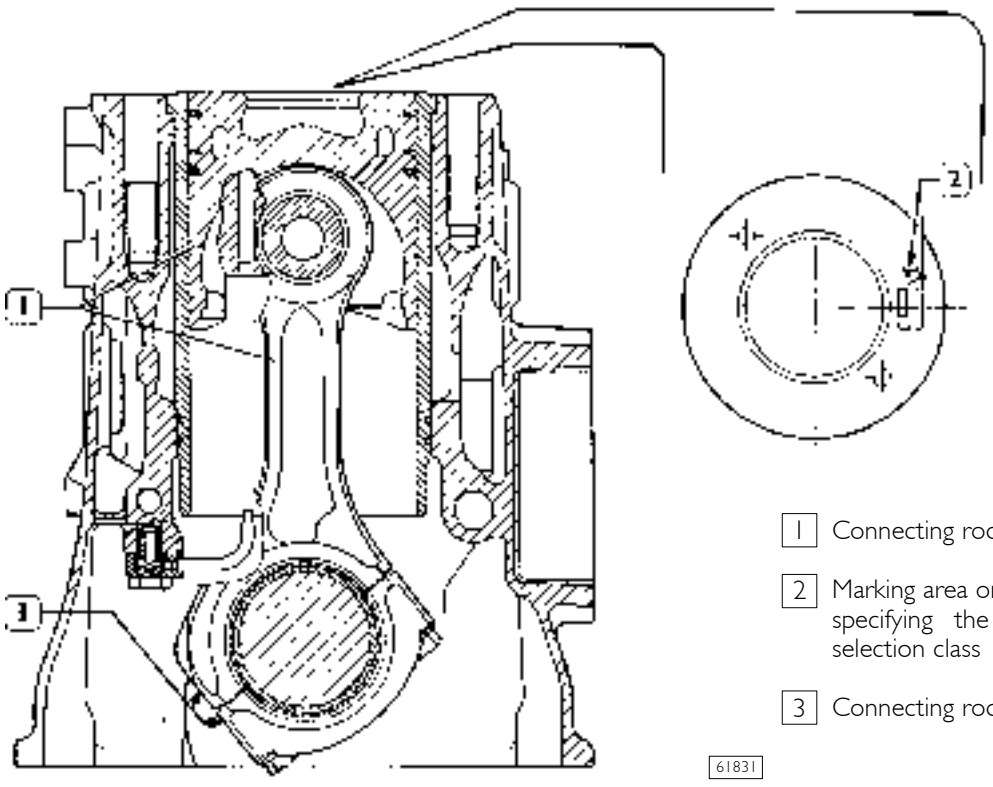
Figure 104



Piston protrusion check

Once assembly is complete, check piston protrusion from cylinder barrels: it must be 0.32-0.69 mm.

Figure 103



1 Connecting rod-piston assembly

2 Marking area on the piston crown of ideogram specifying the assembly position and the selection class

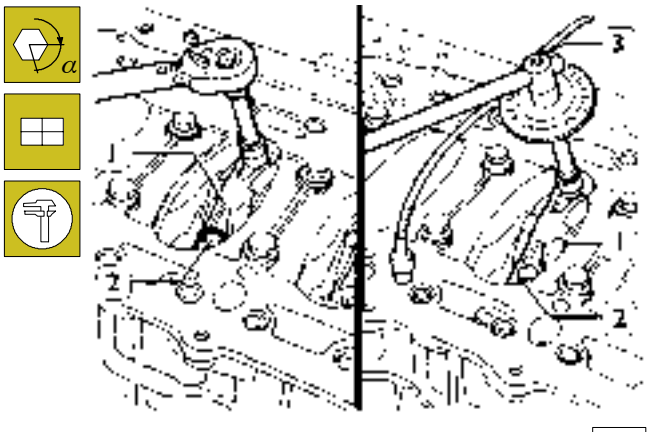
3 Connecting rod marking area (see fig. 96).

540831 Checking assembly clearance of big end pins

To check the clearance proceed as follows:

Connect the connecting rods to the relative main journals, place a length of calibrated wire on the latter.

Figure 105



47594

Install the connecting rod caps (1) with half-bearings; tighten the connecting rod cap fixing screws (2) to 50 Nm (5 kgm) torque. By tool 99395216 (3), tighten the screws further at 40° angle.

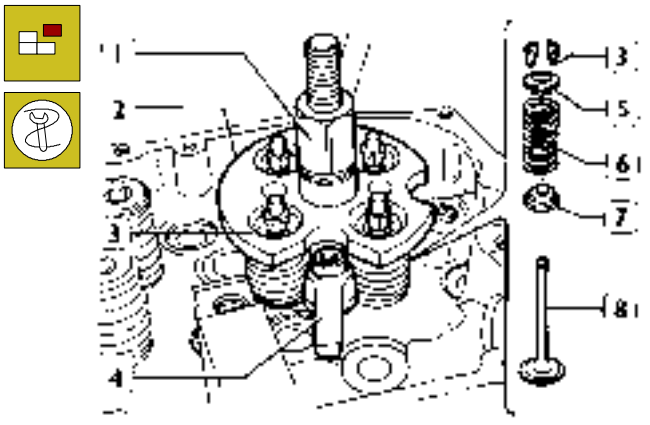
Remove the caps and check the clearance by comparing the width of the calibrated wire with the scale calibration on the envelope containing the wire.

540610 CYLINDER HEAD

Before taking down the cylinder head, check the seal using the appropriate tool; in case of leakage replace the cylinder head.

Valve removal

Figure 106

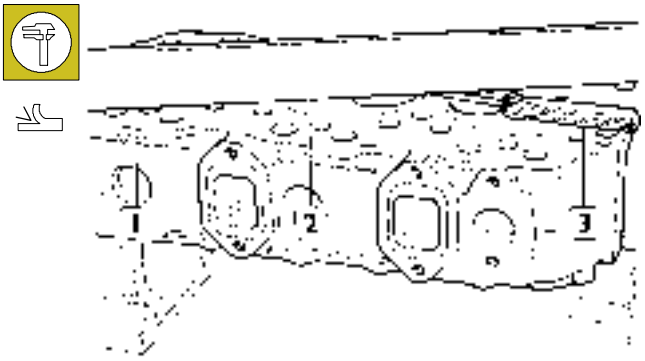


47583

Install and fix tool 99360264 (2) with bracket (4); tighten by lever (1) until cotters are removed (3); remove the tool (2) and the upper plate (5), the spring (6) and the lower plate (7). Repeat the operation on all the valves. Turn the cylinder head upside down and remove the valves (8).

Checking the planarity of the head on the cylinder block

Figure 107 (Demonstration)



36159

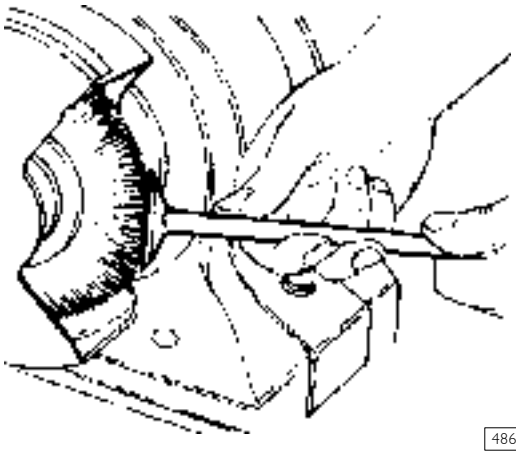
The planarity (1) is checked using a ruler (2) and a thikness gauge (3). If deformations exist, surface the head using proper surface grinder; the maximum amount of material to be removed is 0.2 mm.

After leveling, make sure that valve sinking and injector protrusion are as described in the relative paragraph.

540622 VALVE

Removing deposits and checking the valves

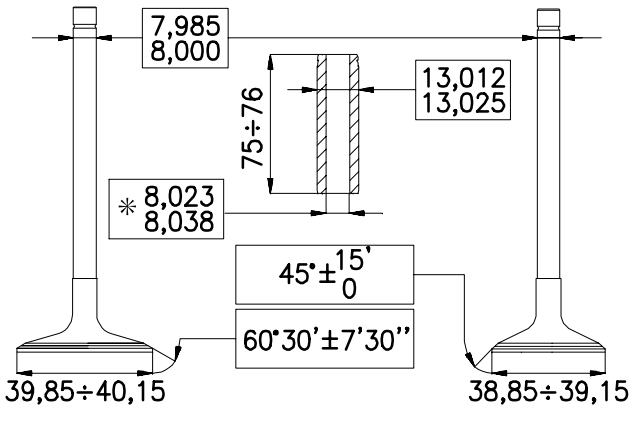
Figure 108



48625

Remove carbon deposits using the metal brush supplied. Check that the valves show no signs of seizure or cracking. Check the diameter of the valve stem using a micrometer (see fig. 109) and replace if necessary.

Figure 109



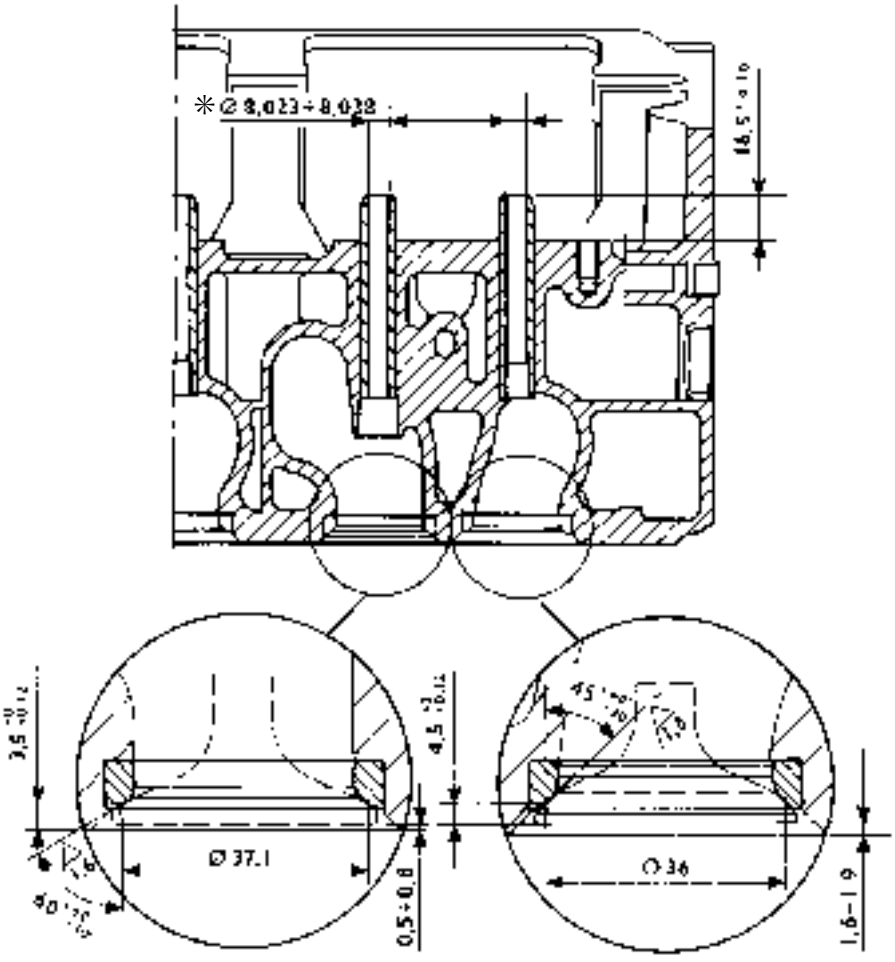
MAIN DATA - VALVES AND VALVE GUIDES

* Values to be obtained after installing the valve guides

Check, by means of a micrometer, that valve stem diameters are as specified; if necessary, grind the valves seat with a grinder, removing the minimum quantity of material.

540667 VALVE GUIDES

Figure 110



INSTALLATION DIAGRAM FOR VALVE GUIDES AND VALVES

* Values to be obtained after installing the guide valves

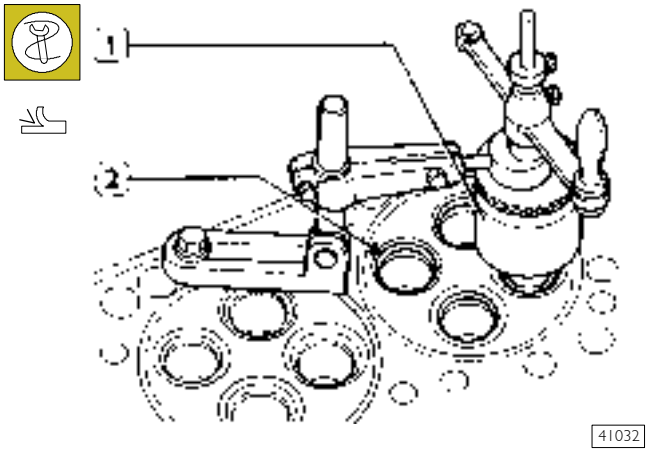
Replacing of valve guides

Remove valve guides by means of tool 99360288.
Install by means of tool 99360288 equipped with part 99360294, which determines the exact installation position of valve guides into the cylinder heads; if they are not available, install the valve guides in the cylinder head so that they project out by mm 16.3 to 16.7 (fig. 110).
After installing the valve guides, smooth their holes with sleeker 99390310.

Replacing - Reaming the valve seats

To replace the valve seats, remove them using the appropriate tool.

Figure 111



Ream the valve seats (2) on cylinder head using tool 99305019 (1).

Valve seats must be reamed whenever valves or valve guides are replaced or ground.

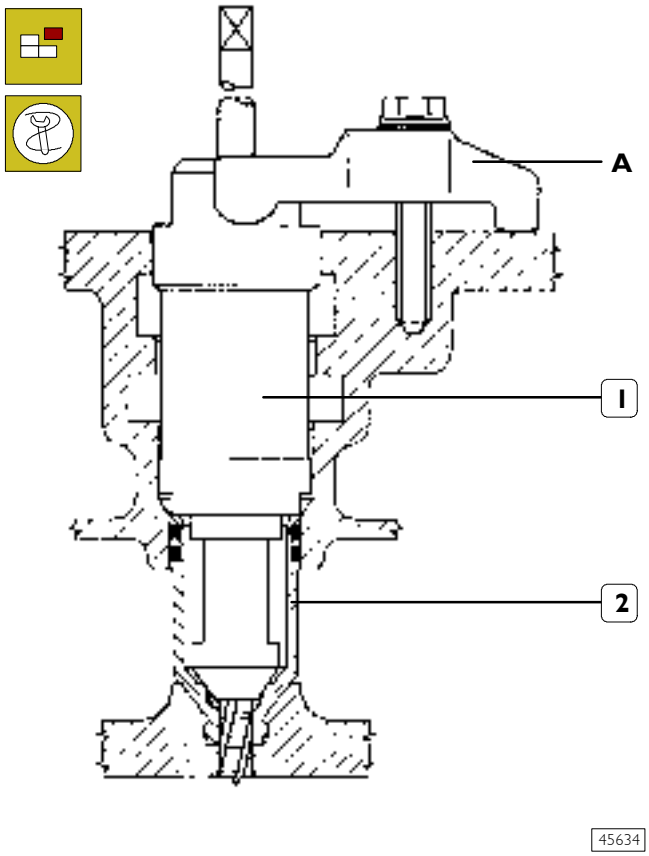
After reaming the valve seats, use tool 99370415, to make sure that the valve position, with respect to the cylinder head surface, is the following:

- -0.5 to -0.8 mm (recessing) of exhaust valves;
- -1.6 to 1.9 mm (recessing) of discharge valves.

540613 REPLACING INJECTOR HOLDER CASES

Removal

Figure 112

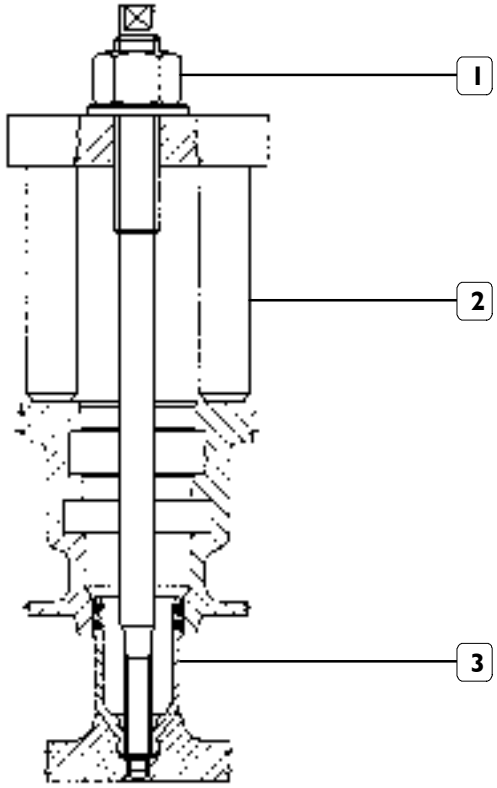


To replace the injector case (2), act as follows:

- thread the case (2) with tool 99390804 (1).

Carry out operations described in figs. 112-115-116-117 by fixing tools to the cylinder head by means of braket A.

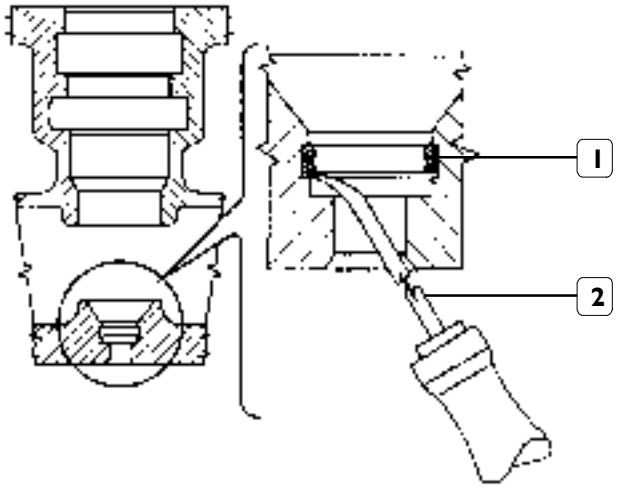
Figure 113



45631

❑ fasten extractor 99342149 (2) to case (3), by tightening the nut (1), and pull out the case from cylinder head.

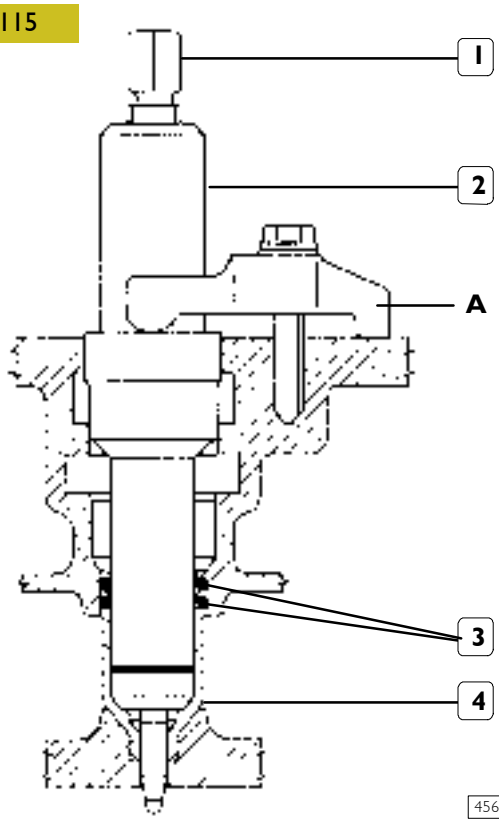
Figure 114



45633

❑ Remove any residue (1), with tool 99390772 (2), from the cylinder head groove.

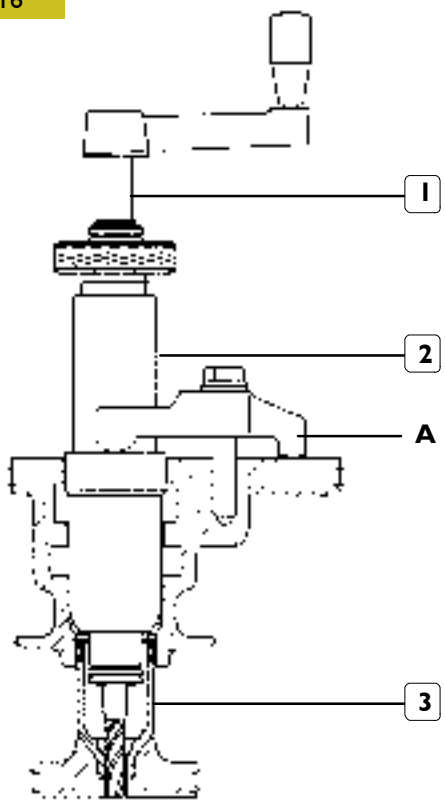
Figure 115



45635

❑ Lubricate sealing rings (3) and fit them to the case (4); fix tool 99360554 (2) to the cylinder head by means of bracket **A**, install the new case, tighten the screw (1), upsetting the case lower part.

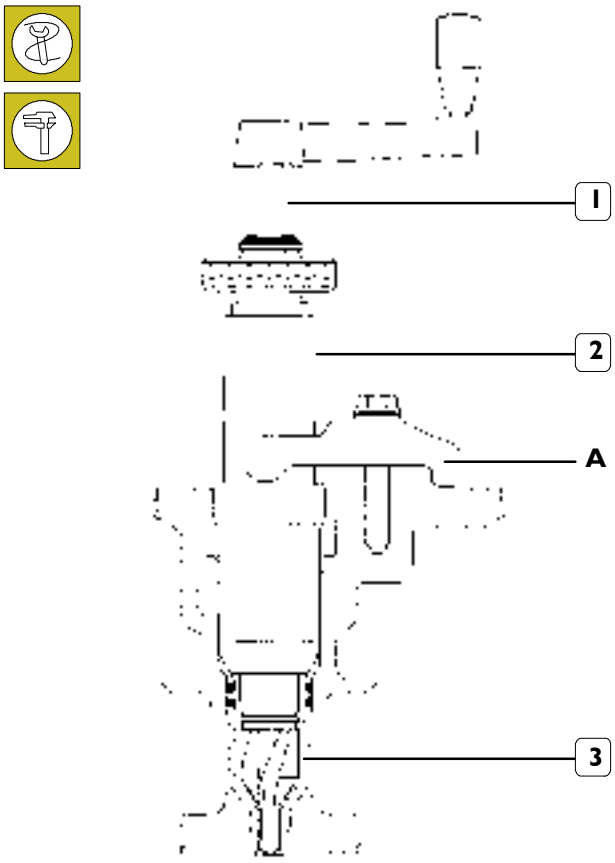
Figure 116



45632

❑ Adjust the casing hole (3) with borer 99394043 (1) and guide bushing 99394014 (2).

Figure 117

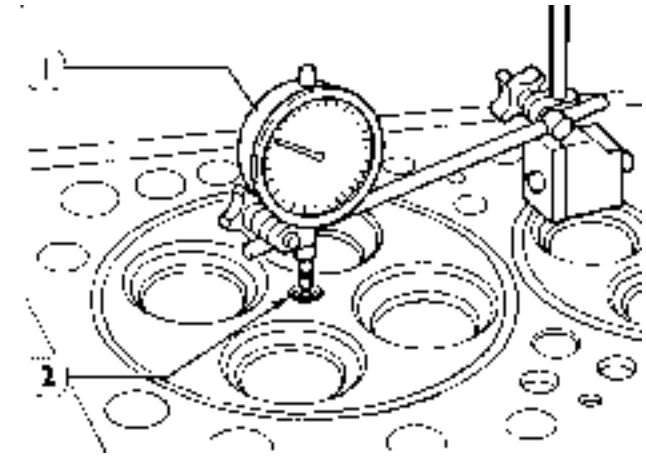


45636

❑ Through miller 99394041 (1) and bushing 99394014 (2), ream the injector seat in the case (3), check the injector protrusion from the cylinder head plane which must be 0.7 mm.

Checking protrusion of injectors

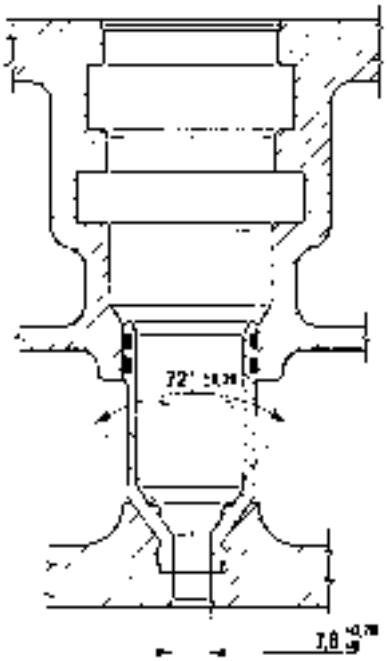
Figure 118



47585

Using dial gauge (1), check the protrusion of the injector (2) which must be 0.7 mm.

Figure 119



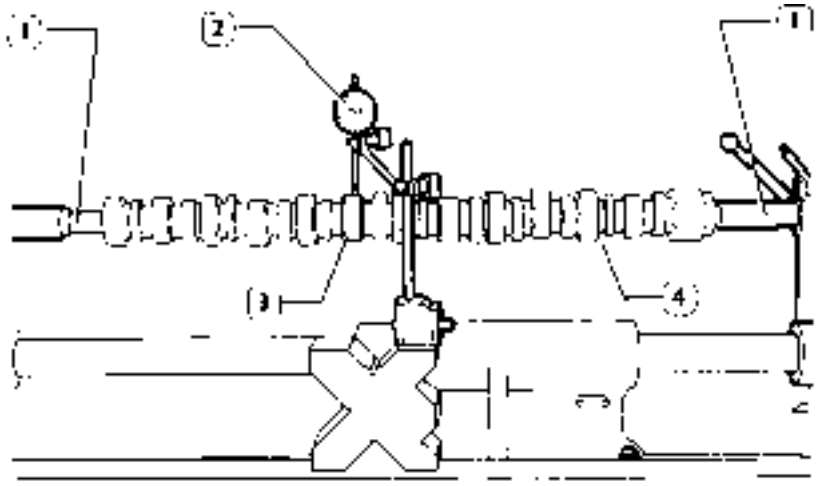
44909

INSTALLATION DIAGRAM FOR INJECTOR CASE

5412 TIMING GEAR

541211 Checking cam lift and pin alignment

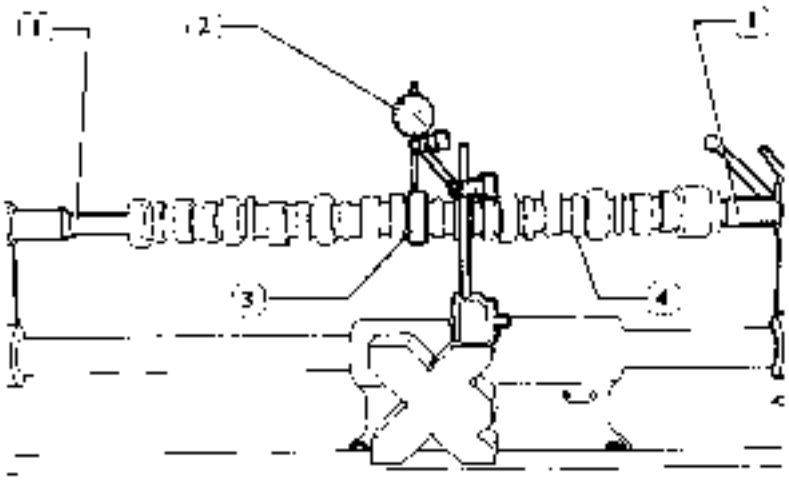
Figure 120



47506

Place the camshaft (4) on the tailstock (1) and check cam lift (3) using a centesimal gauge (2); values are shown in table on page 20.

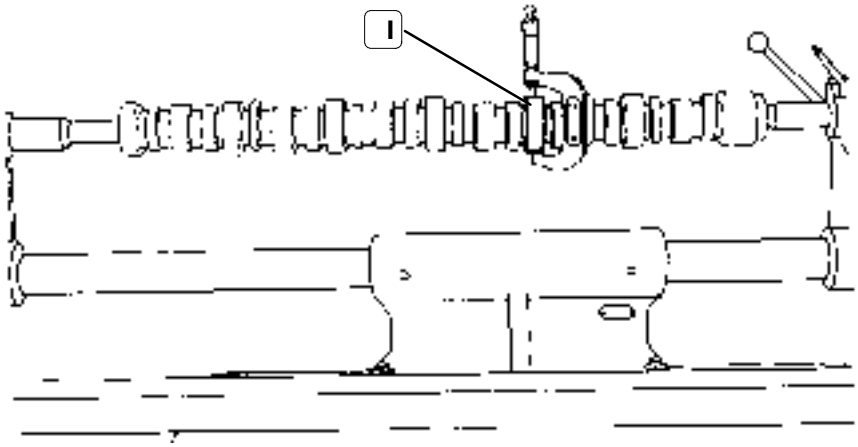
Figure 121



47507

When the camshaft (4) is on the tailstock (1), check alignment of supporting pin (3) using a centesimal gauge (2); it must not exceed 0.030 mm. If misalignment exceeds this value, replace the shaft.

Figure 122

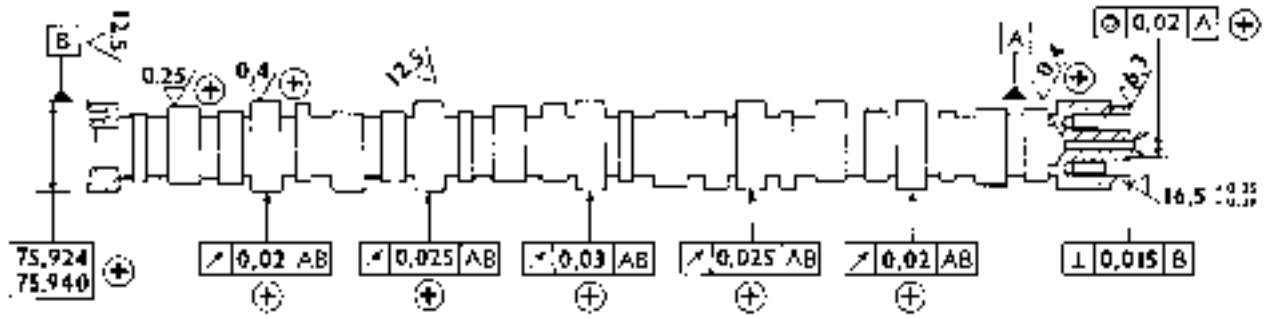


47505

In order to check installation clearance, measure bush inner diameter and camshaft pin (1) diameter; the real clearance is obtained by their difference.
If clearance exceeds 0.150 mm, replace bushes and, if necessary, the camshaft.

541210 Camshaft

Figure 123



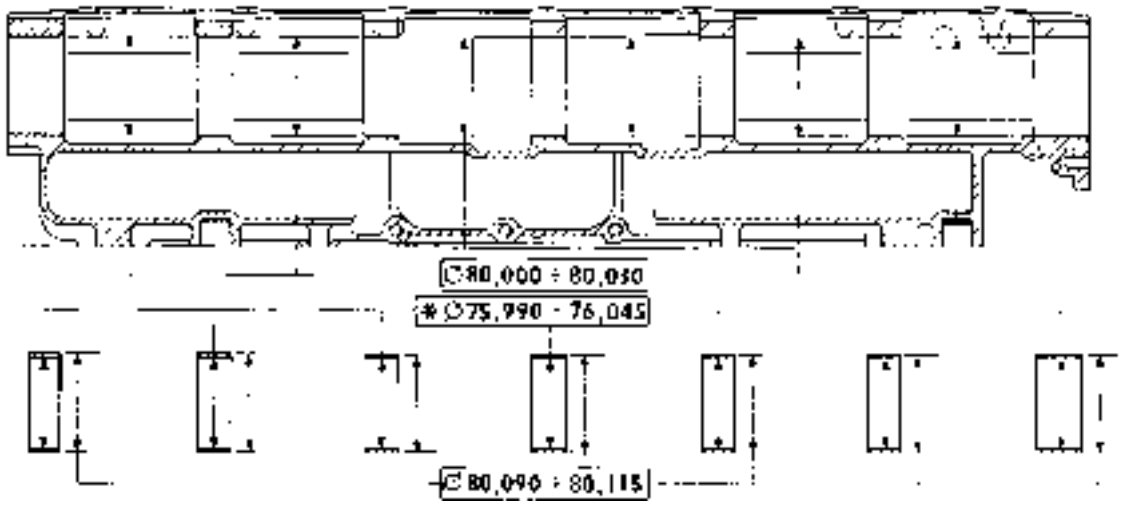
47504

MAIN DATA - CAMSHAFT AND TOLERANCES
The surfaces of shaft supporting pin and cams must be extremely smooth; if you see any sign of seizing or scoring, replace the shaft and the relative bushes.

TOLERANCES	TOLERANCE CHARACTERISTIC	SYMBOL
ORIENTATION	Perpendicularity	⊥
POSITION	Concentricity or coaxial alignment	◎
OSCILLATION	Circular oscillation	↗
IMPORTANCE CLASS ASSIGNED TO PRODUCT CHARACTERISTICS		SYMBOL
CRITICAL		©
IMPORTANT		⊕
SECONDARY		⊖

541213 Bushes

Figure 124



47508

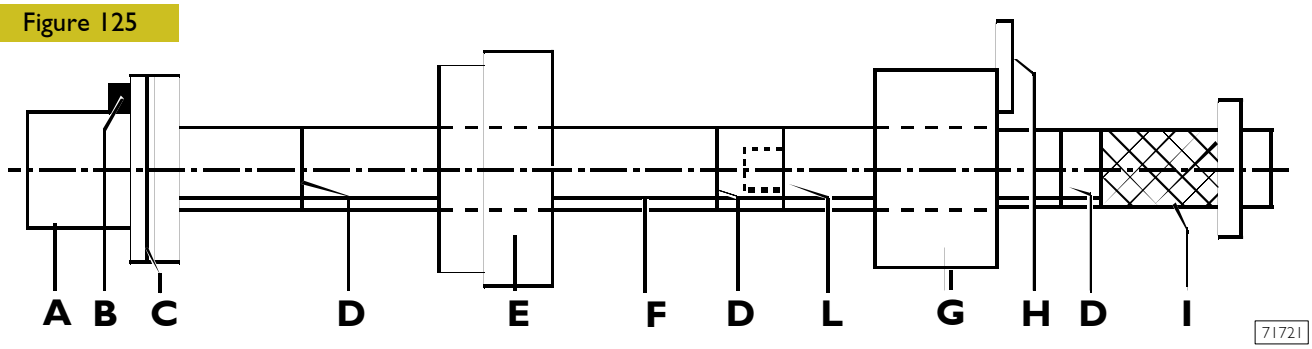
MAIN DATA - CAMSHAFT BUSHES AND RELATIVE BLOCK SEATS
* Bush inner diameter after installation

The bush surfaces must not show any sign of seizing or scoring; if they do replace them.

Measure the bush inner diameters with a baremeter and replace them, if the value measured exceeds the tolerance value.
To take down and fit back the bushes, use the proper tool 99360487.

541213 Replacing camshaft bushes using beater 99360487

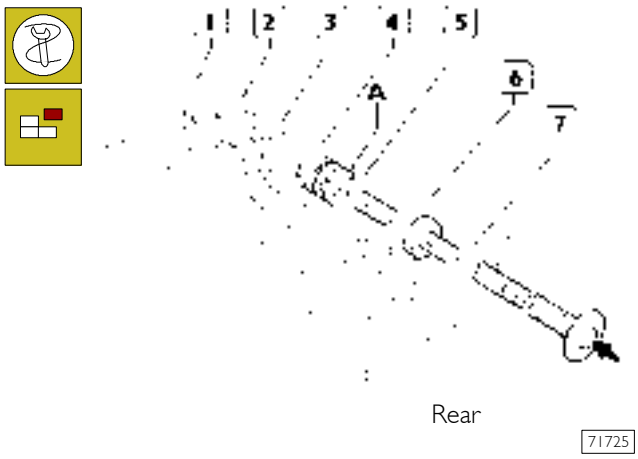
Figure 125



A. Drift with seat for bushings to insert/extract. - B. Grub screw for positioning bushings. - C. Reference mark to insert seventh bushing correctly. - D. Reference mark to insert bushings 1, 2, 3, 4, 5, 6 correctly (red marks). - E. Guide bushing. - F. Guide line. - G. Guide bushing to secure to the seventh bushing mount. - H. Plate fixing yellow bushing to cylinder head. - I. Grip. - L. Extension coupling.

Removal

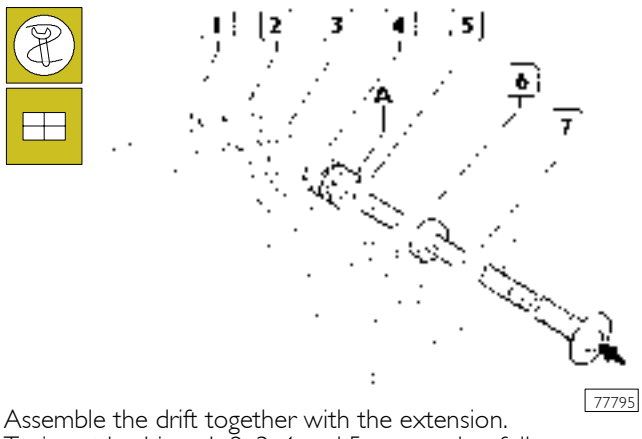
Figure 126



The sequence for removing the bushings is 7, 6, 5, 4, 3, 2, 1.
The bushings are extracted from the front of the single seats.
Removal does not require the drift extension for bushings 5, 6 and 7 and it is not necessary to use the guide bushing.
For bushings 1, 2, 3 and 4 it is necessary to use the extension and the guide bushings.
Position the drift accurately during the phase of removal.

Assembly

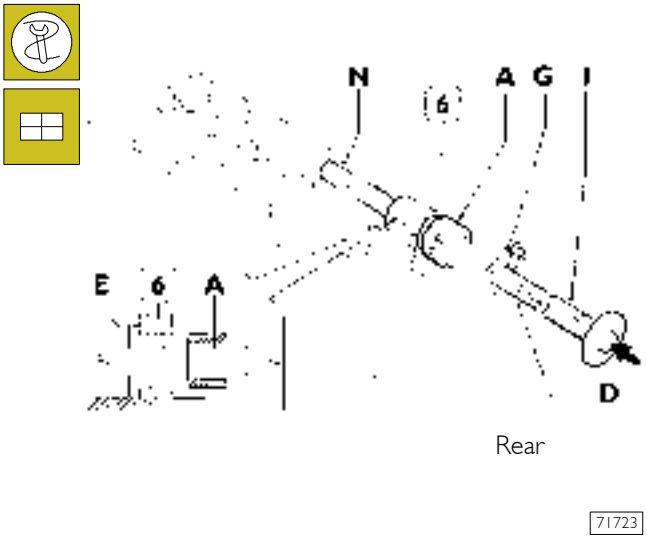
Figure 127



Assemble the drift together with the extension.
To insert bushings 1, 2, 3, 4 and 5, proceed as follows:

1 Position the bushing to insert on the drift (A) making the grub screw on it coincide with the seat (B) (Figure 125) on the bushing.
2 Position the guide bushing (E) and secure the guide bushing (G) (Figure 125) on the seat of the 7th bushing with the plate (H).
3 While driving in the bushing, make the reference mark (F) match the mark (M). In this way, when it is driven home, the lubrication hole on the bushing will coincide with the oil pipe in its seat.
The bushing is driven home when the 1st red reference mark (D) is flush with the guide bushing (G).

Figure 128



To insert the bushing (6), proceed as follows:

- ❑ Unscrew the grip (I) and the extension (N).
- ❑ Position the extension (N) and the guide bushing (E) as shown in the figure.
- ❑ Repeat steps 1, 2, 3.

Figure 129

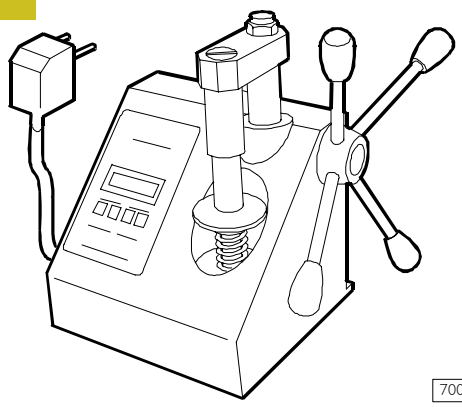
Rear 71724

To insert bushing (7), proceed as follows:

- ❑ Unscrew the grip (I) and the extension (N).
- ❑ Refit the guide (G) from the inside as shown in the figure.
- ❑ Position the bushing on the drift (A) and bring it close up to the seat, making the bushing hole match the lubrication hole in the head. Drive it home.
  The 7th bushing is driven in when the reference mark (C) is flush with the bushing seat.

540665 VALVE SPRINGS

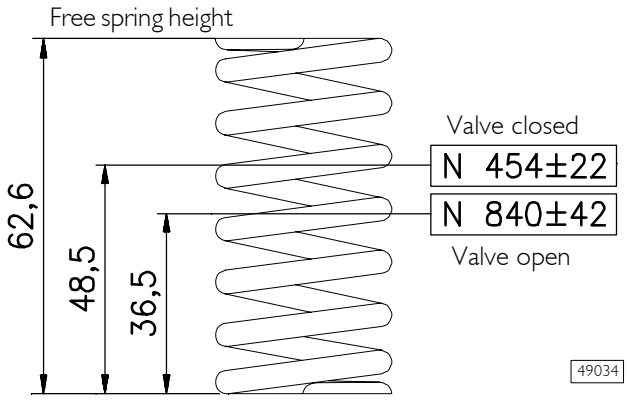
Figure 130



70000

Before assembly, the flexibility of the valve springs has to be checked with the tool 99305047.
Compare the load and elastic deformation data with those of the new springs given in the following figure.

Figure 131

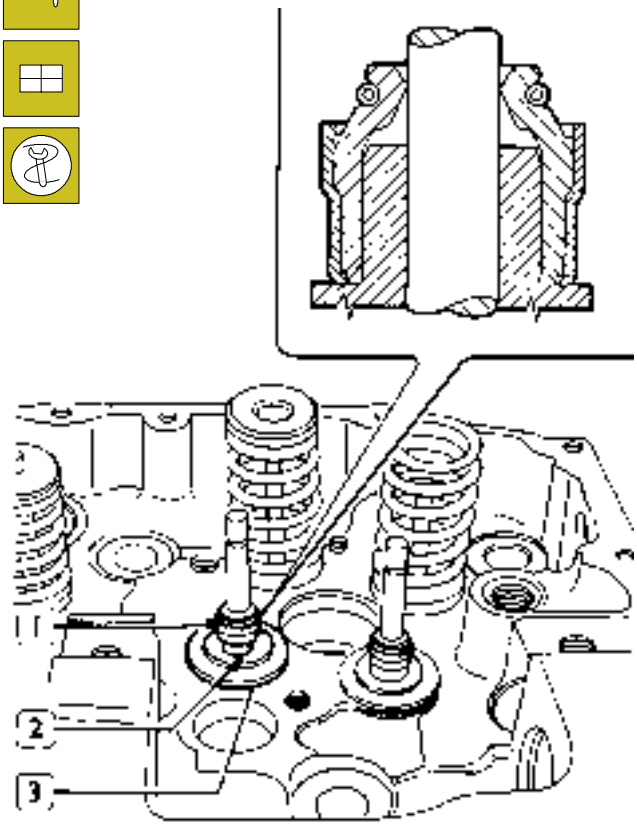


49034

MAIN DATA TO CONTROL EXHAUST AND DISCHARGE VALVE SPRING

Fitting the valves and oil seal ring

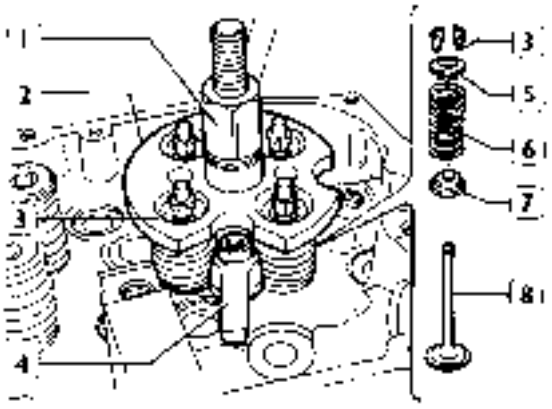
Figure 132



49033

Lubricate the valve stem and place the valves in the relevant valve guides; install the lower plates (3) using tool 99360292, fit the oil seal ring (1) on valve guides (2), then install the valves as shown:

Figure 133

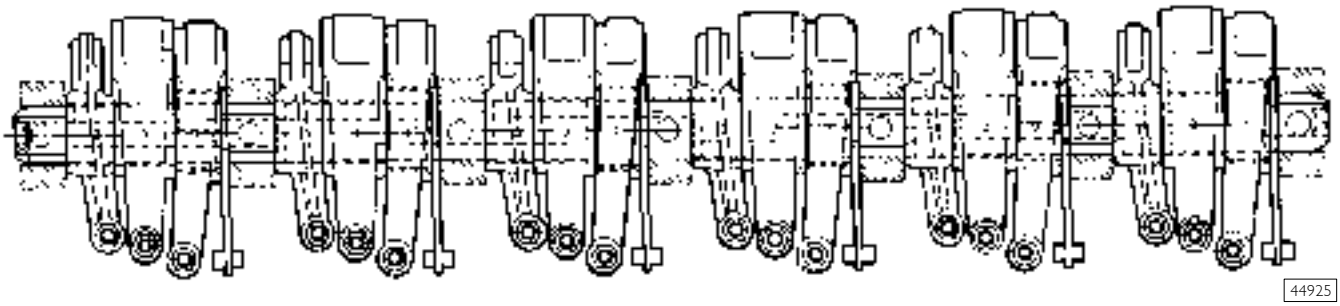


47583

- ❑ fit springs (6) and the upper plate (5);
- ❑ apply tool 99360264 (2) and block it with bracket (4); tighten the lever (1) until cotters are installed (3), remove tool (2).

5412 ROCKER SHAFT

Figure 134



44925

The camshaft cams directly control rockers: 6 for injectors and 12 for valves.

Rockers slide directly on the cam profiles via rollers.

The other end acts on a bar directly supported by the two valves stems.

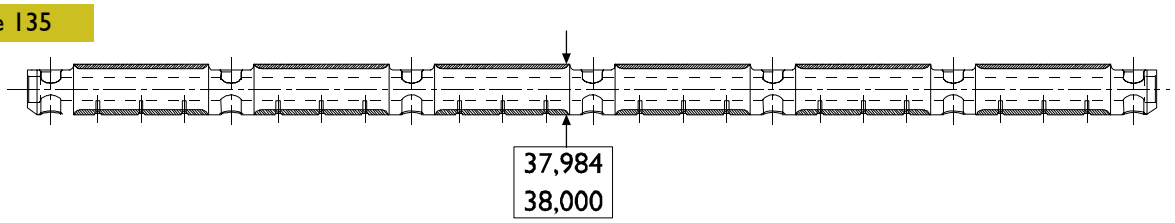
A pad is placed between the rocker adjusting screw and the bar.

Two lubrication holes are obtained inside the rockers.

The rocker shaft practically covers the whole cylinder head; remove it to have access to all the underlying components.

Shaft

Figure 135



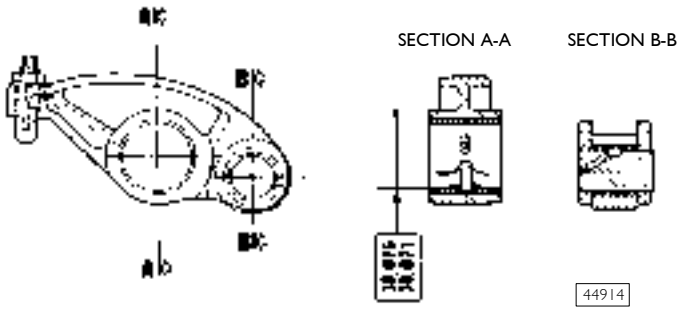
79171

MAIN DATA OF THE ROCKER ARM SHAFT

Check that the surface of the shaft shows no scoring or signs of seizure; if it does, replace it.

Rocker

Figure 136

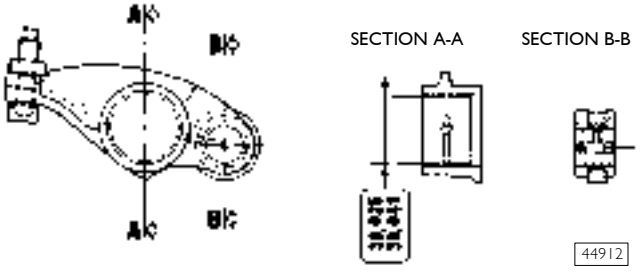


44914

The bush surfaces must not show any trace of scoring of excessive wear; otherwise, replace bushes or the whole rocker.

PUMP INJECTOR ROCKER

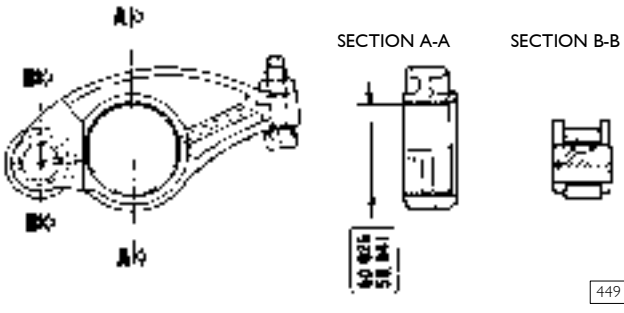
Figure 137



44912

EXHAUST VALVES ROCKER

Figure 138



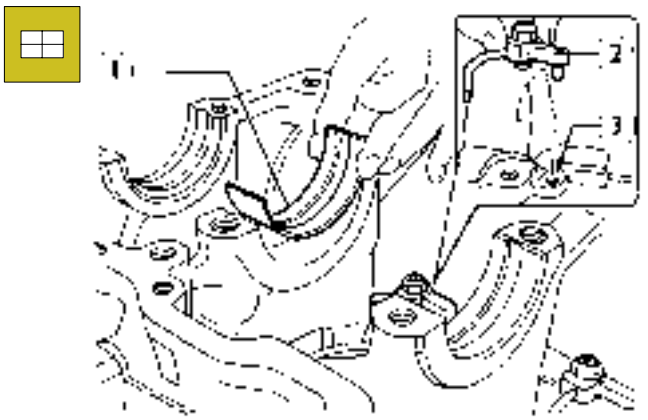
44913

DISCHARGE VALVE ROCKER

ASSEMBLING THE ENGINE ON THE BENCH

Fix the engine block to the stand 99322230 by means of brackets 99361035.
Install the cylinder liners as described in page 49.

Figure 139

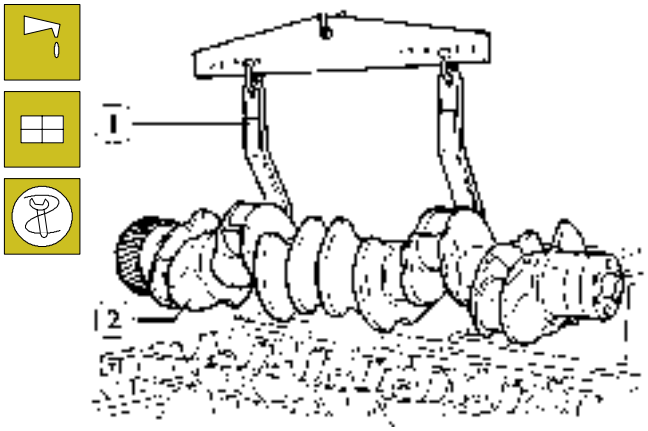


47586

Fit the oil spray nozzles (2), so that the dowel coincides with the block hole (3).

Place the half bearings (1) on the main bearings.

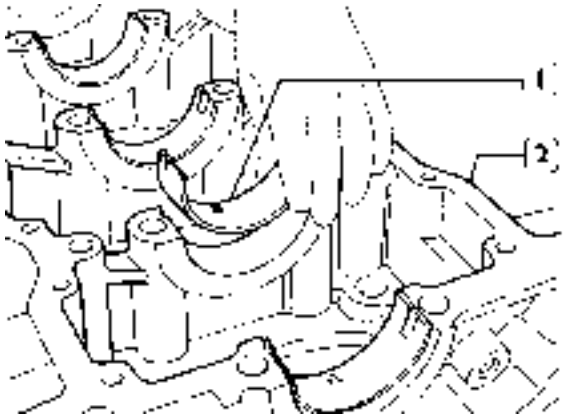
Figure 140



47570

Lubricate the half bearings, then install the crankshaft (2) by means of hoist and hook 99360500 (1).

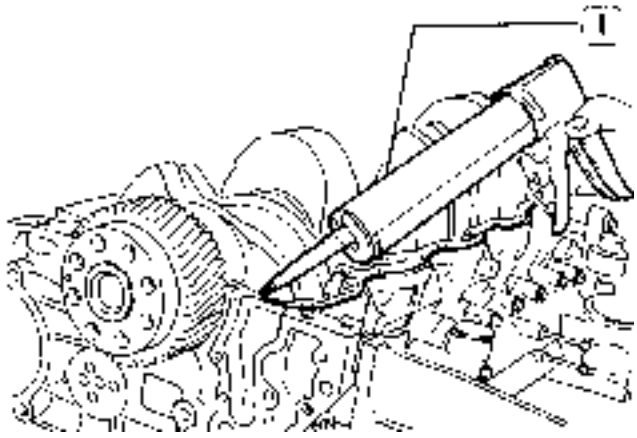
Figure 141



49021

Place the half-bearings (1) on the main bearings in the underblock (2).

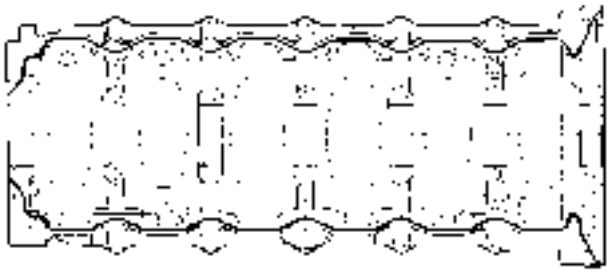
Figure 142



47595

By means of suitable equipment (1) apply silicone LOCTITE 5699 to the block, as shown in the figure.

Figure 143

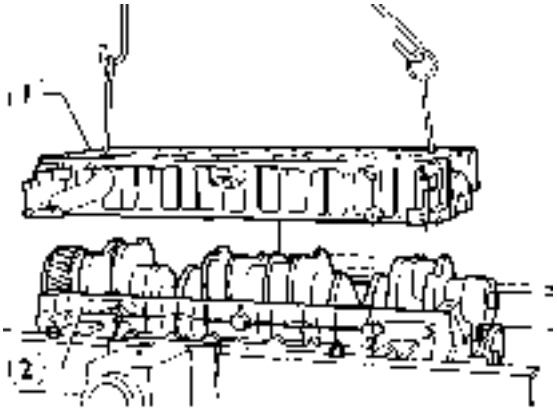


47596

Sealant application diagram

Fit the underblock within 10' of the application of the sealant.

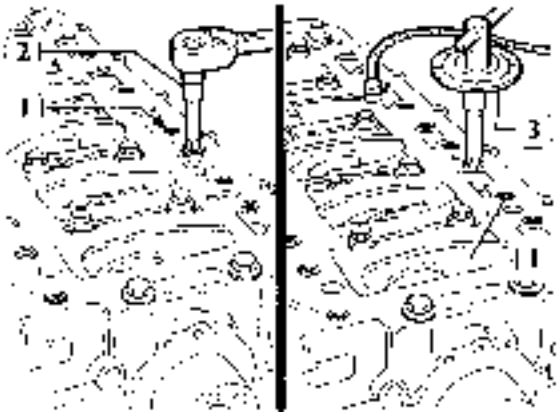
Figure 144



49022

Fit the underblock by means of a suitable hoist and hooks (1).

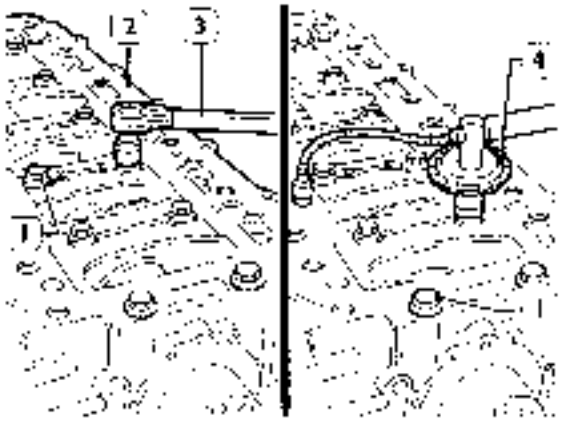
Figure 145



47581

Fit the underblock and, using a dynamometric wrench (2), close the splined outer (1) screws to 25 Nm torque, according to the diagram shown on page 79.

Figure 146



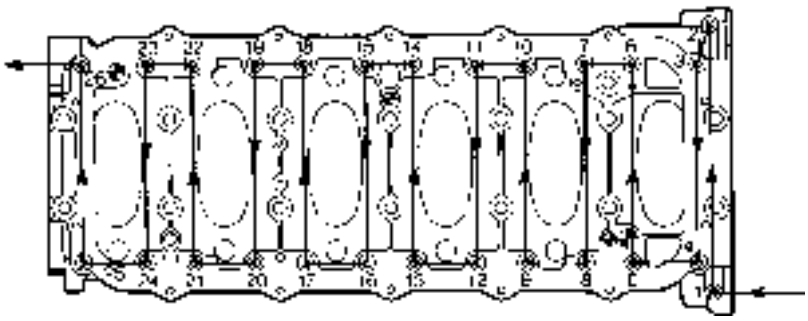
47579

Close the inner screws (1) to 140 Nm torque by means of a dynamometric wrench (3), then with two further angular phases 60° + 60°, using tool 99395216 (4). Tighten again the outer screws (1, Figure 145) with 90° angular closing, using tool 99395215 (3, Figure 145).

DIAGRAM SHOWING THE UNDERBLOCK FIXING SCREWS TIGHTENING ORDER

Figure 147

FRONT SIDE

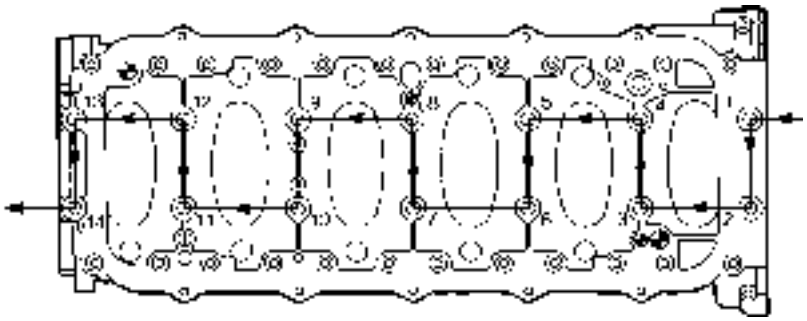


44897

First phase: outer screws preliminary tightening

(25 Nm)

FRONT SIDE

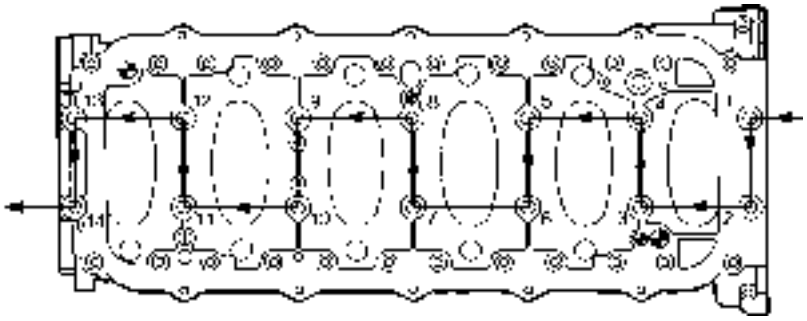


44898

Second phase: inner screws preliminary tightening

(140 Nm)

FRONT SIDE

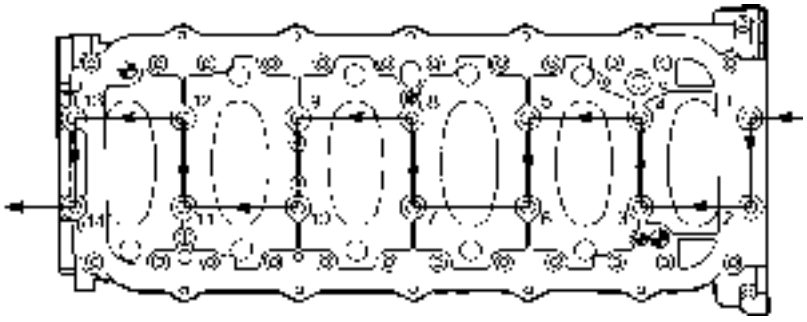


44898

Third phase: inner screws angle closing

(60°)

FRONT SIDE

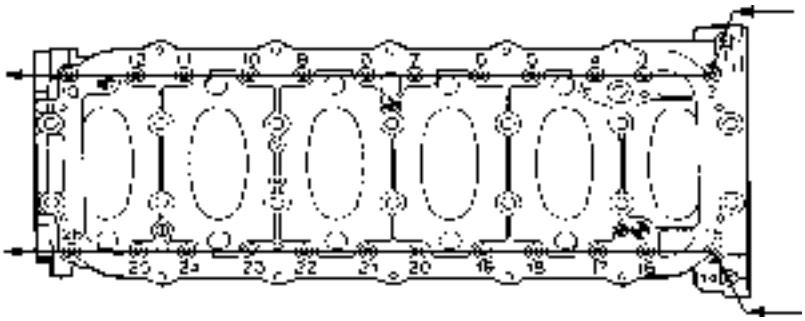


44898

Fourth phase: inner screws angle closing

(60°)

FRONT SIDE

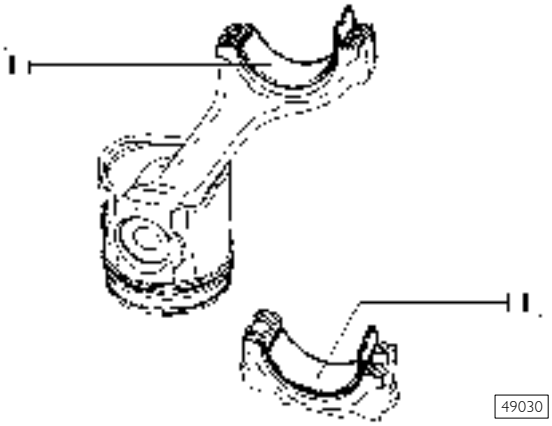


44899

Fifth phase: outer screws angle closing

(90°)

Figure 148



49030

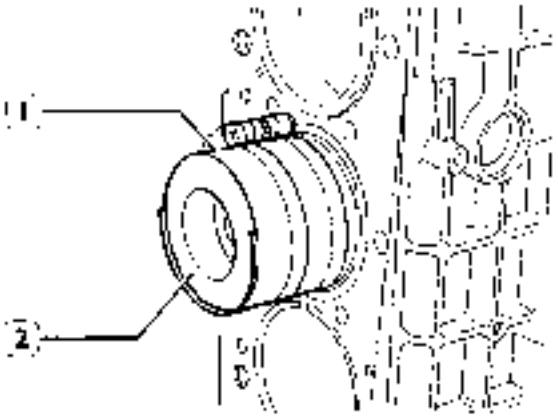
Rotate the cylinder assembly placing it vertically.
Lubricate the half-bearings (1) and fit them in the connecting rod and the cap.

Not finding it necessary to replace the connecting rod bearings, you need to fit them back in exactly the same sequence and position as in removal.
If the big end bearings need to be replaced, choose them according to the description given from page 52 to page 58.

Do not make any adjustment on the bearing shells.

Fitting the connecting rod-piston assembly into the cylinder liners

Figure 150



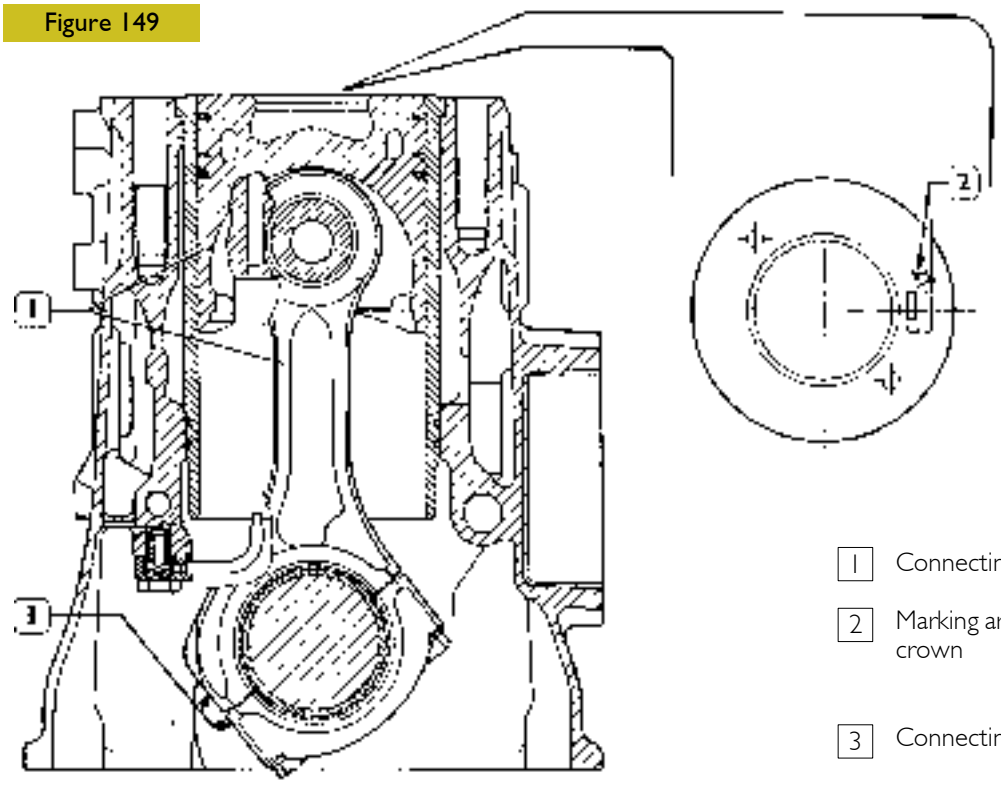
47593

Fit the connecting rod-piston assemblies (2) into the piston liners, using the band 99360605 (1, Figure 150). Check the following:

- ❑ the openings of the split rings are offset by 120°;
- ❑ all pistons belong to the same class, A or B;
- ❑ ideogram (2, Figure 149), stamped on the piston crown, is placed toward the engine flywheel, or the cavity, on the piston skirt, corresponds to the position of the oil spray nozzles

The pistons are supplied as spares in class A and can also be fitted in class B cylinder liners.

Figure 149



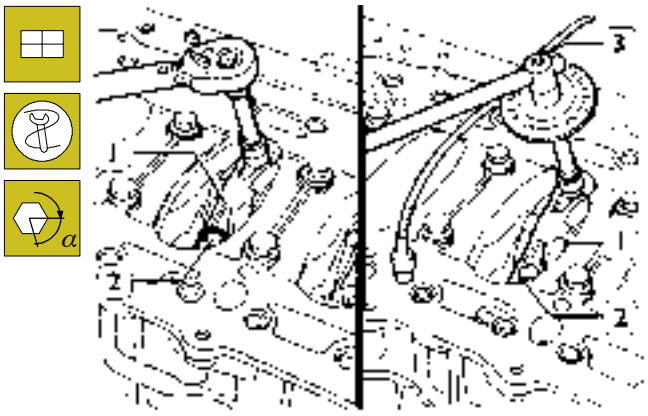
1 Connecting rod-piston assembly

2 Marking area of ideogram on the piston crown

3 Connecting rod marking area

61831

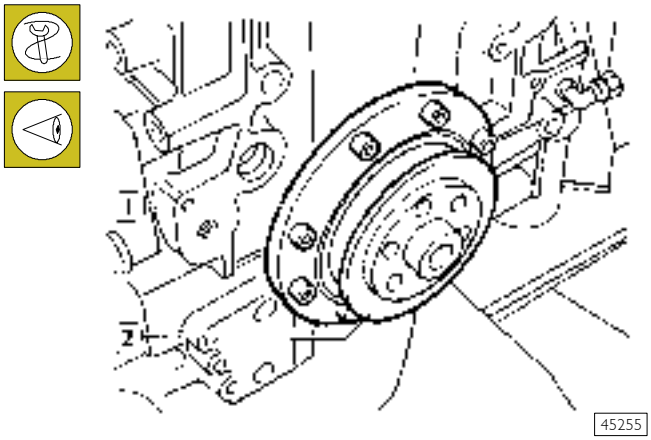
Figure 151



47594

Connect the connecting rods to the relative journals, fit the connection rod caps (1) with half bearings; tighten the fixing screws (2) of the connecting rod caps to 50 Nm torque (5 kgm). Using tool 99395216 (3), further tighten screws with 40° angle.

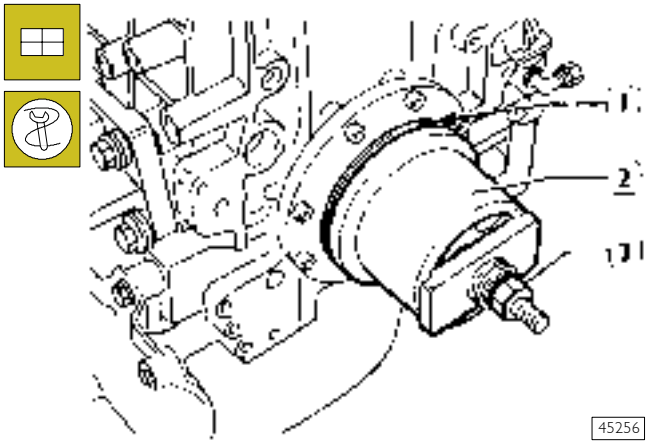
Figure 152



45255

By means of centering ring 99396033 (2), check the exact cover position (1), otherwise act as necessary and tighten the screws.

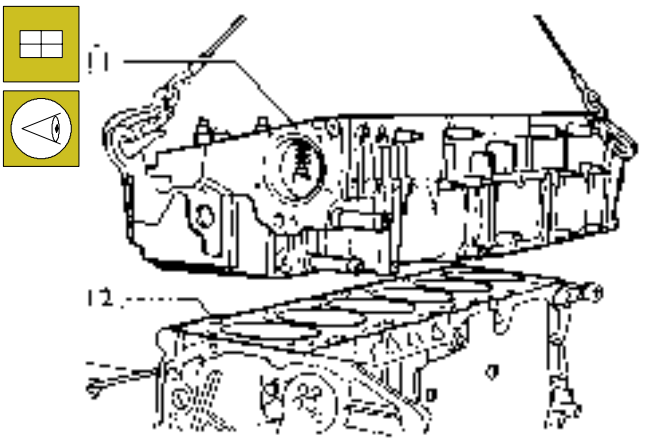
Figure 153



45256

Fit the sealing gasket (1), install the fitting tool 99346245 (2) and drive the sealing gasket (1) by screwing nut (3).

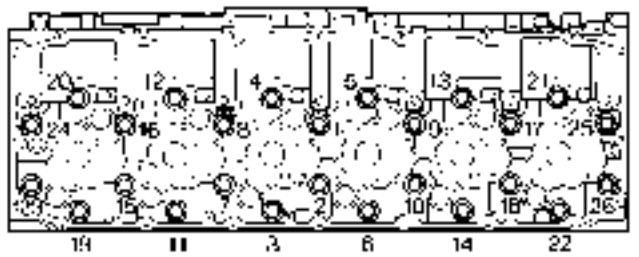
Figure 154



45266

Make sure that pistons 1-6 are exactly at the TDC Place the sealing gasket (2) on the block. Fit the cylinder head (1) and tighten screws as shown in figs. 155, 156 and 157.

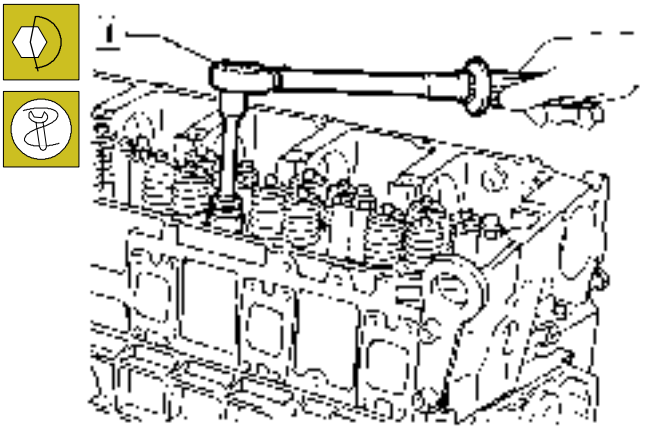
Figure 155



44900

Diagram showing the cylinder head fixing screws tightening order

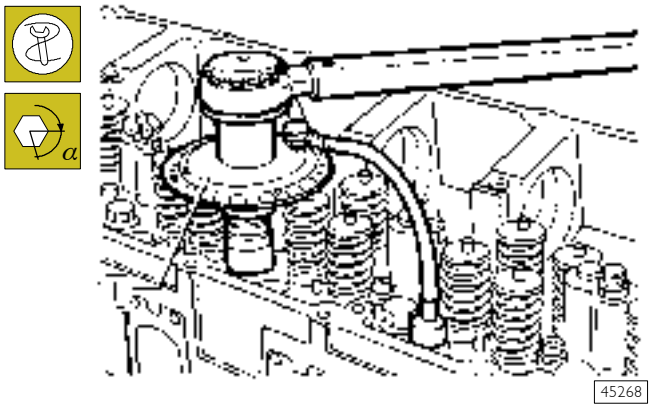
Figure 156



45267

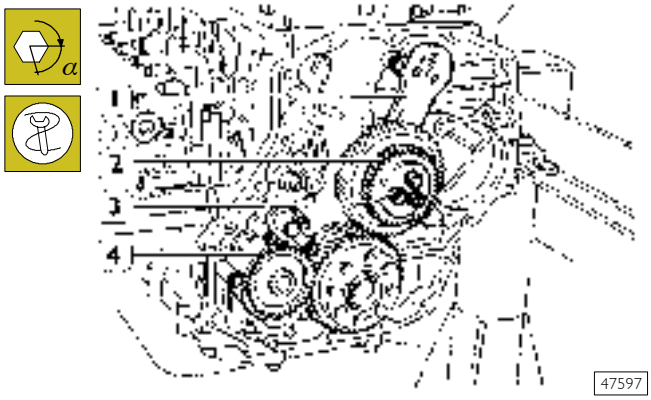
❑ Preliminary tightening by means of a dynamometric wrench (1):
1st phase: 50 Nm (5 kgm:
2nd phase: 100 Nm (10 kgm)

Figure 157



❑ Angle closing by means of tool 99395216 (1):
3rd phase: 90° angle
4th phase: 75° angle

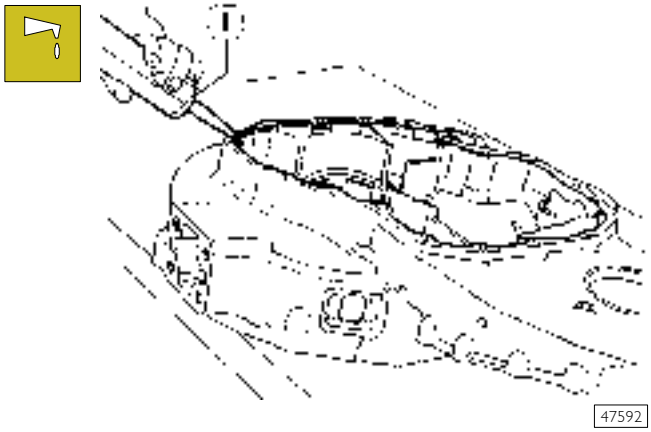
Figure 158



Fit the oil pump (4), intermediate gears (2) with rod (1) and tighten screws (3) in two phases:

preliminary tightening	30 Nm
angle closing	90°

Figure 159



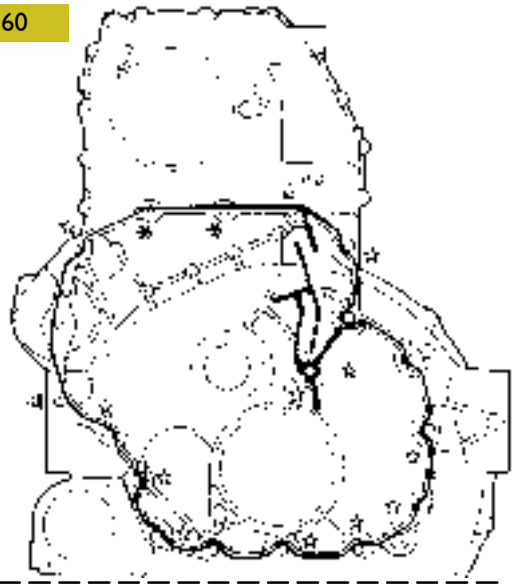
Apply sealant LOCTITE 5699 to the gear box using the proper equipment (1).

The sealer string (1) diameter is to be 1,5 $\pm^{0.5}_{0.2}$

Install the gear box within 10' of the application of the sealant.

Tighten the screws shown in the figure by means of a dynamometric wrench, in compliance with the following order and tightening torque:

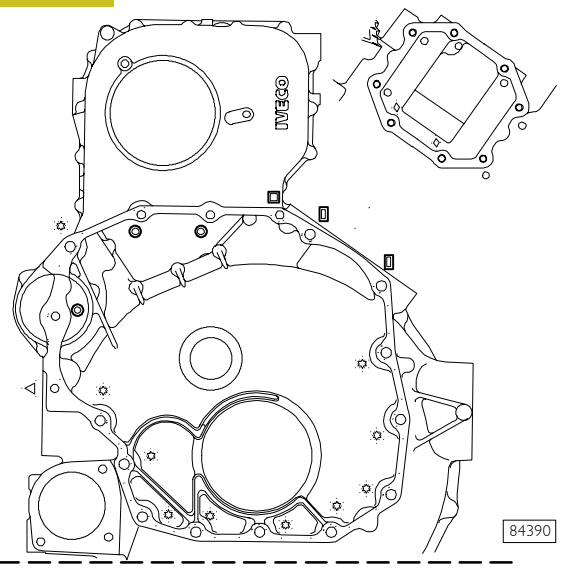
Figure 160



Engines without power take-off

- ☆ no. 13 screws M12 x 1.75 x 80 tightening torque 63 Nm
- ✳ no. 3 screws M10 x 1.5 x 35 tightening torque 42 Nm
- □ no. 1 screw M10 x 1.5 x 100 tightening torque 42 Nm
- △ no. 1 screw M10 x 1.5 x 180 tightening torque 42 Nm
- ▭ no. 2 screws M18 x 1.25 x 125 tightening torque 24 Nm

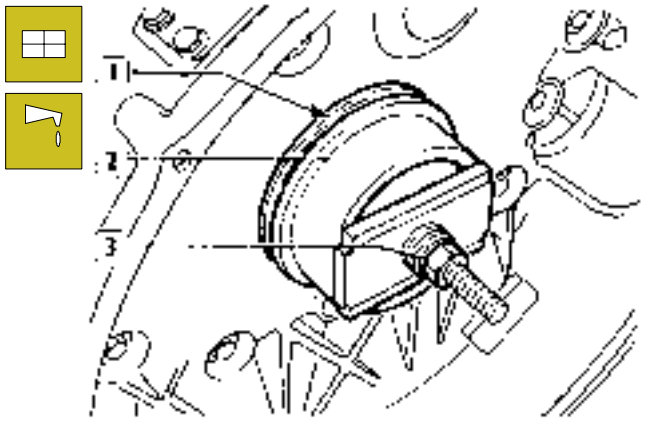
Figure 161



Engines with power take-off

- ☆ no. 10 screws M12 x 1.75 x 80 tightening torque 63 Nm
- ⊙ no. 3 screws M10 x 1.5 x 35 tightening torque 42 Nm
- □ no. 1 screw M10 x 1.5 x 170 tightening torque 42 Nm
- △ no. 1 screw M10 x 1.5 x 180 tightening torque 42 Nm
- ▭ no. 2 screws M12 x 1.75 x 125 tightening torque 63 Nm
- ○ no. 8 screw M10 x 1,5 x 120
- ◊ no. 2 screw M10 x 1,5 x 120 (apply to the thread LOCTITE 275)

Figure 162



45258

Fit the sealing gasket (1), install the fitting tool 99346246 (2) and drive the sealing gasket by screwing the nut (3).

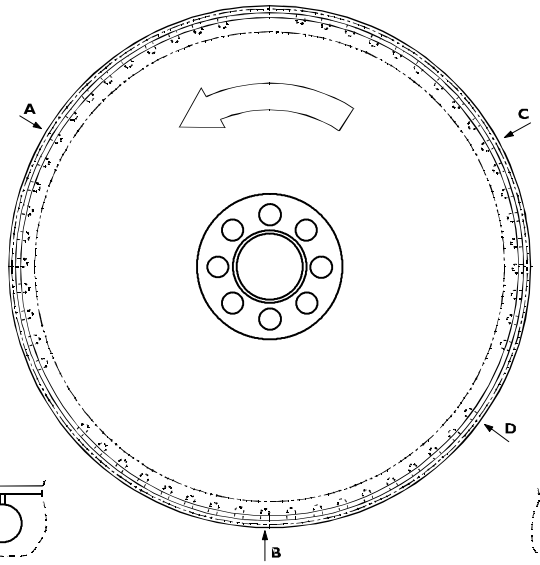
540850 ENGINE FLYWHEEL

If the teeth of the ring gear mounted on the engine flywheel, for starting the engine, are very damaged, replace the ring gear. It must be fitted after heating the ring gear to a temperature of approx. 200°C.

Fitting engine flywheel

The crankshaft has a locating peg that has to couple with the relevant seat on the engine flywheel.

Figure 163



VIEW OF HOLES: A - B - C

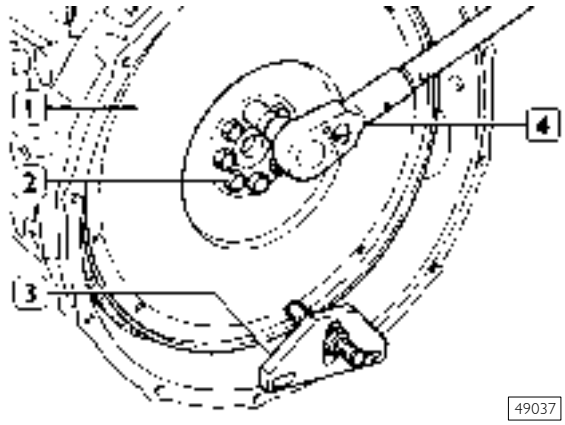
VIEW OF HOLES: D

60668

DETAIL OF PUNCH MARKS ON ENGINE FLYWHEEL FOR PISTON POSITIONS

A. Hole on flywheel with one reference mark, corresponding to the TDC of pistons 3-4. - B. Hole on flywheel with one reference mark, corresponding to the TDC of pistons 1-6. - C. Hole on flywheel with one reference mark, corresponding to the TDC of pistons 2-5. - D. Hole on flywheel with two reference marks, position corresponding to 54°.

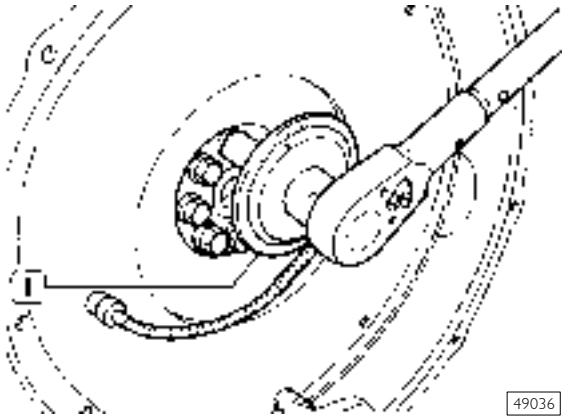
Figure 164



49037

Position the flywheel (1) on the crankshaft, lubricate the thread of the screws (2) with engine oil and screw them down. Lock rotation with tool 99360351 (3). Lock the screws (2) in three phases.
First phase: pre-tightening with torque wrench (4) to a torque of 100 Nm (10 kgm).

Figure 165

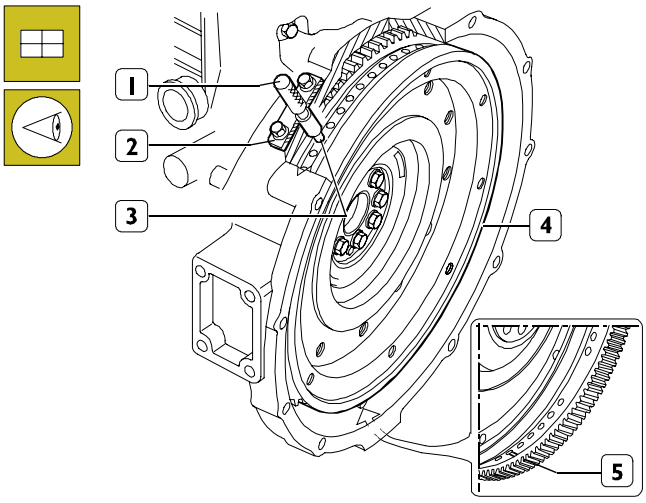


49036

Second phase: closing to angle of 60° with tool 9939516 (1).

Fitting camshaft

Figure 166



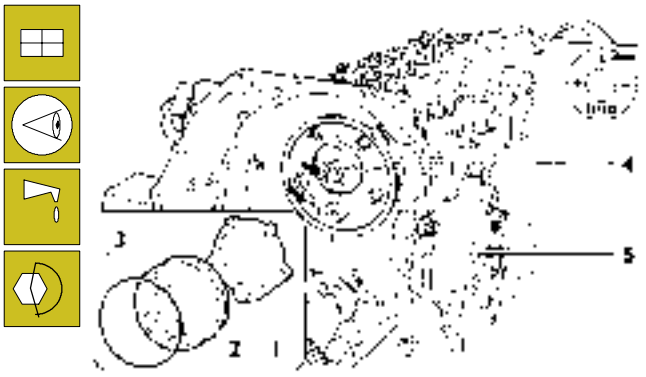
72436

Position the crankshaft with the pistons 1 and 6 at the top dead centre (T.D.C.).
This situation occurs when:

1. The hole with reference mark (5) of the engine flywheel (4) can be seen through the inspection window.
2. The tool 99360612 (1), through the seat (2) of the engine speed sensor, enters the hole (3) in the engine flywheel (4).

If this condition does not occur, turn the engine flywheel (4) appropriately.
Remove the tool 99360612 (1).

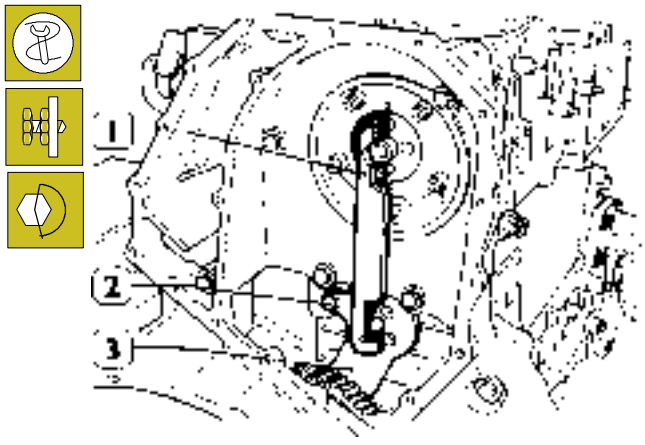
Figure 167



73843

Fit the camshaft (4), positioning it observing the reference marks (→) as shown in the figure.
Lubricate the seal (3) and fit it on the shoulder plate (2).
Mount the shoulder plate (2) with the sheet metal gasket (1) and tighten the screws (5) to the required torque.

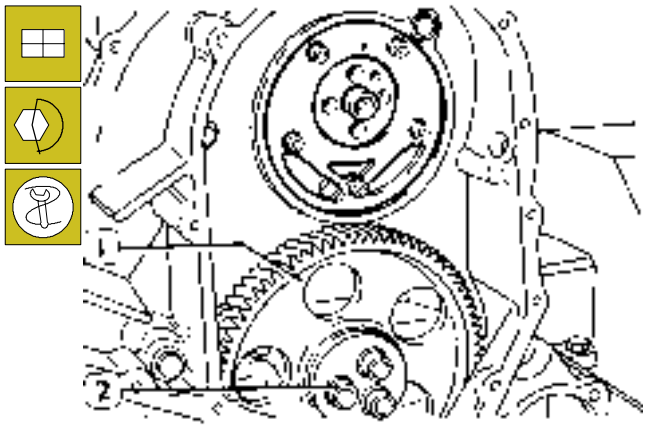
Figure 168



45376

❑ Apply gauge 99395215 (1), check and record the position of the rod (3) for the transmission gear, tighten the screw (2) to the prescribed torque.

Figure 169

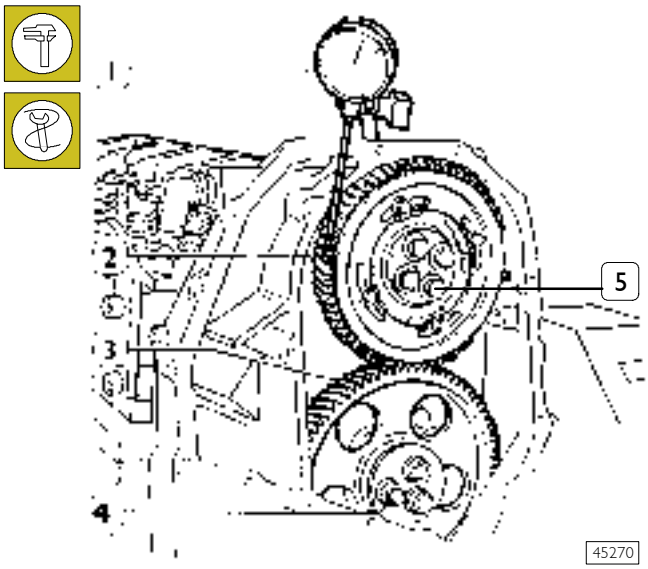


45269

❑ Remove the transmission gear (1) and tighten screws (2) by means of proper splined wrench, to the prescribed torque.

Replace the idle gear bushing (1) when wear is detected. After installing the bushing, adjust it to j 58.010 ± 0.10 mm.

Figure 170

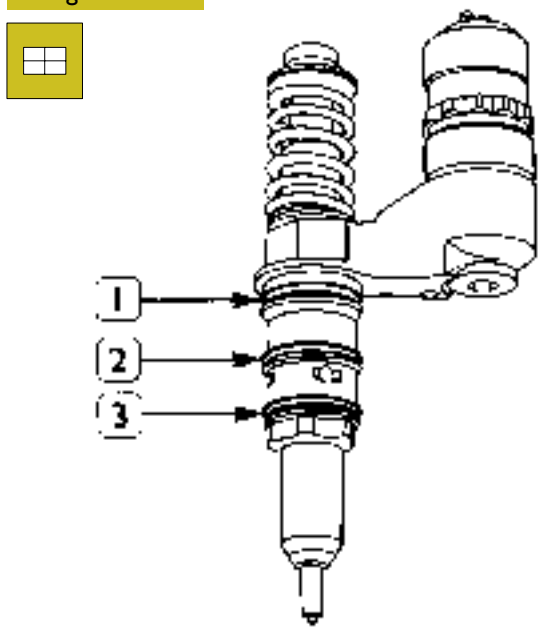


Position the gear (2) on the camshaft so that the 4 slots are centred with the holes for fixing the camshaft, without fully locking the screws (5).
Using the dial gauge with a magnetic base (1), check that the clearance between the gears (2 and 3) is 0.073 – 0.195 mm; if this is not so, adjust the clearance as follows:

- ❑ Loosen the screws (4) fixing the idle gear (3).
- ❑ Loosen the screw (2, Figure 168) fixing the link rod. Shift the link rod (3, Figure 168) to obtain the required clearance.
- ❑ Lock the screw (2, Figure 168) fixing the link rod and screws (4, Figure 170) fixing the idle gear to the required torque.

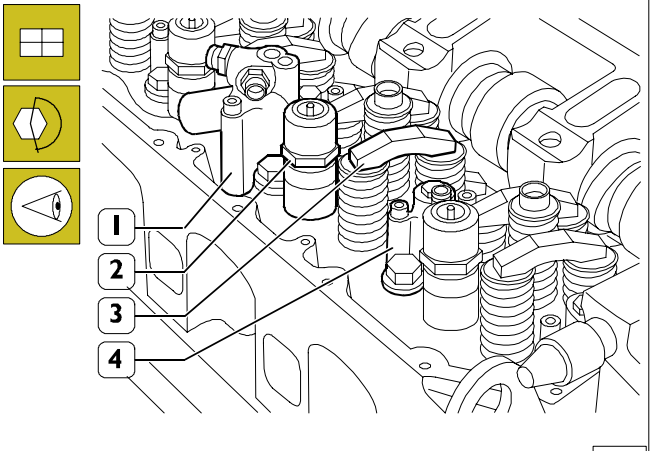
Fitting pump-injectors

Figure 171



Fit the seals (1) (2) (3) on the injectors.

Figure 172



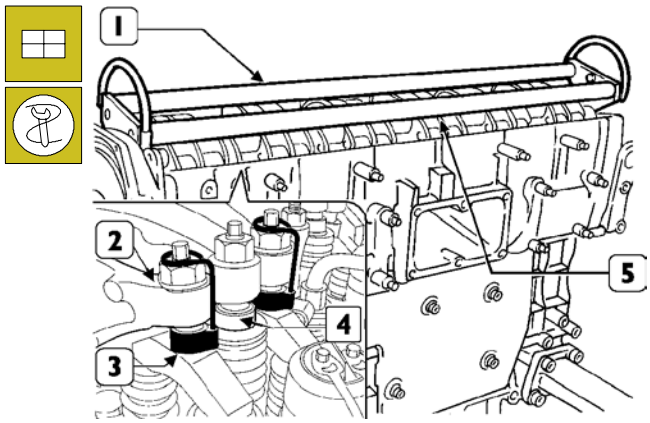
Mount:

- ❑ The injectors (2) and, using a torque wrench, lock the bracket fixing screws to a torque of 26 Nm.
- ❑ The exhaust brake cylinders (1) and (4) and, using a torque wrench, fix them to a torque of 19 Nm.
- ❑ The crosspieces (3) on the valve stem, all with the largest hole on the same side.

Fitting rocker-arm shaft assembly

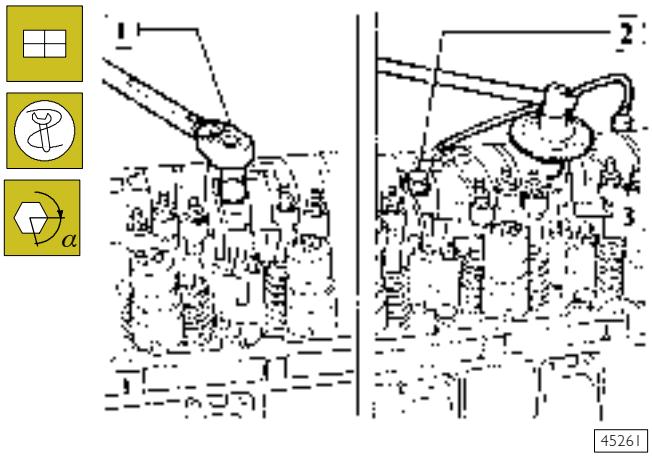
Figure 173

Before refitting the rocker-arm shaft assembly, make sure that all the adjustment screws have been fully unscrewed.



Using tool 99360144 (3), fasten the blocks (4) to the rocker arms (2).
Apply the tool 99360553 (1) to the rocker arm shaft (5) and mount the shaft on the cylinder head.

Figure 174

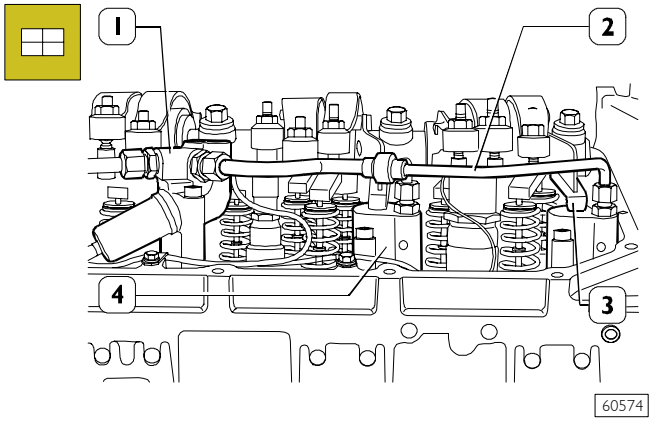


45261

Lock the screws (2) fixing the rocker-arm shaft as follows:

- ❑ 1st phase: tightening to a torque of 40 Nm (10 kgm) with the torque wrench (1).
- ❑ 2nd phase: closing with an angle of 60° using the tool 99395216 (3).

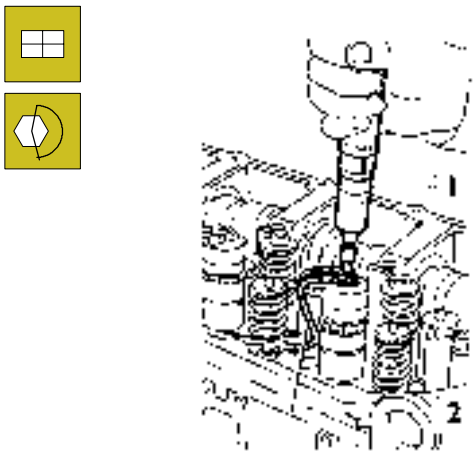
Figure 175



60574

- ❑ Mount the engine brake lever retaining springs (3).
- ❑ Connect the pipe (2) to the engine brake cylinders (4) and to the cylinder with the engine brake solenoid valve (1).

Figure 176

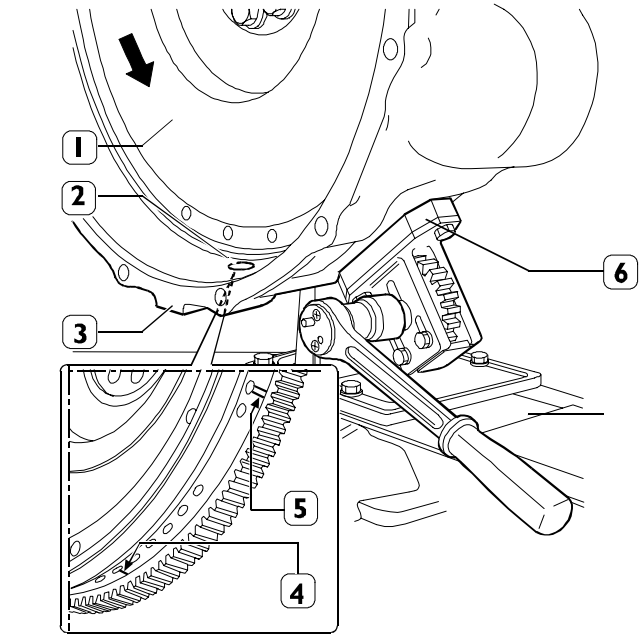


71777

Mount the electric wiring (2), securing it on the electro-injectors with a torque screwdriver (1) to a torque of 1.36 - 1.92 Nm.

Camshaft timing

Figure 177

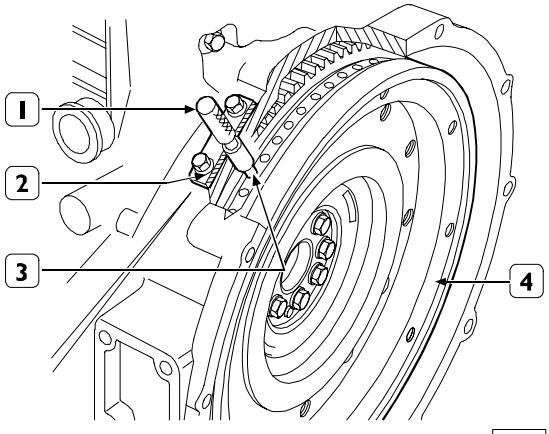


71776

Apply the tool 99360321 (6) to the gearbox (3).

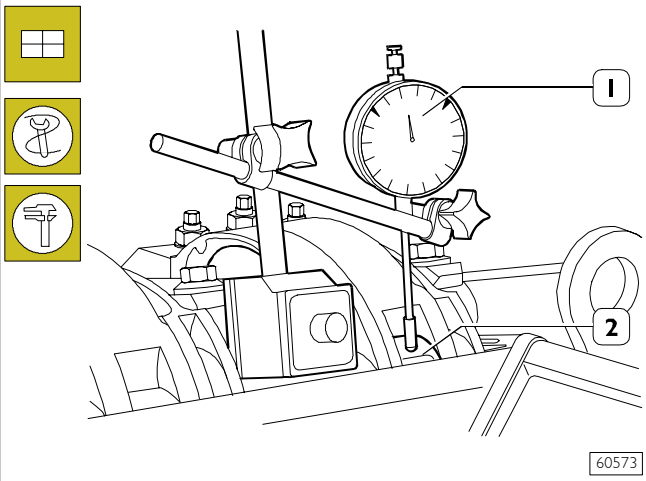
The arrow shows the direction of rotation of the engine when running.
Using the above-mentioned tool, turn the engine flywheel (1) in the direction of rotation of the engine so as to take the piston of cylinder no.1 to approximately the T.D.C. in the phase of combustion. This condition occurs when the hole with one reference mark (4), after the hole with two reference marks (5) on the engine flywheel (1), can be seen through the inspection window (2).

Figure 178



The exact position of piston no.1 at the T.D.C. is obtained when in the above-described conditions the tool 99360612 (1) goes through the seat (2) of the engine speed sensor into the hole (3) in the engine flywheel (4).
If this is not the case, turn and adjust the engine flywheel (4) appropriately.
Remove the tool 99360612 (1).

Figure 179



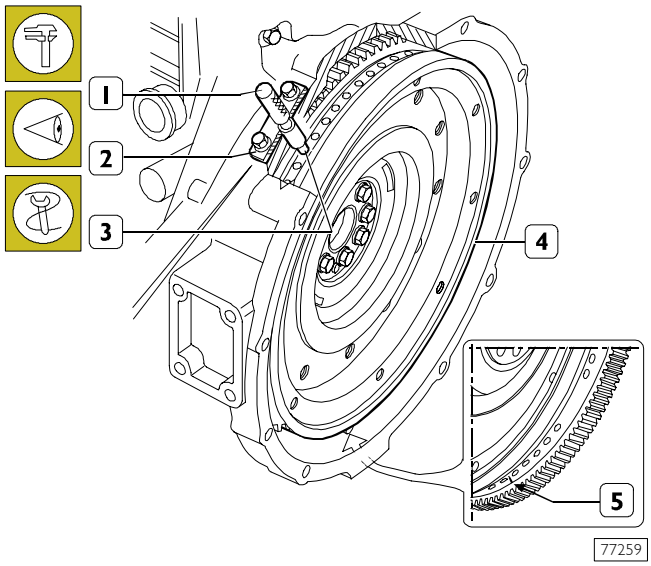
Set the dial gauge with the magnetic base (1) with the rod on the roller (2) of the rocker arm that governs the injector of cylinder no.1 and pre-load it by 6 mm.

With tool 99360321 (6, Figure 177), turn the crankshaft clockwise until the pointer of the dial gauge reaches the minimum value beyond which it can no longer fall.

Reset the dial gauge.

Turn the engine flywheel anticlockwise until the dial gauge gives a reading for the lift of the cam of the camshaft of 4.90 ± 0.05 mm.

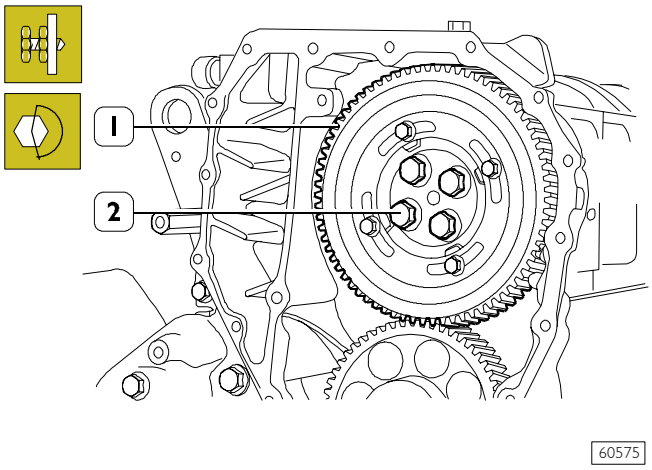
Figure 180



The camshaft is in step if at the cam lift values of 4.90±0.05 mm there are the following conditions:

1) The hole marked with a notch (5) can be seen through the inspection window
2) The tool 99360612 (1) through the seat (2) of the engine speed sensor goes into the hole (3) in the engine flywheel (4).

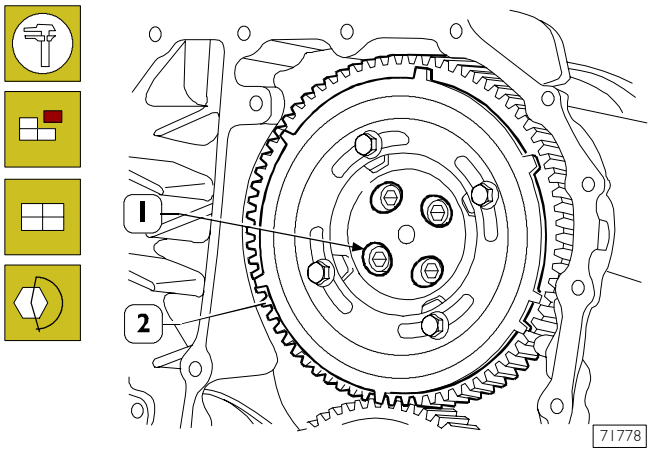
Figure 181



If you do not obtain the conditions illustrated in Figure 180 and described in points 1 and 2, proceed as follows:

1) Loosen the screws (2) securing the gear (1) to the camshaft and utilize the slots (1, Figure 182) on the gear (2, Figure 182).
2) Turn the engine flywheel appropriately so as to bring about the conditions described in points 1 and 2 Figure 180, it being understood that the cam lift must not change at all.
3) Lock the screws (2) and repeat the check as described above.
4) Tighten the screws (2) to the required torque.

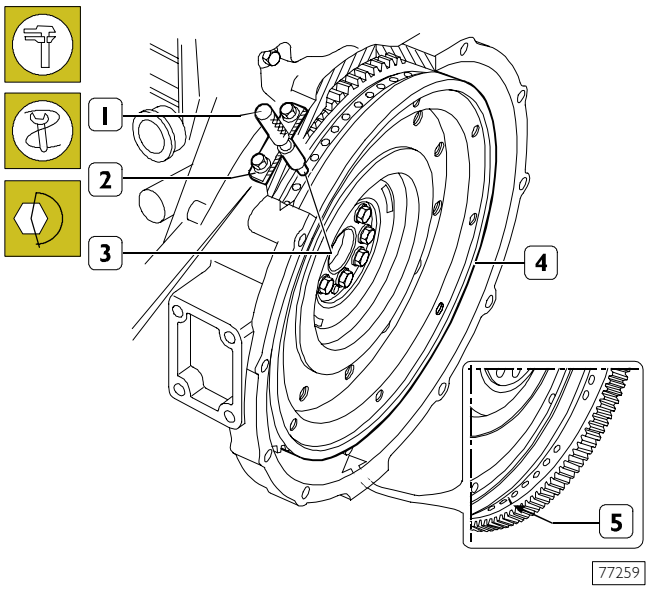
Figure 182



When it is not possible to adjust advance through the slots (1) and the camshaft turns because integral with the gear (2); thus the cam lift reference value varies and it is necessary to proceed in the following way:

1) Fasten the screws (2, Figure 181) and rotate the engine flywheel clockwise by ~1/2 turn;
2) Turn the engine flywheel anticlockwise until the dial gauge gives a reading of the lift of the cam of the camshaft of 4.90 ± 0.05 mm
3) Take out the screws (2, Figure 181) and remove the gear (2) from the camshaft.

Figure 183



Turn the flywheel (4) again to bring about the following conditions:

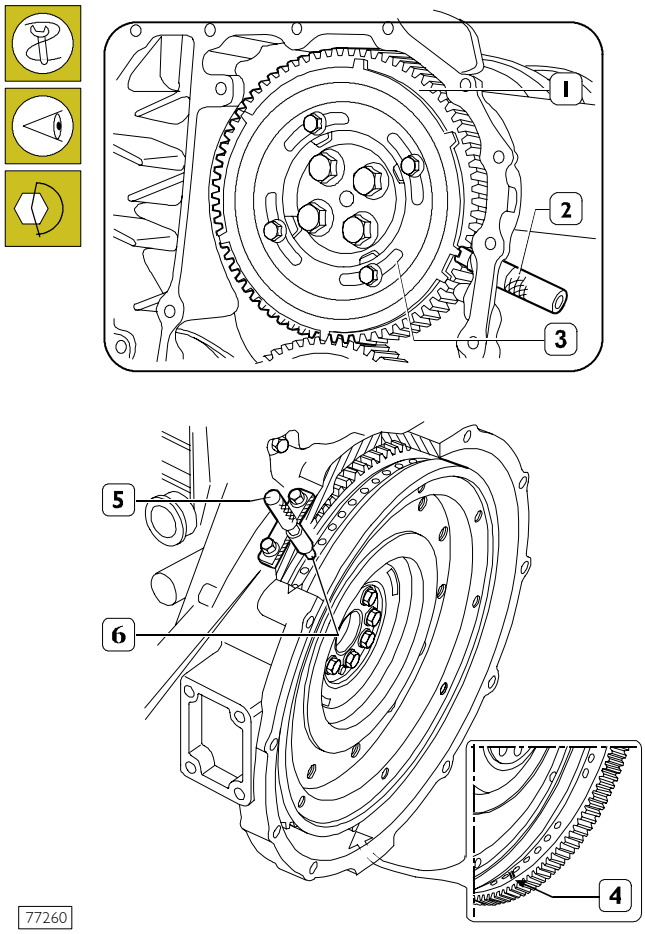
- ❑ Notch (5) visible through the lower inspection window;
- ❑ The tool 99360612 (1) inserted in the hole (3) in the engine flywheel (4) through the seat (2) of the engine speed sensor.

Mount the gear (2, Figure 182) with the 4 slots (1, Figure 182) centred with the fixing holes of the camshaft, locking the relevant screws to the required tightening torque. Check the timing of the shaft by first turning the flywheel clockwise to discharge the cam completely and then turn the flywheel anticlockwise until the dial gauge gives a reading of: 4.90 ± 0.05 mm

Check the timing conditions described in Figure 180.

Phonic wheel timing

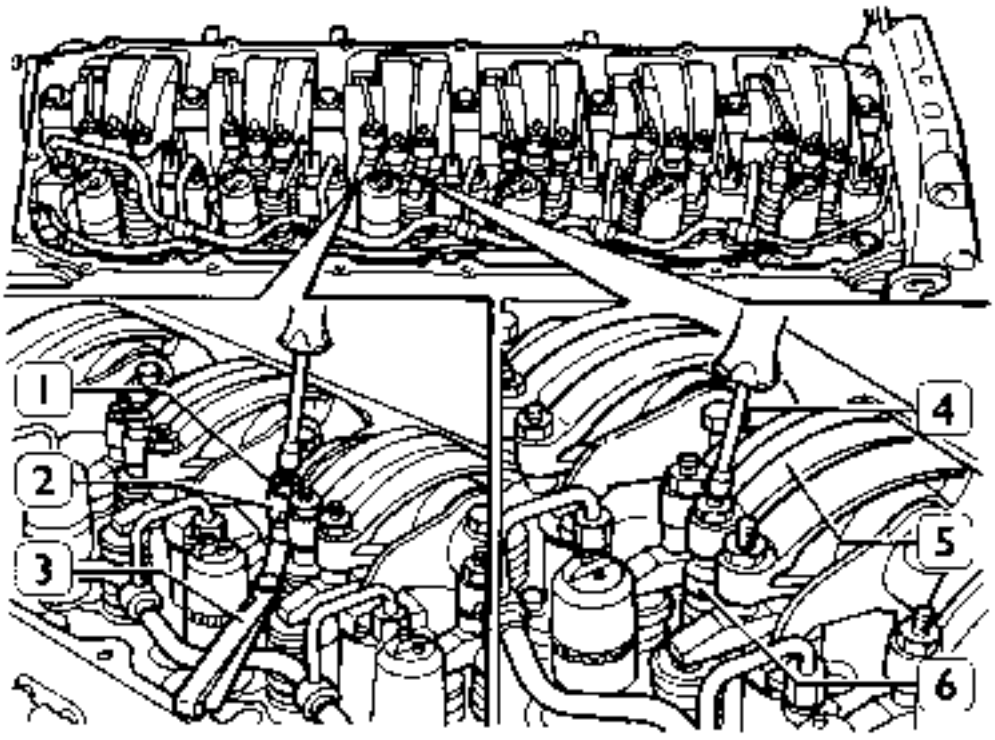
Figure 184



Turn the output shaft bringing cylinder piston 1 at compression stage to TDC.; turn the flywheel by about 1/4 turn in opposite direction than normal direction of rotation. Turn the flywheel again according to normal direction of rotation until the hole marked with the double notch (4) can be seen through the inspection hole set under the flywheel housing. Fit tool 99360612 (5) into the flywheel sensor seat (6).
Fit tool 99360613 (2), through the timing sensor seat, on the tooth obtained on the phonic wheel.
Should tool (2) fitting be difficult, slacken screws (3) and direct the phonic wheel (1) properly to position the tool (2) on the tooth. Tighten the screws (3).

Intake and exhaust rocker play adjustment and pre-loading of rockers controlling pump injectors.

Figure 185



ADJUSTMENT OF INTAKE, EXHAUST AND INJECTION ROCKERS

Adjustment of clearances between rockers and valve studs and preloading of pump injector rockers should be carried out with extreme care.

Take the cylinder where clearance must be adjusted to the bursting phase; its valves are closed while balancing the symmetric cylinder valves.
Symmetric cylinders are 1-6, 2-5 and 3-4.
In order to properly operate, follow these instructions and data specified on the table.

Adjustment of clearance between the rockers and rods controlling intake and exhaust valves:

- ❑ Using a polygonal wrench, loosen nut (1) locking the adjustment screw;
- ❑ Insert the thickness gauge blade (3);
- ❑ Tighten or untighten the adjustment screw with the appropriate wrench;
- ❑ Make sure that the gauge blade (3) can slide with a slight friction;
- ❑ Lock the nut (1), by blocking the adjustment screw.

Pre-loading of rockers controlling pump injectors:

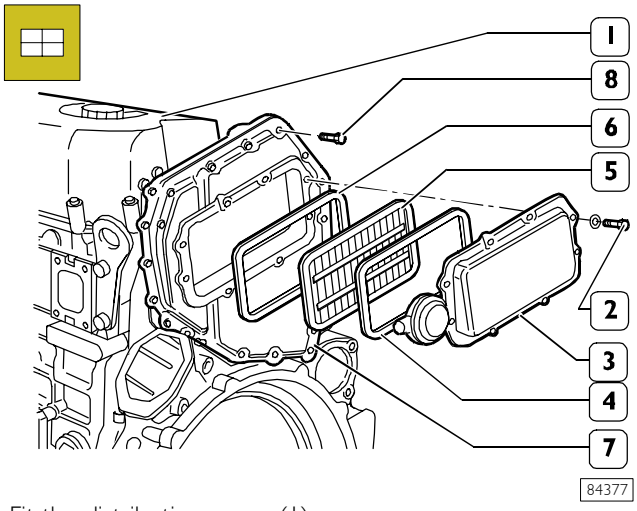
- ❑ Using a polygonal wrench, loosen the nut locking the rocker adjustment screw (5) controlling the pump injector (6);
- ❑ Using an appropriate wrench (4), loosen the adjustment screw until the pumping element is at the end-of-stroke;
- ❑ Tighten the adjustment screw, with a dynamometric wrench, to 5 Nm tightening torque (0.5 kgm);
- ❑ Untighten the adjustment screw by 1/2 to 3/4 rotation;
- ❑ Tighten the locking nut.

FIRING ORDER **1-4-2-6-3-5**

Clockwise start-up and rotation	Adjusting cylinder valve no.	Adjusting clearance of cylinder valve no.	Adjusting pre-loading of cylinder injector no.
1 and 6 at P.M.S.	6	1	5
120°	3	4	1
120°	5	2	4
120°	1	6	2
120°	4	3	6
120°	2	5	3

In order to properly carry out the above-mentioned adjustments, follow the sequence specified in the table, checking the exact position in each rotation phase by means of pin 99360612, to be inserted in the 11th hole in each of the three sectors with 18 holes each.

Figure 186



Fit the distribution cover (1).

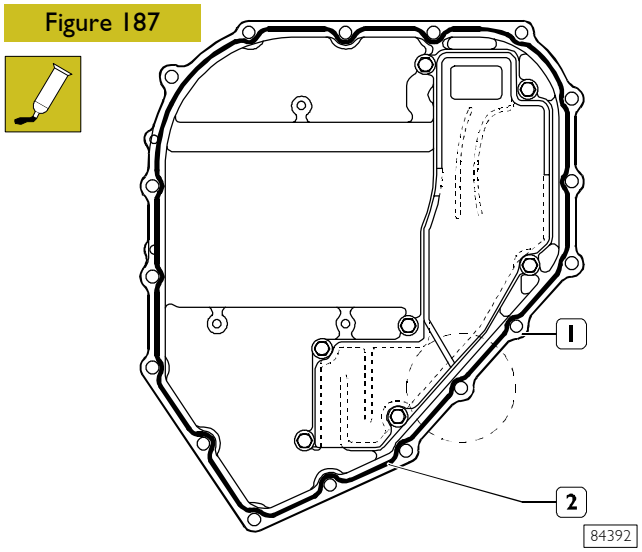
Fit the blow-by case (7) and its gasket and then tighten the screws (8) to the prescribed torque.
Install the filter (5) and the gaskets (4 and 6).

The filter (5) operation is unidirectional, therefore it must be assembled with the two sight supports as illustrated in the figure.

Fit the cover (3) and tighten the fastening screws (2) to the prescribed torque.

Apply silicone LOCTITE 5699 on the blow-by case (7) surface of engines fitted with P.T.O. according to the procedure described in the following figure.

Figure 187



Apply silicone LOCTITE 5699 on the blow-by case and form a string (2) of Ø 1.5 $\pm^{0.5}_{0.2}$ as shown in the figure.

Fit the blow-by case (1) within 10' from sealer application.

ENGINE COMPLETION

Complete the engine by installing or connecting the following components:

- ❑ thermostatic unit;
- ❑ belt tensioner, water pump, alternator;
- ❑ control belt;
- ❑ belt tensioner, conditioner compressor;
- ❑ control belt.

Figure 188

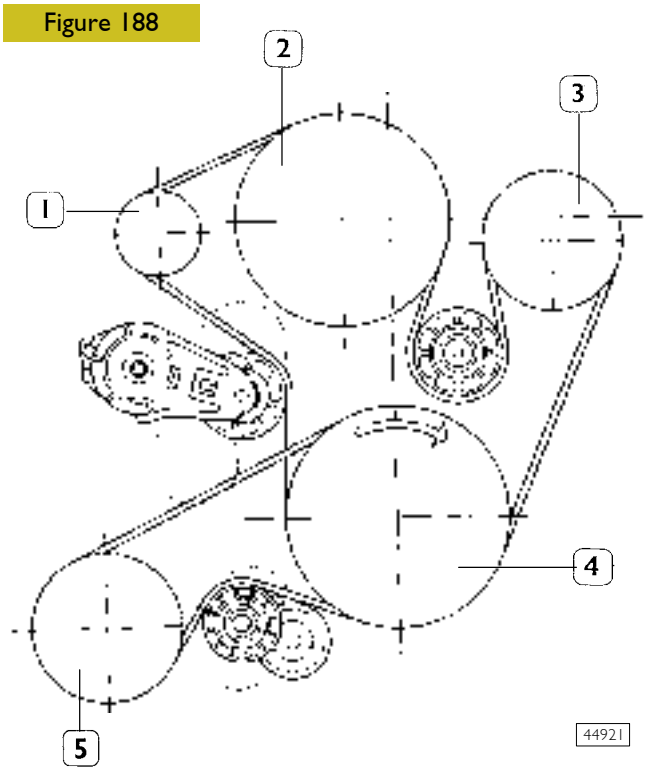
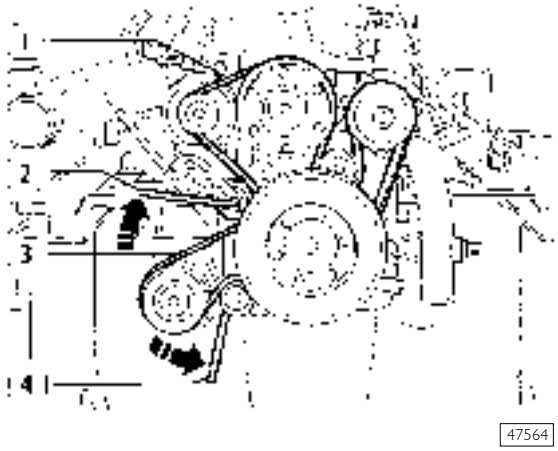


DIAGRAM FOR THE INSTALLATION OF FAN BELTS - WATER PUMP - ALTERNATOR AND CONDITIONER COMPRESSOR
1. Alternator - 2. Fan - 3. Water pump - 4. Crankshaft - 5. Conditioner compressor

Figure 189

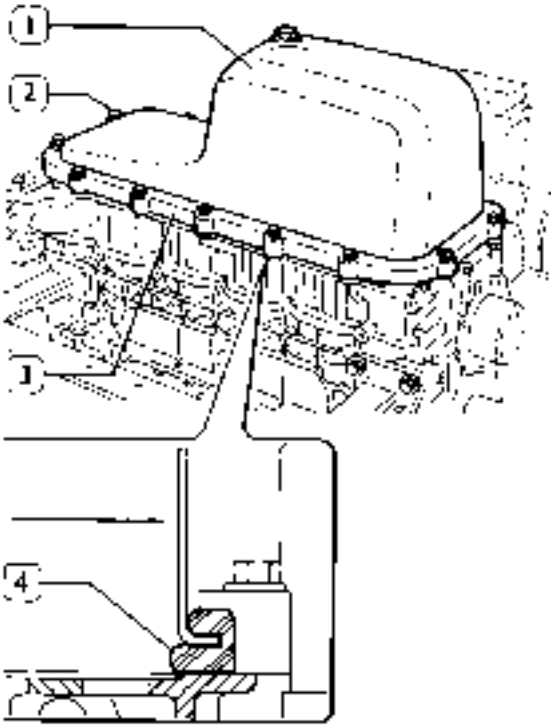


To install belts (1-3), use the appropriate tools (2-4,) to work on the tensioners, as shown by arrows.

Automatic tensioners do not require further adjustments after the installation.

- ❑ damping flywheel;
- ❑ fan;
- ❑ compressor;
- ❑ fuel pump;
- ❑ fuel filter and piping;
- ❑ pre-heating resistance;
- ❑ intake manifold;
- ❑ soundproof shields;
- ❑ heat exchanger;
- ❑ oil filter, lubricating the gasket;
- ❑ rockers caps;
- ❑ exhaust manifold;
- ❑ turbocharger and its oil and water piping;
- ❑ power take-off (P.T.O.) (if any) and related pipes;
- ❑ oil level stick and oil vapor vent;
- ❑ rotate the engine and install the oil rose pipe.

Figure 190



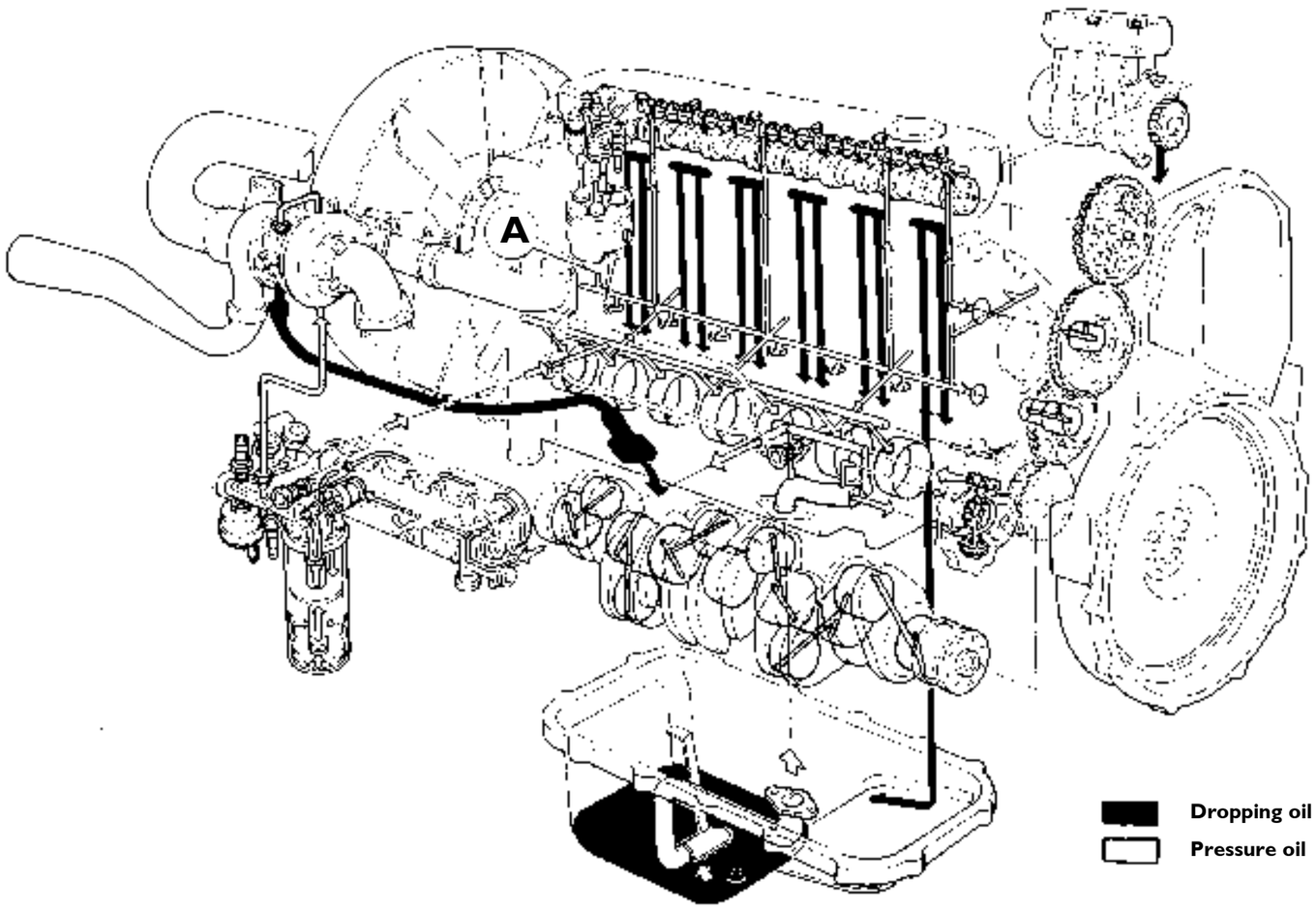
47573

- ❑ place the gasket (4) on the oil sump (1), position the spacer (3) and fit the sump to the engine block by tightening screws (2) to the prescribed torque;
- ❑ electric connections and sensors;
- ❑ remove the engine from the stand and fit the starter;
- ❑ fill the engine with the oil quantity required.

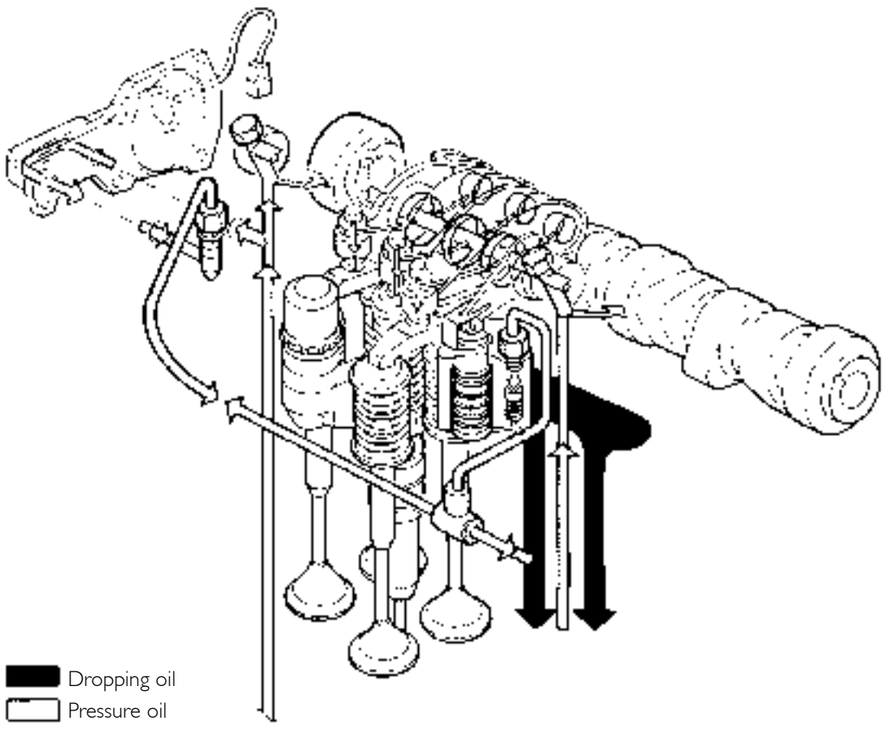
5430 LUBRICATION

Engine lubrication is obtained with a gear pump driven by the crankshaft via gears.
A heat exchanger governs the temperature of the lubricating oil.
The oil filter, signalling sensors and safety valves are installed in the intercooler.

Figure 191



Lubrication circuit

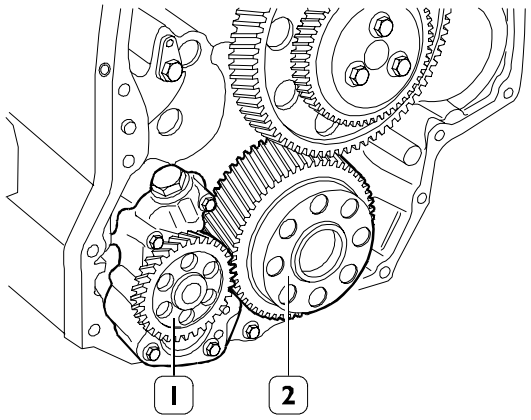


DETAIL A

44918

543010 Oil pump

Figure 192



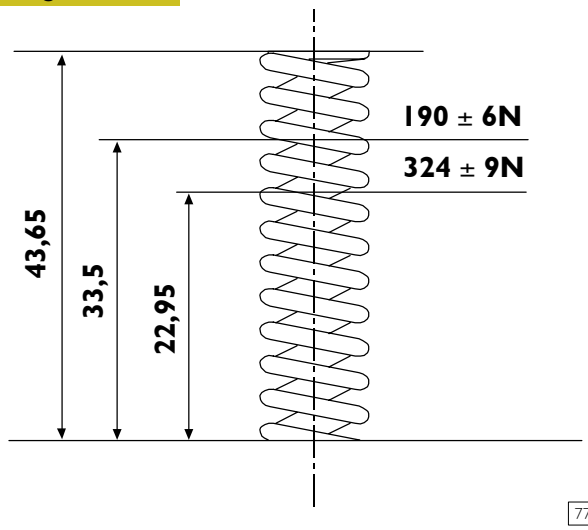
60560

The oil pump (1) cannot be overhauled. On finding any damage, replace the oil pump assembly.

See under the relevant heading for replacing the gear (2) of the crankshaft.

Overpressure valve

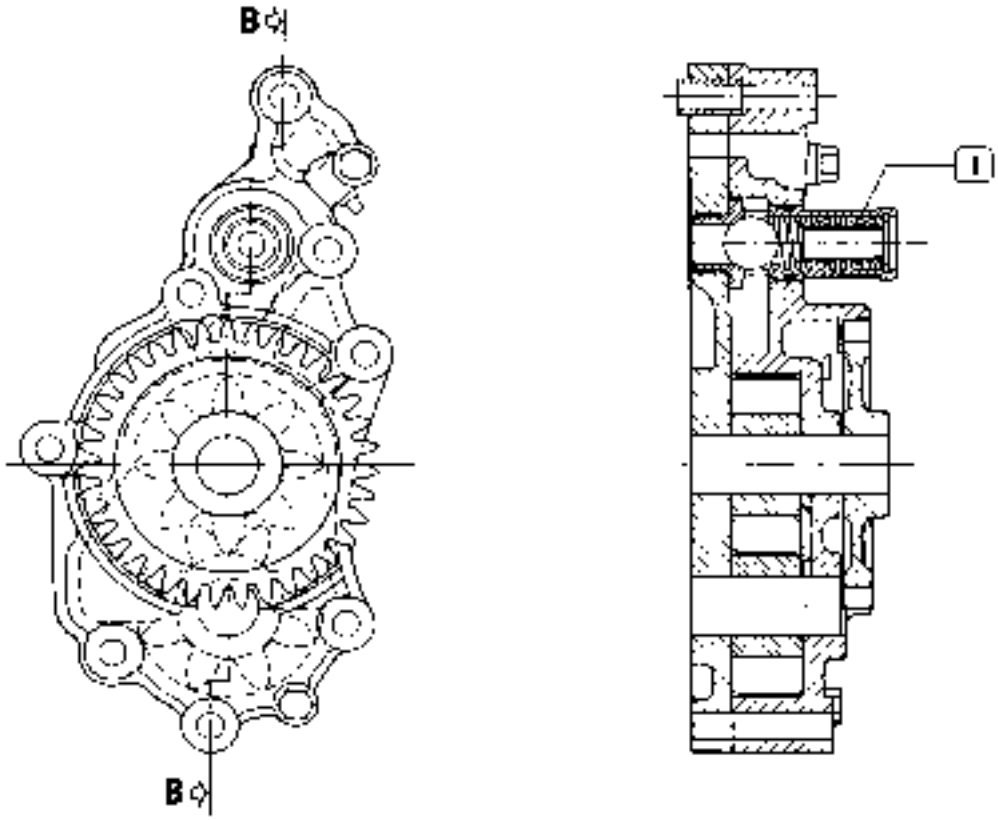
Figure 194



77820

MAIN DATA TO CHECK THE OVERPRESSURE VALVE SPRING

Figure 193



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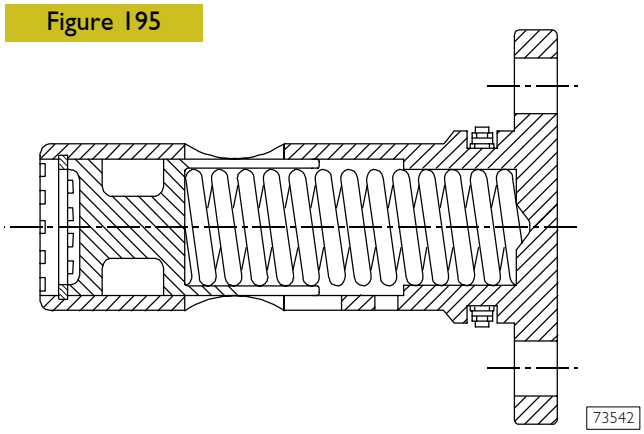
OIL PUMP CROSS-SECTION
1. Overpressure valve – Start of opening pressure 10.1 ± 0.7 bars

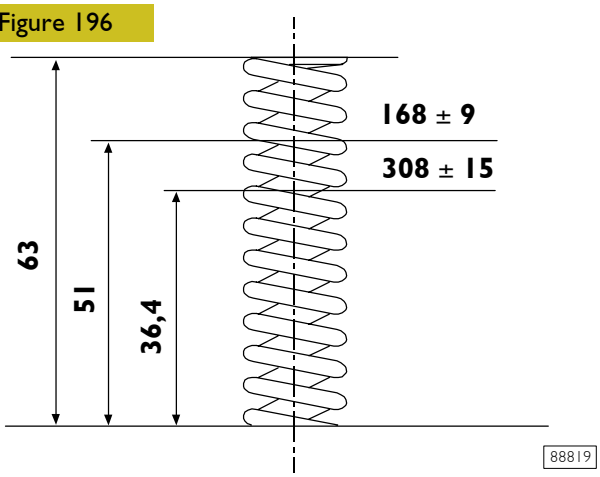
Oil pressure control valve

Figure 195



The oil pressure control valve is located on the left-hand side of the crankcase.
Start of opening pressure 5 bars.

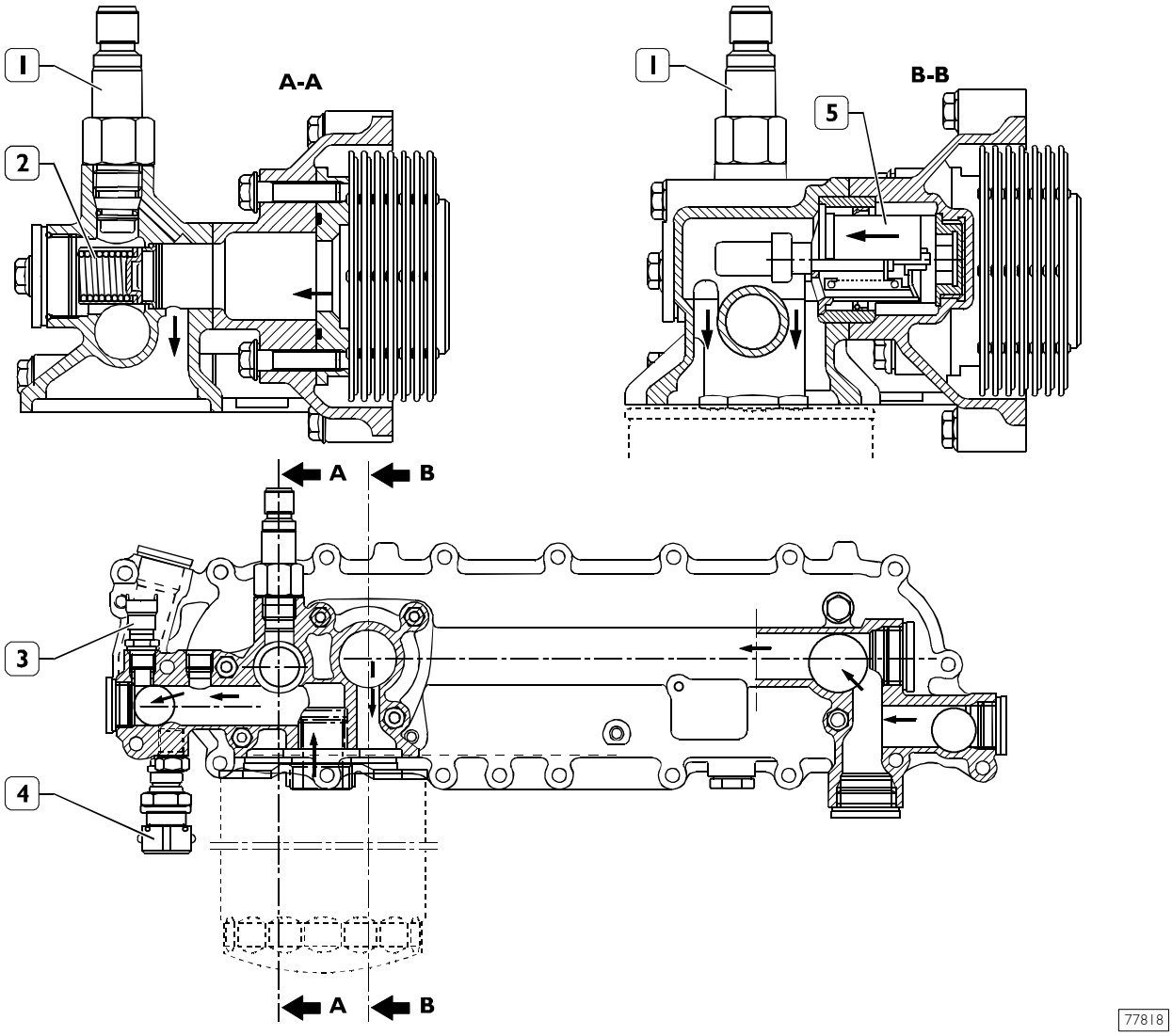
Figure 196



MAIN DATA TO CHECK THE OIL PRESSURE CONTROL VALVE SPRING

543110 Heat exchanger

Figure 197

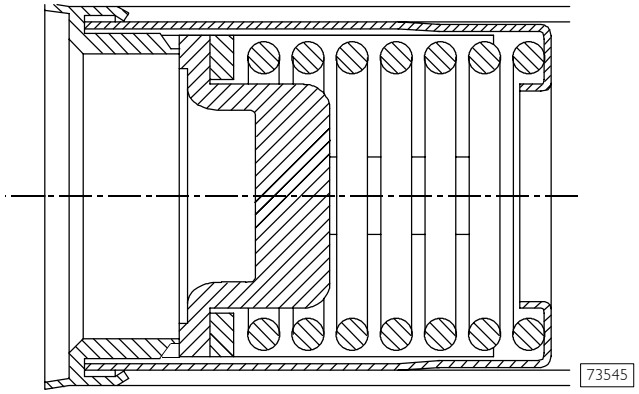


HEAT EXCHANGER

The following elements are fitted on the intercooler: 1. Transmitter for low pressure warning lamp - 2. By-pass valve - 3. Oil temperature sensor - 4. Oil pressure sensor for single gauge - 5. Heat valve. Number of intercooler elements: 7

By-pass valve

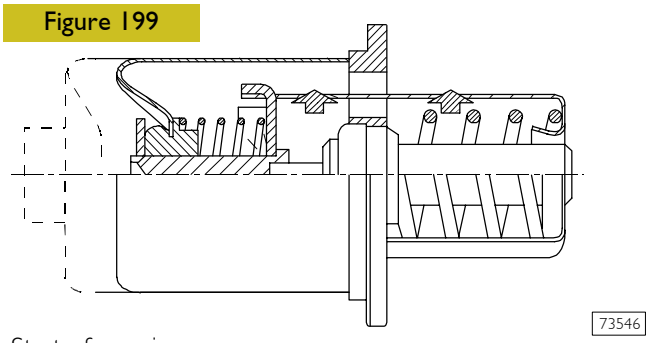
Figure 198



The valve quickly opens at a pressure of: 3 bars.

Thermostatic valve

Figure 199



Start of opening:

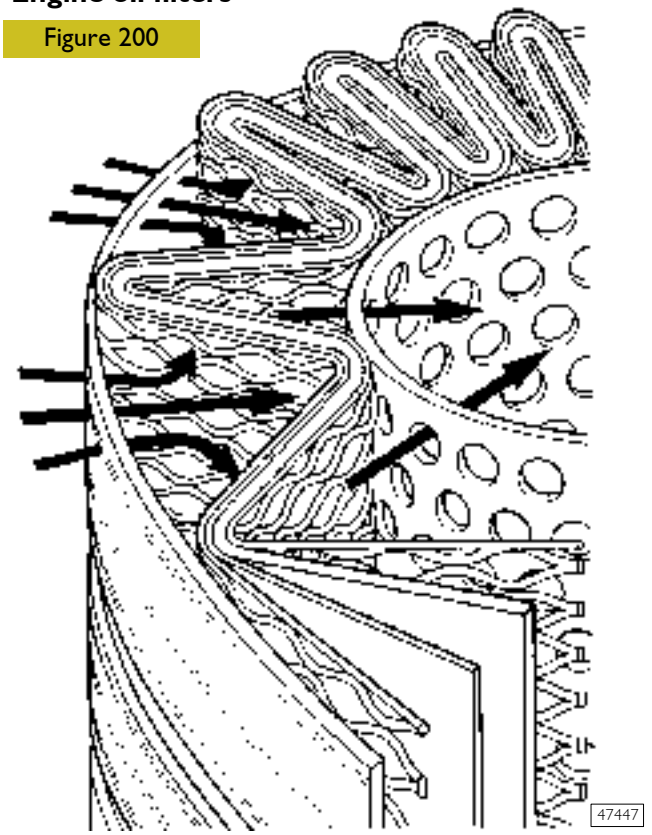
- travel 0.1 mm at a temperature of 82 ± 2°C.

End of opening:

- travel 8 mm at a temperature of 97°C.

Engine oil filters

Figure 200



This is a new generation of filters that permit much more thorough filtration as they are able to holder back a greater amount of particles of smaller dimensions than those held back by conventional filters with a paper filtering element.

These high-filtration devices, to date used only in industrial processes, make it possible to:

- reduce the wear of engine components over time;
- maintain the performance/specifications of the oil and thereby lengthen the time intervals between changes.

External spiral winding

The filtering elements are closely wound by a spiral so that each fold is firmly anchored to the spiral with respect to the others. This produces a uniform use of the element even in the worst conditions such as cold starting with fluids with a high viscosity and peaks of flow. In addition, it ensures uniform distribution of the flow over the entire length of the filtering element, with consequent optimization of the loss of load and of its working life.

Mount upstream

To optimize flow distribution and the rigidity of the filtering element, this has an exclusive mount composed of a strong mesh made of nylon and an extremely strong synthetic material.

Filtering element

Composed of inert inorganic fibres bound with an exclusive resin to a structure with graded holes, the element is manufactured exclusively to precise procedures and strict quality control.

Mount downstream

A mount for the filtering element and a strong nylon mesh make it even stronger, which is especially helpful during cold starts and long periods of use. The performance of the filter remains constant and reliable throughout its working life and from one element to another, irrespective of the changes in working conditions.

Structural parts

The o-rings equipping the filtering element ensure a perfect seal between it and the container, eliminating by-pass risks and keeping filter performance constant. Strong corrosion-proof bottoms and a sturdy internal metal core complete the structure of the filtering element.

When mounting the filters, keep to the following rules:

- Oil and fit new seals.
- Screw down the filters to bring the seals into contact with the supporting bases.
- Tighten the filter to a torque of 35÷40 Nm.

5432 COOLING

Description

The engine cooling system works with forced circulation inside closed circuit and can be connected to an additional heater (if any) and to the intarder intercooler.
It consists mainly of the following components:

- ❑ an expansion reservoir whose plug (1) incorporates two valves – discharge and charge – controlling the system pressure.
- ❑ a coolant level sensor placed at the bottom of the expansion reservoir with two coupling points:
  - coupling point for sensor S1 6 litres
  - coupling point for sensor S2 3.7 litres
- ❑ an engine cooling unit to dissipate the heat taken by the coolant from the engine through the intercooler.
- ❑ a heat exchanger to cool down lubrication oil;
- ❑ a water pump with centrifugal system incorporated in the cylinder block;
- ❑ an electric fan consisting of a 2-speed electro-magnetic joint equipped with a neutral wheel shaft hub fitted with a metal plate moving along the axis and where the fan is installed. It is controlled electronically by the vehicle Multiplex system.
- ❑ a 3-way thermostat controlling the coolant circulation.

Operation

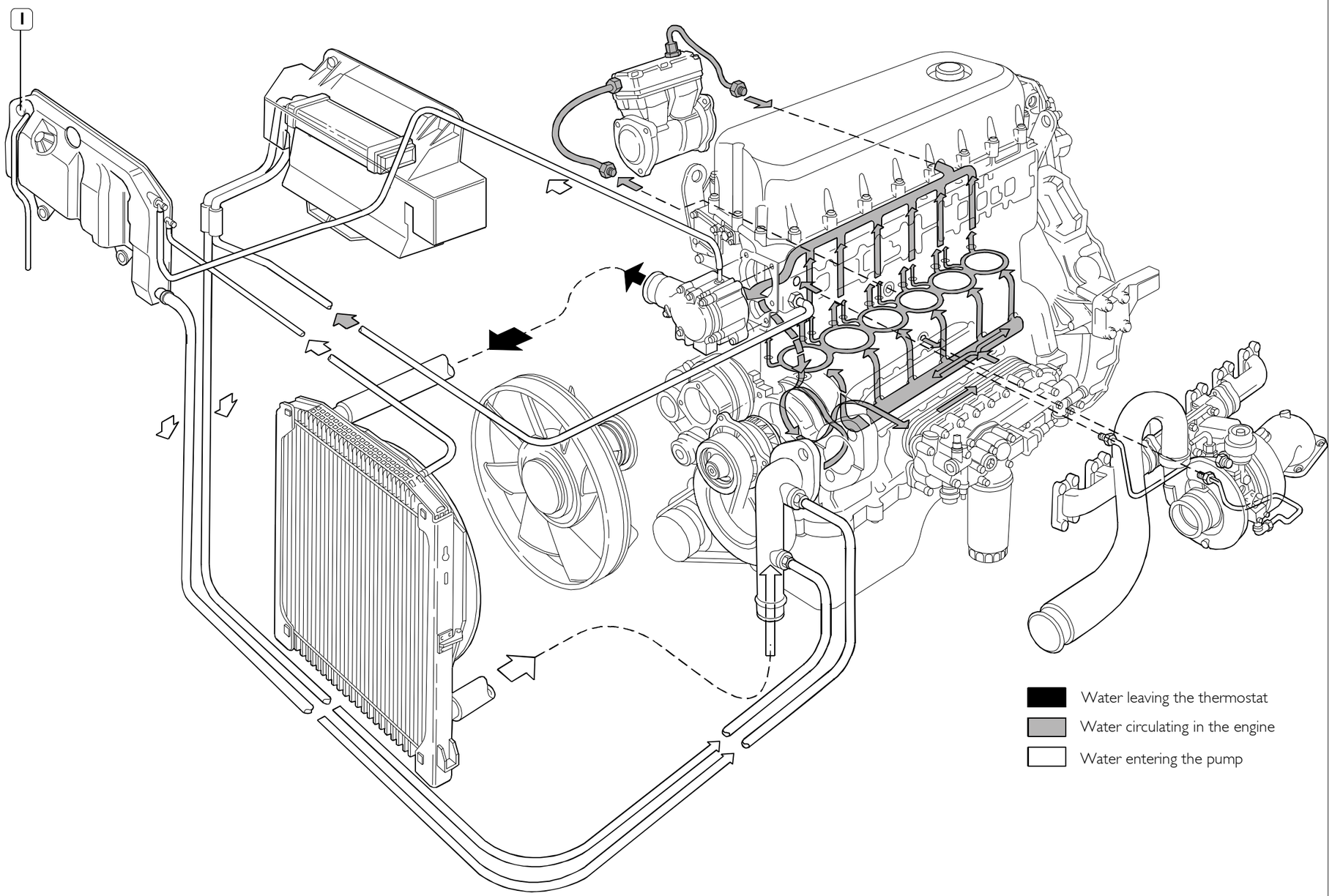
The water pump is actuated by the crankshaft through a poli-V belt and sends coolant to the cylinder block, especially to the cylinder head (bigger quantity). When the coolant temperature reaches and overcomes the operating temperature, the thermostat is opened and from here the coolant flows into the radiator and is cooled down by the fan.
The pressure inside the system depending on the temperature variation is controlled by the discharge and charge valves incorporated in the expansion reservoir filling plug (1).
The discharge valve has a double function:

- ❑ keep the system under light pressure in order to raise the coolant boiling point;
- ❑ discharge the pressure surplus in the atmosphere as a result of the coolant high temperature.

The charge valve makes it possible to transfer the coolant from the expansion reservoir to the radiator when a depression is generated inside the system as a result of the coolant volume reduction depending on the fall in the coolant temperature.
Discharge valve opening:

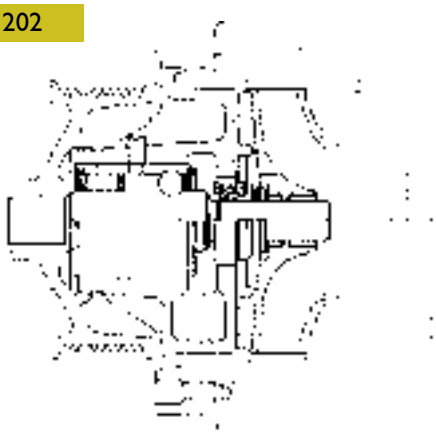
• 1st breather	0.9 $^{+0.2}_{-0.1}$	bar
• 2nd breather	1.2 $^{+0.2}_{-0.1}$	bar
Charge valve opening	-0.03 $^{+0}_{-0.02}$	bar

Figure 201



543210 Water pump

Figure 202



WATER PUMP SECTION

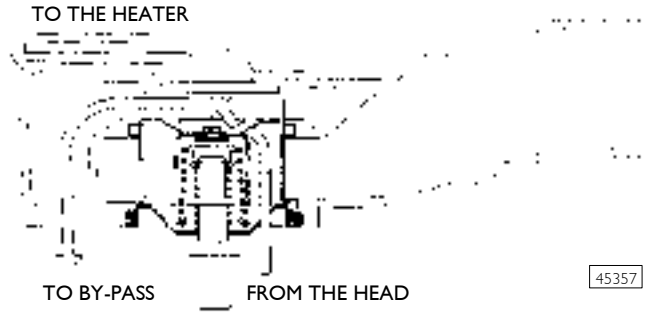
The water pump consists of: rotor, seal bearing and control pulley.

Make sure that the pump casing has no cracking or water leakage; otherwise, replace the entire pump.

543250 Thermostat

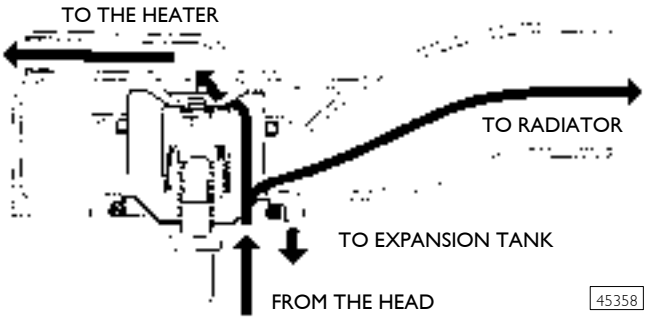
THERMOSTAT OPERATION VIEW

Figure 203



Water circulating in the engine

Figure 204



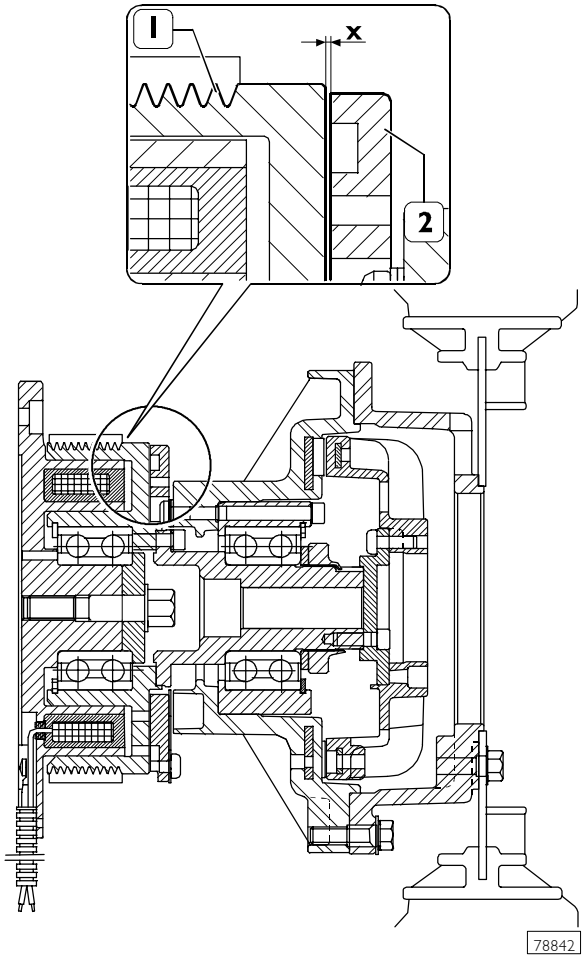
Water issuing from thermostat

Check the thermostat works properly; replace it if in doubt.

Temperature of start of travel 84°C ±2°C.
Minimum travel 15 mm at 94°C ±2°C.

543210 Electromagnetic coupling

Figure 205



ELECTROMAGNETIC COUPLING SECTION

The electro-magnetic joint action depends on:

- ❑ the coolant temperature;
- ❑ the climate control system fluid pressure (if any);
- ❑ the slowing down action of the intarder on (if any).

Coolant temperature for:

- ❑ engagement 93°C
- ❑ disengagement 88°C

With climate control system

Climate control system fluid pressure:

- ❑ 2nd speed engagement 22 bar

With intarder

With braking power below 41% of maximum power.
Coolant temperature for:

- ❑ 2nd speed engagement 93°C
- ❑ disengagement 88°C

With braking power over 41% of maximum power:
Coolant temperature for:

- ❑ 2nd speed engagement 85°C
- ❑ disengagement 80°C

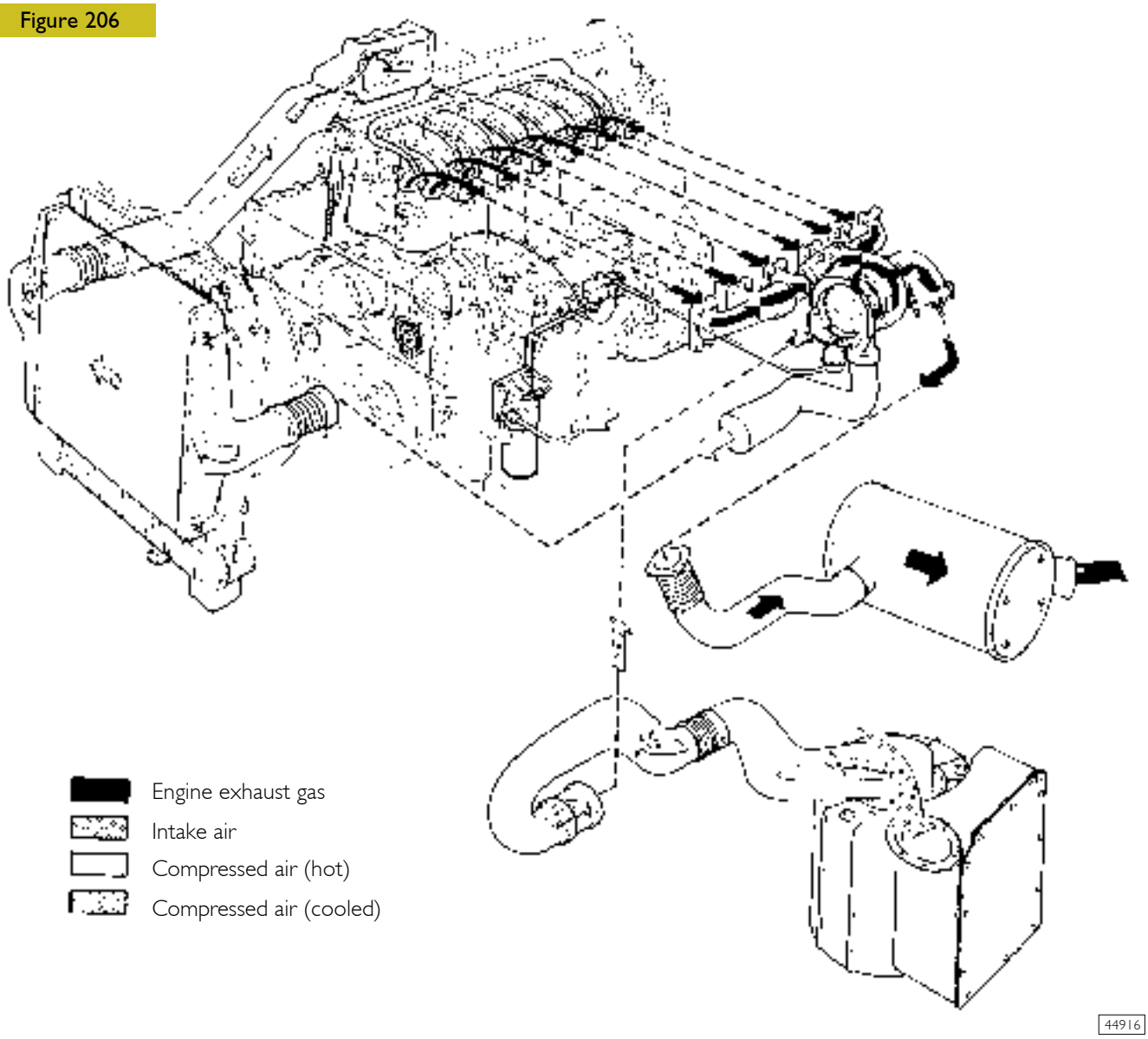
Using a feeler gauge, check the gap between the anchor assembly (2) and the pulley (1), it must be no greater than 2.5 mm.
As to the description of the electro-magnetic joint operation and servicing, see the "Manual for electric/electronic system repairing" St. 603.93.191.

5424 TURBOCHARGING

The turbocharging system consists of:

- air filter;
- variable geometry turbocharger;
- "intercooler" radiator.

Figure 206



TURBOCHARGING DIAGRAM

TURBOCHARGER

Operating principle

The variable geometry turbocharger (VGT) consists of a centrifugal compressor and a turbine, equipped with a mobile device which adjusts the speed by changing the area of the passing section of exhaust gases to the turbine.

Thanks to this solution, gas velocity and turbine speed can be high even when the engine is idling.

If the gas is made to go through a narrow passage, in fact, it flows faster, so that the turbine rotates more quickly.

The movement of the device, choking the exhaust gas flowing section, is carried out by a mechanism, activated by a pneumatic actuator.

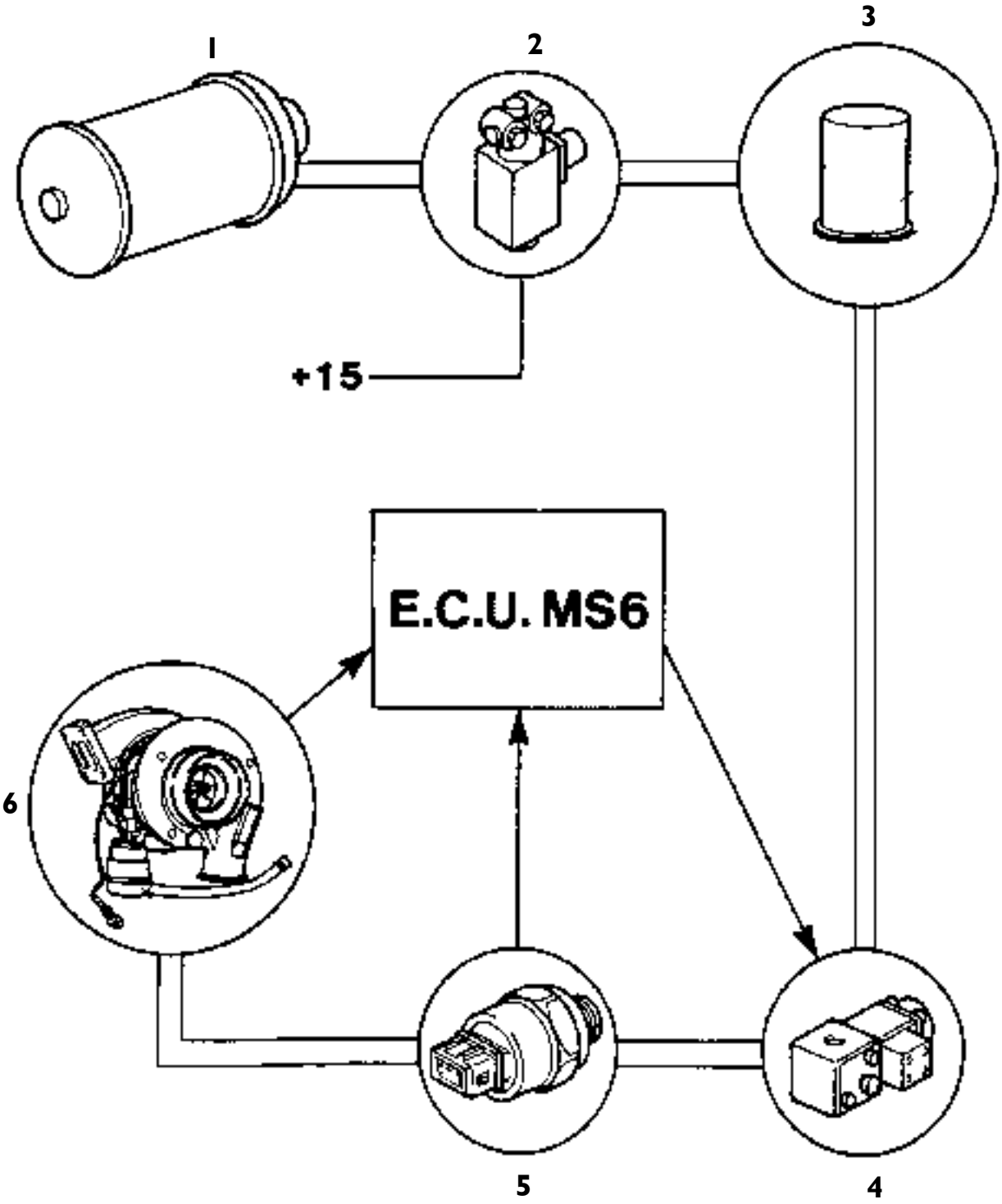
This actuator is directly controlled by the electronic control unit by a proportional solenoid valve.

The device is in maximum closing condition at idle speed.

At high engine operating speed, the electronic control system is activated and increases the passing section, in order to allow the in-coming gases to flow without increasing their speed.

A toroidal chamber is obtained during the casting process in the central body for the passage of the coolant.

Figure 207

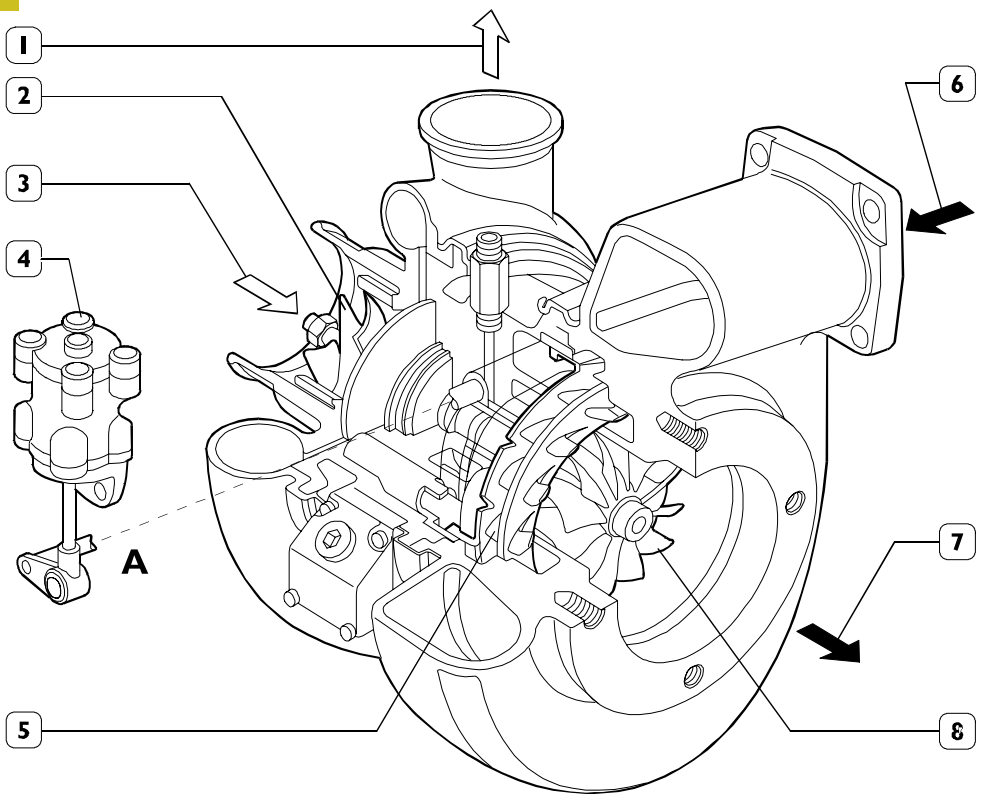


CONTROL AIR SYSTEM DIAGRAM

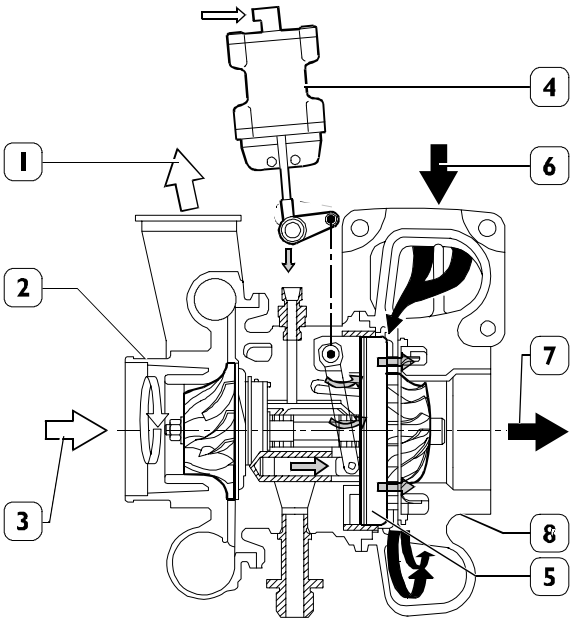
1) Service tank
2) Shut-off solenoid valve
3) Air filter
4) VGT control solenoid valve
5) Actuator pressure sensor
6) Turbine actuator

TURBO COMPRESSOR HOLSET HX 40V

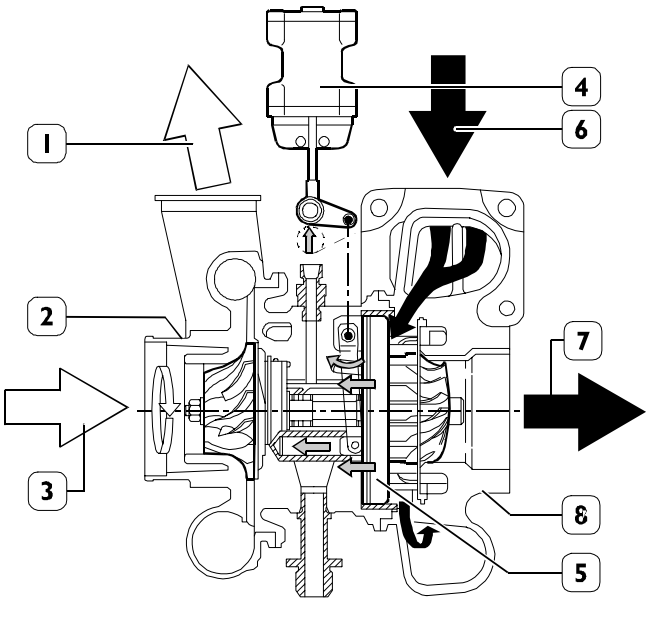
Figure 208



1. Air delivery to the intake manifold - 2. Compressor - 3. Air inlet - 4. Actuator - 5. Exhaust gas speed governor - 6. Exhaust gas inlet - 7. Exhaust gas outlet - 8. Turbine



CROSS-SECTION OF MINIMUM FLOW



CROSS-SECTION OF MAXIMUM FLOW

CROSS-SECTION OF TURBOCHARGER

1. Air delivery to the intake manifold - 2. Compressor - 3. Air inlet - 4. Actuator - 5. Exhaust gas flow-rate adjustment ring - 6. Exhaust gas inlet - 7. Exhaust gas outlet - 8. Turbine - 9. Exhaust gas flow-rate control fork

Figure 209

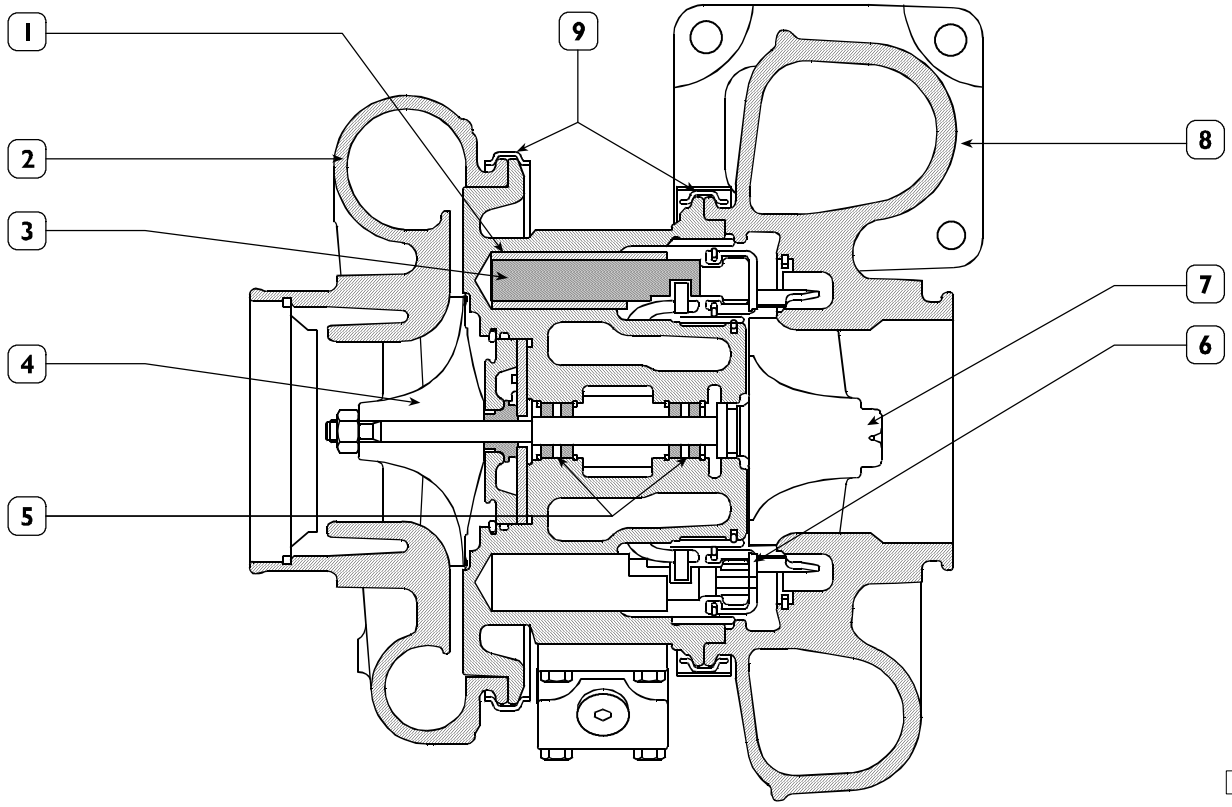
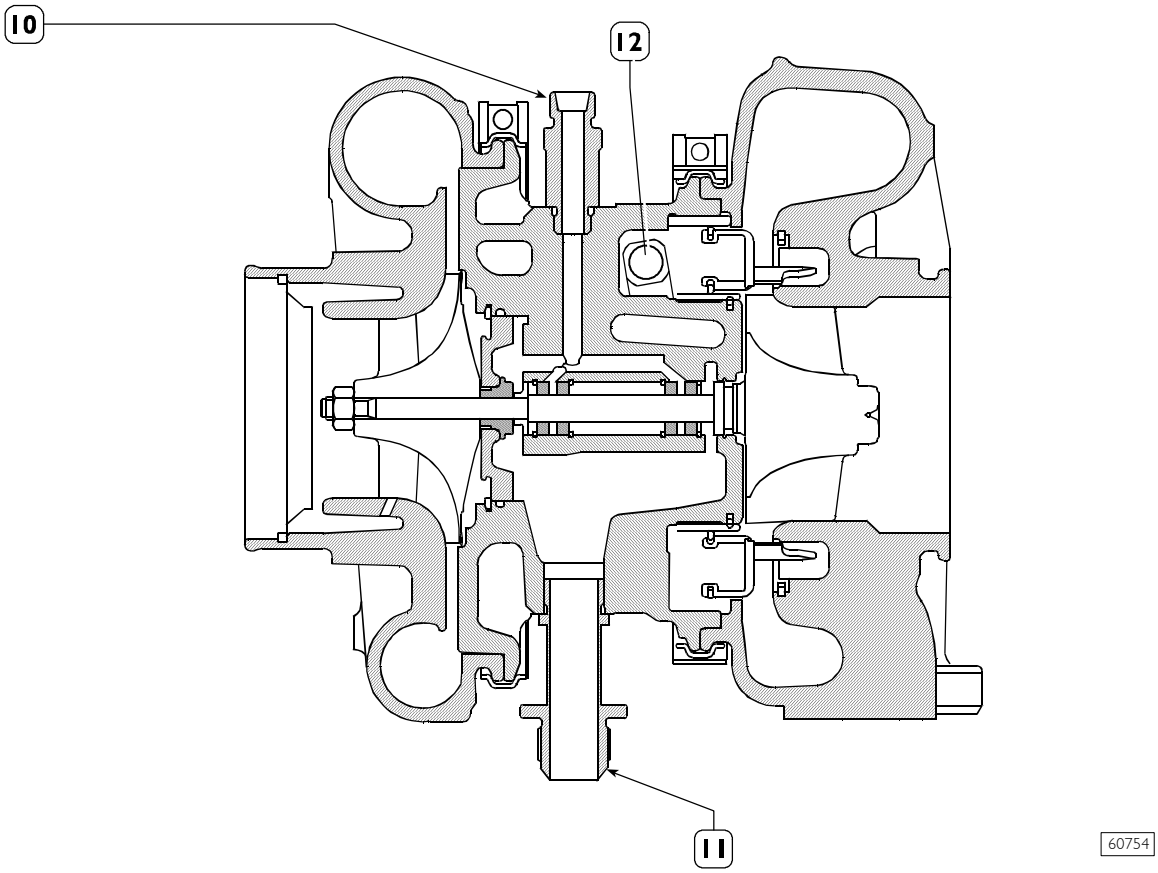
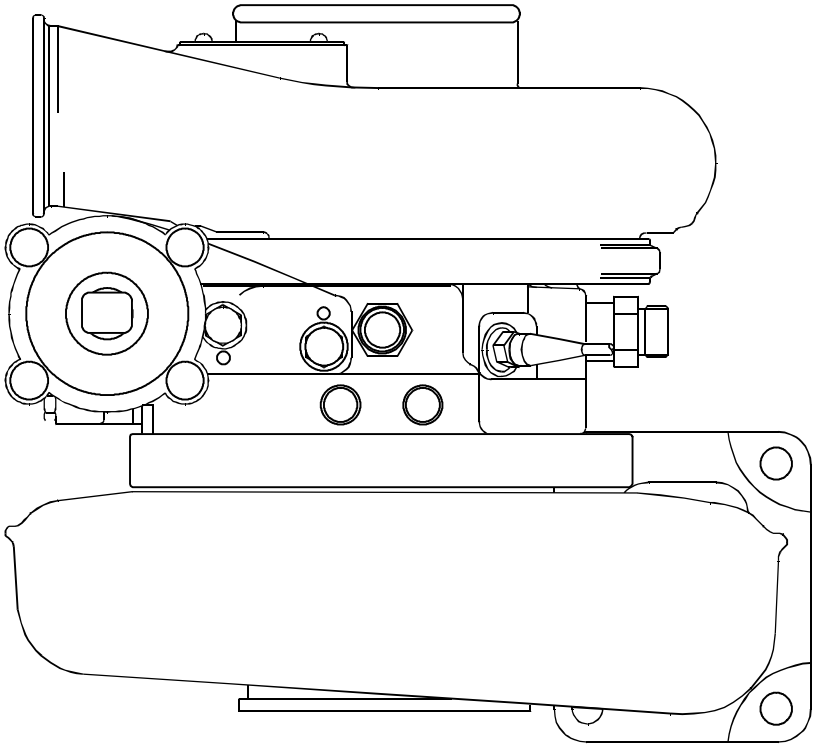


Figure 210



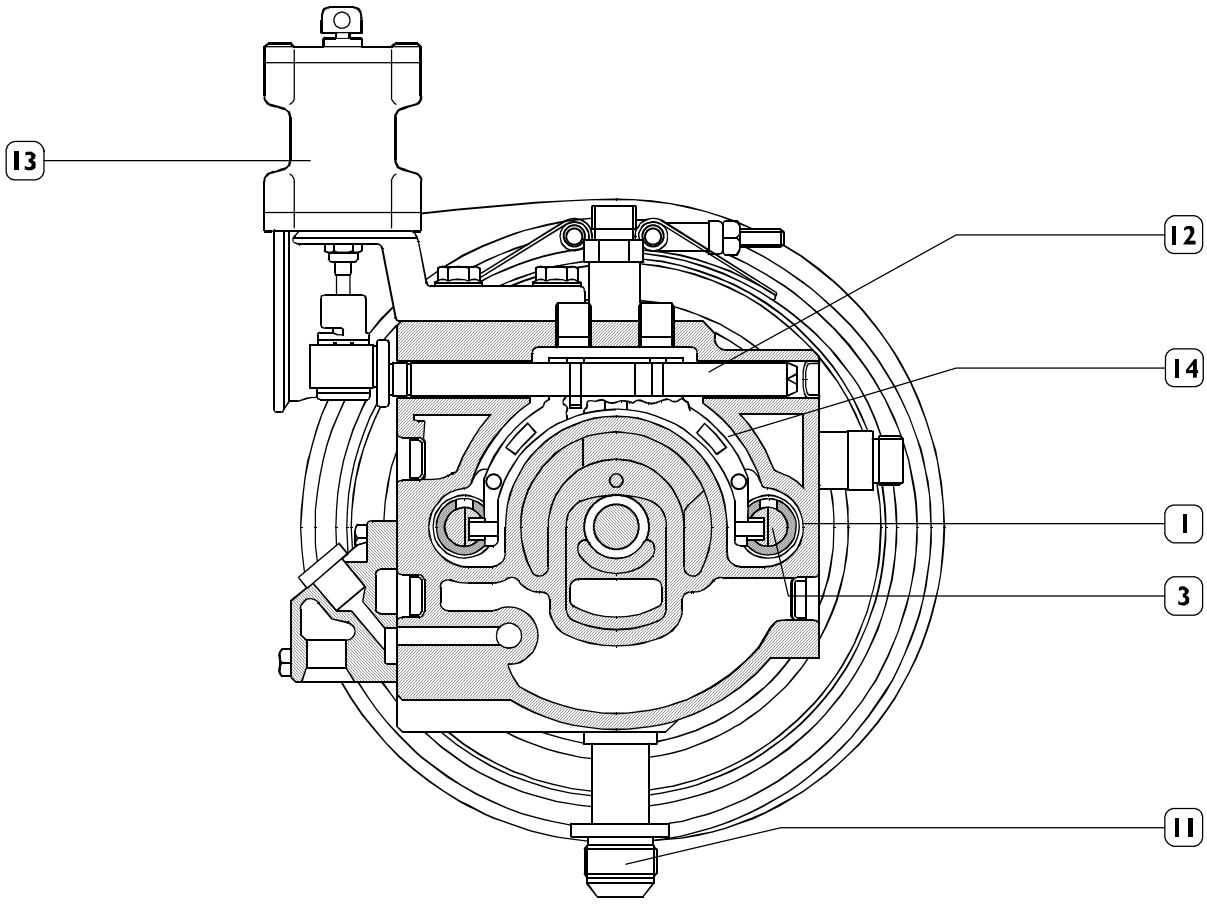
1. Slide guide - 2. Compressor - 3. Slide rods - 4. Compressor fan - 5. Lubrication bushings - 6. Exhaust gas flow-rate adjustment ring - 7. Exhaust gas fan - 8. Gas exhaust body - 9. Locking rings - 10. Oil delivery - 11. Oil outlet - 12. Actuator drive shaft

Figure 211



71762

Figure 212

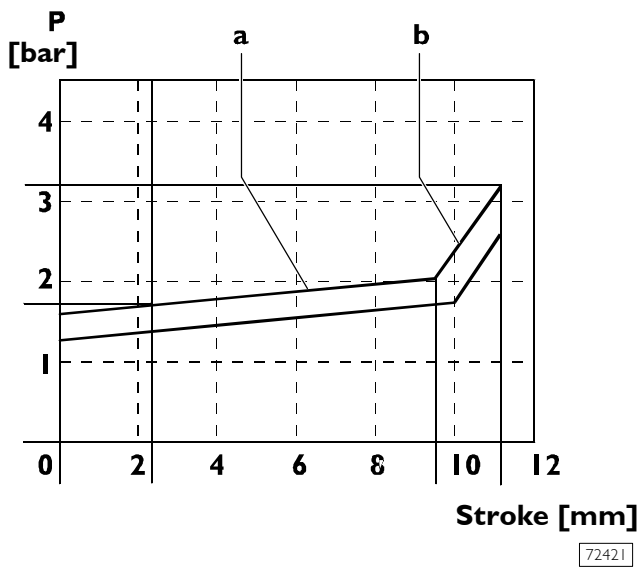


71763

1. Slide guide - 3. Slide rod - 11. Oil outlet - 12. Actuator drive shaft - 13. Actuator - 14. Exhaust gas flow-rate control fork

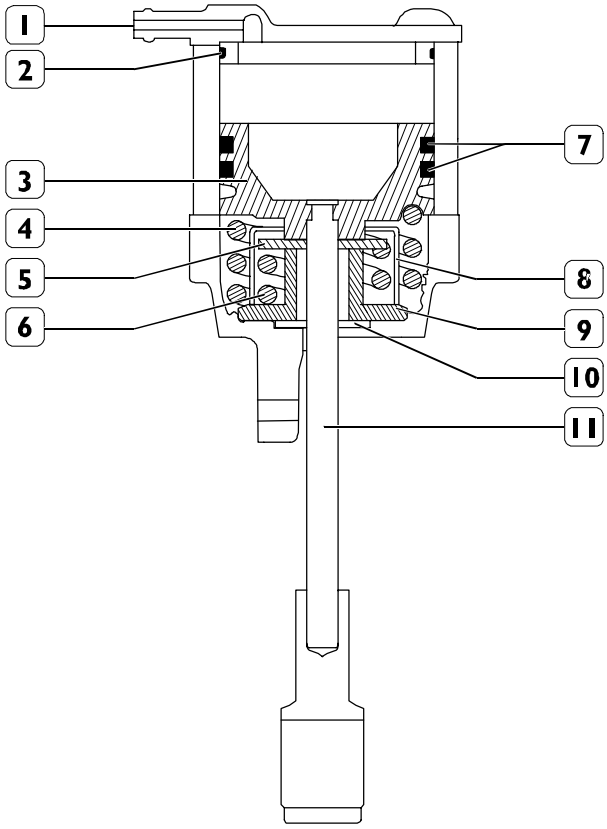
Actuator

Figure 213



a Gradient characterized by the effect of the external spring (4).

b Gradient characterized by the effect of the external (4) and internal (6) springs.



1. Air inlet - 2. Gasket - 3. Piston - 4. External spring - 5. Internal spring control disc - 6. Internal spring - 7. O-ring - 8. Spring holder - 9. Limit stop - 10. Dust seal - 11. Control rod

Working principle

The actuator piston, connected to the drive rod, is controlled with the compressed air introduced through the air inlet (1) on the top of the actuator.

Modulating the air pressure varies the movement of the piston and turbine control rod. As the piston moves, it progressively compresses the external spring (4) until the base of the piston reaches the disc (5) controlling the internal spring (6).

On further increasing the pressure, the piston, via the disc (5), interferes with the bottom limit stop (10).

Using two springs makes it possible to vary the ratio between the piston stroke and the pressure. Approximately 85% of the stroke of the rod is opposed by the external spring and 15% by the internal one.

Solenoid valve for VGT control

This N.C. proportional solenoid valve is located on the left-hand side of the crankcase under the turbine.

The electronic control unit, via a PWM signal, controls the solenoid valve, governing the supply pressure of the turbine actuator, which, on changing its position, modifies the cross-section of the flow of exhaust gases onto the blades of the impeller and therefore its speed.

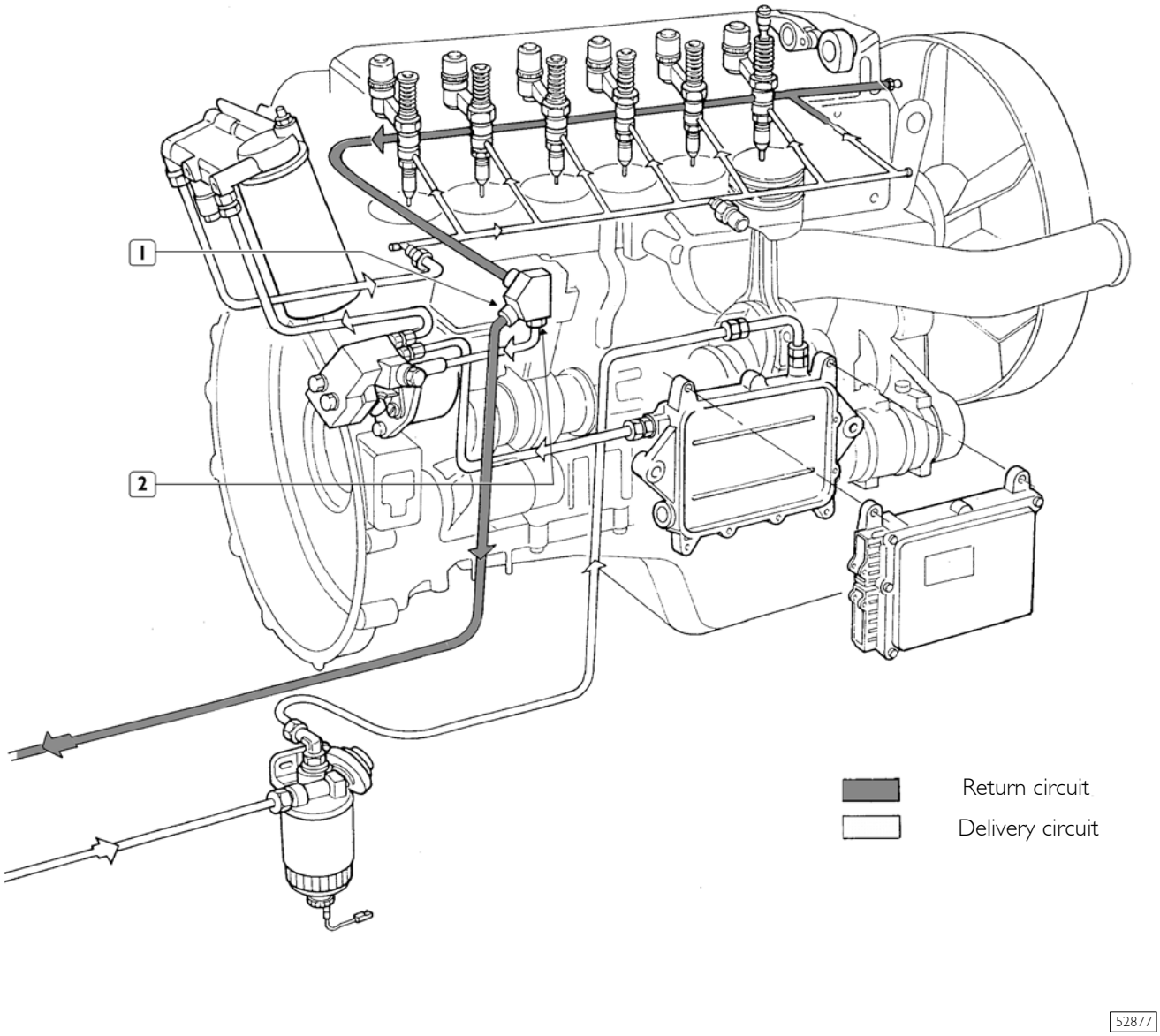
The VGT solenoid valve is connected to the electronic control unit between pins A18/A31.

The resistance of the coil is approx. 20-30 Ohms.

FUEL FEED

Fuel feed is obtained by means of a pump, fuel filter and pre-filter, 6 pump-injectors controlled by the camshaft by means of rockers and by the electronic control unit.

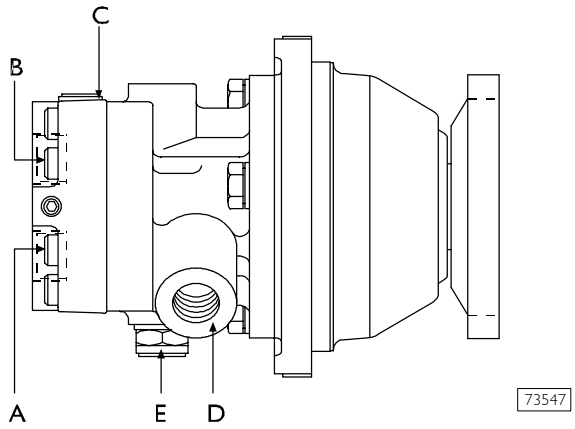
Figure 214



1. Valve for return circuit, starts opening 0.2 bar - 2. Valve for return circuit, starts opening 3.5 bar

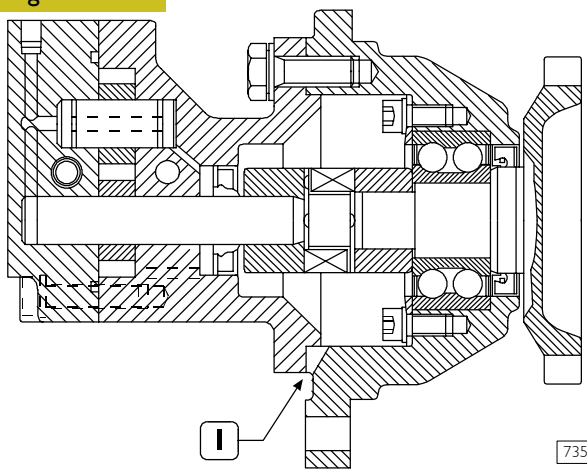
Fuel pump

Figure 215



A. Fuel inlet – B. Fuel delivery – C. By-pass nut – D. Fuel return from the pump-injectors – E. Pressure relief valve – Opening pressure: 5-8 bars

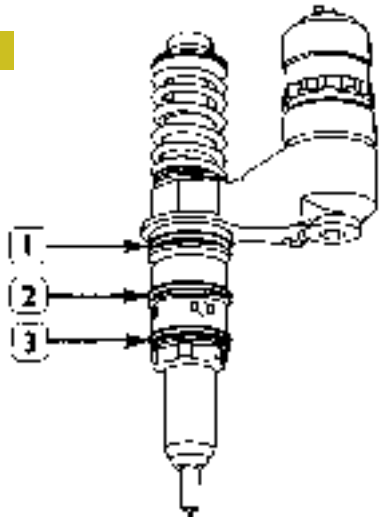
Figure 216



CROSS-SECTION OF THE FUEL PUMP
1. Oil and fuel leakage indicator

Injector-pump

Figure 217



1. Fuel/oil seal – 2. Fuel/diesel seal – 3. Fuel/exhaust gas seal

The injector-pump is composed of: pumping element, nozzle, solenoid valve.

Pumping element

The pumping element is operated by a rocker arm governed directly by the cam of the camshaft.
The pumping element is able to ensure a high delivery pressure. The return stroke is made by means of a return spring.

Nozzle

Garages are authorized to perform fault diagnosis solely on the entire injection system and may not work inside the injector-pump, which must only be replaced.
A specific fault-diagnosis program, included in the control unit, is able to check the operation of each injector (it deactivates one at a time and checks the delivery of the other five).
Fault diagnosis makes it possible to distinguish errors of an electrical origin from ones of a mechanical/hydraulic origin.
It indicates broken pump-injectors.
It is therefore necessary to interpret all the control unit error messages correctly.
Any defects in the injectors are to be resolved by replacing them.

Solenoid valve

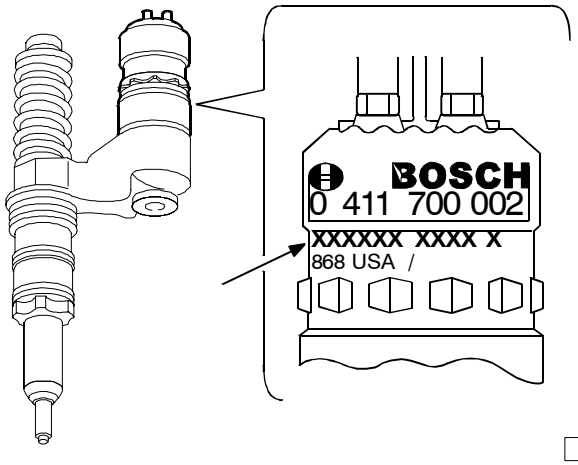
The solenoid, which is energized at each active phase of the cycle, via a signal from the control unit, controls a slide valve that shuts off the pumping element delivery pipe.
When the solenoid is not energized, the valve is open, the fuel is pumped but it flows back into the return pipe with the normal transfer pressure of approximately 5 bars.
When the solenoid is energized, the valve shuts and the fuel, not being able to flow back into the return pipe, is pumped into the nozzle at high pressure, causing the needle to lift.
The amount of fuel injected depends on the length of time the slide valve is closed and therefore on the time for which the solenoid is energized.
The solenoid valve is joined to the injector body and cannot be removed.
On the top there are two screws securing the electrical wiring from the control unit.
To ensure signal transmission, tighten the screws with a torque wrench to a torque of 1.36 – 1.92 Nm (0.136 – 0.192 kgm).

775010 Replacing injectors-pump

Injectors have to be replaced with great care (for their removal see the description on pages 44 and 45, for fitting them see the description on pages 85 and 86).

If this job is done with the engine on the vehicle, before removing the injectors-pump drain off the fuel contained in the pipes in the cylinder head by unscrewing the delivery and return fittings on the cylinder head.

Figure 218

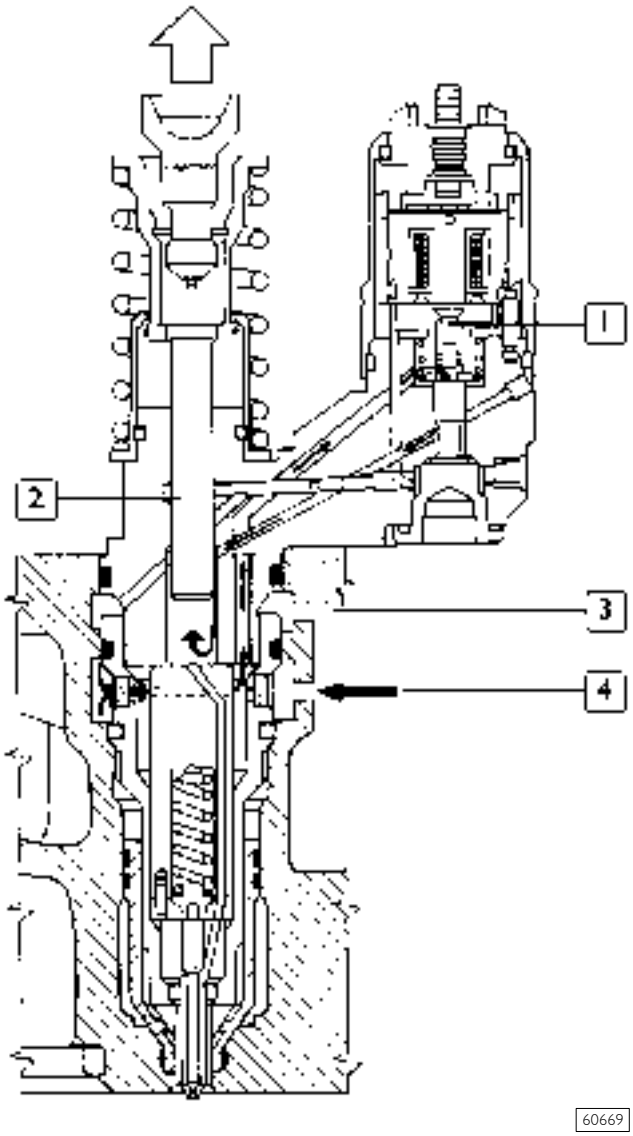


For each injector replaced, hook up to the MODUS station and, when asked by the program, enter the code punched on the injector (→) to reprogram the control unit.

When checking the clearance of the rocker arms, it is important to check the injector-pump pre-load.

Injector Phases

Figure 219

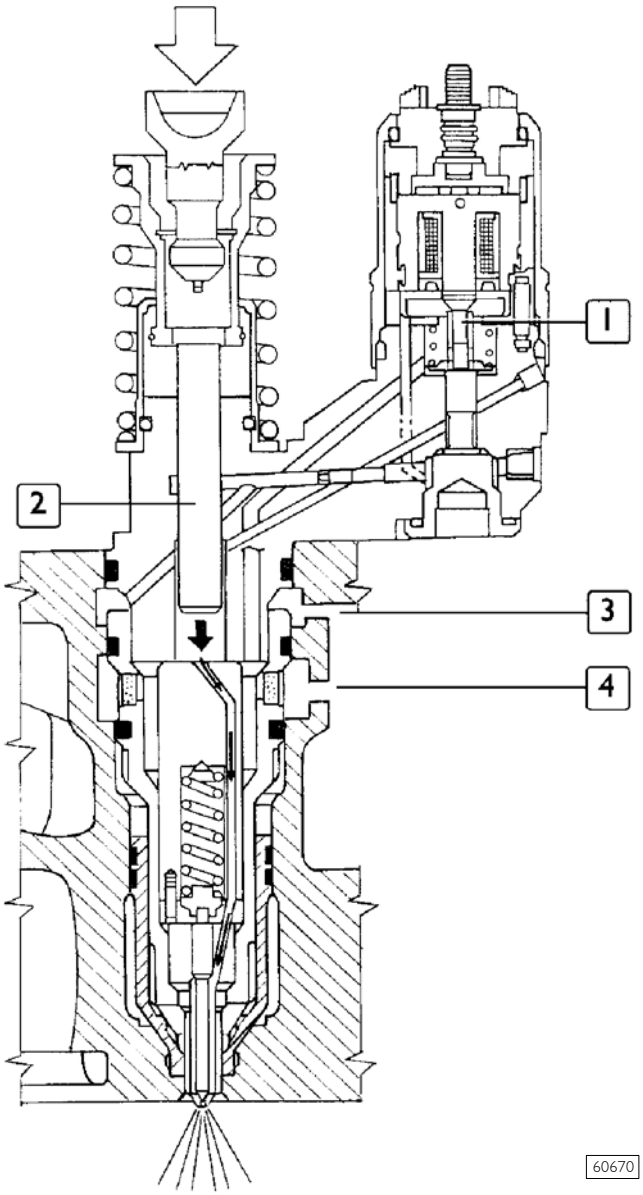


1. Fuel valve - 2. Pumping element - 3. Fuel outlet - 4. Filling and backflow passage

Filling phase

During the filling phase the pumping element (2) runs up to the top position.
After passing the highest point of the cam, the rocker arm roller comes near the base ring of the cam.
The fuel valve (1) is open and fuel can flow into the injector via the bottom passage (4) of the cylinder head.
Filling continues until the pumping element reaches its top limit.

Figure 220



1. Fuel valve - 2. Pumping element - 3. Fuel outlet - 4. Filling and backflow passage

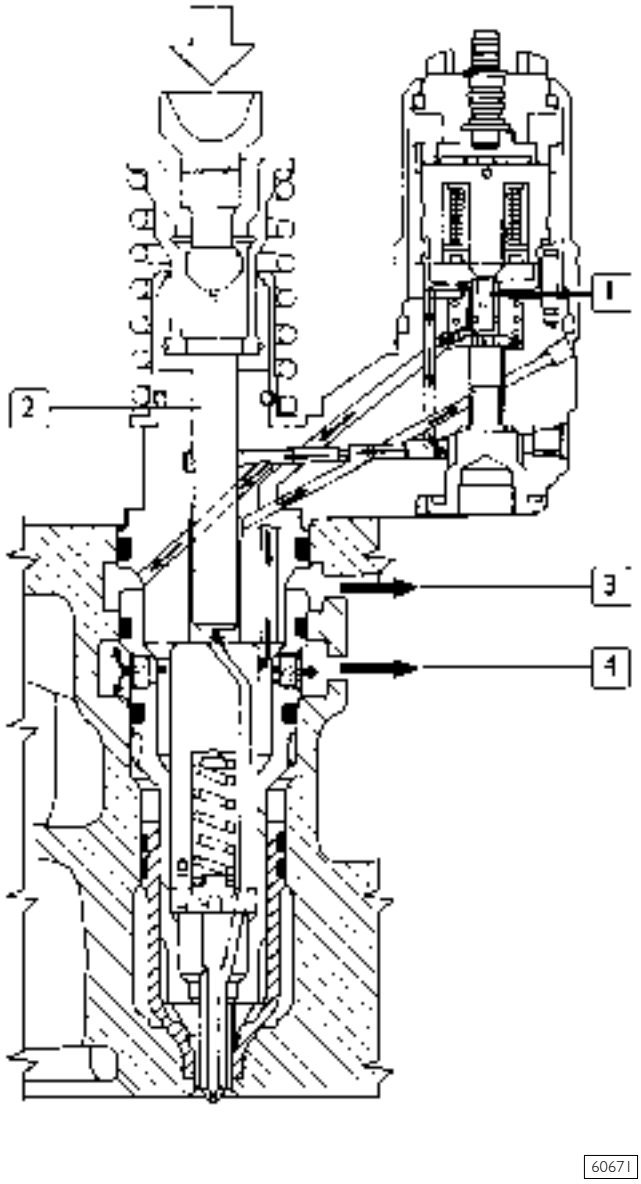
Injection phase

The injection phase begins when, at a certain point in the down phase of the pumping element, the solenoid valve gets energized and the fuel valve (1) shuts.

The moment delivery begins, appropriately calculated by the electronic control unit, depends on the working conditions of the engine.

The cam continues with the rocker arm to push the pumping element (2) and the injection phase continues as long as the fuel valve (1) stays shut.

Figure 221



1. Fuel valve - 2. Pumping element - 3. Fuel outlet - 4. Filling and backflow passage

Pressure Reduction phase

Injection ceases when the fuel valve (1) opens, at a certain point in the down stroke of the pumping element, after the solenoid valve gets de-energized.

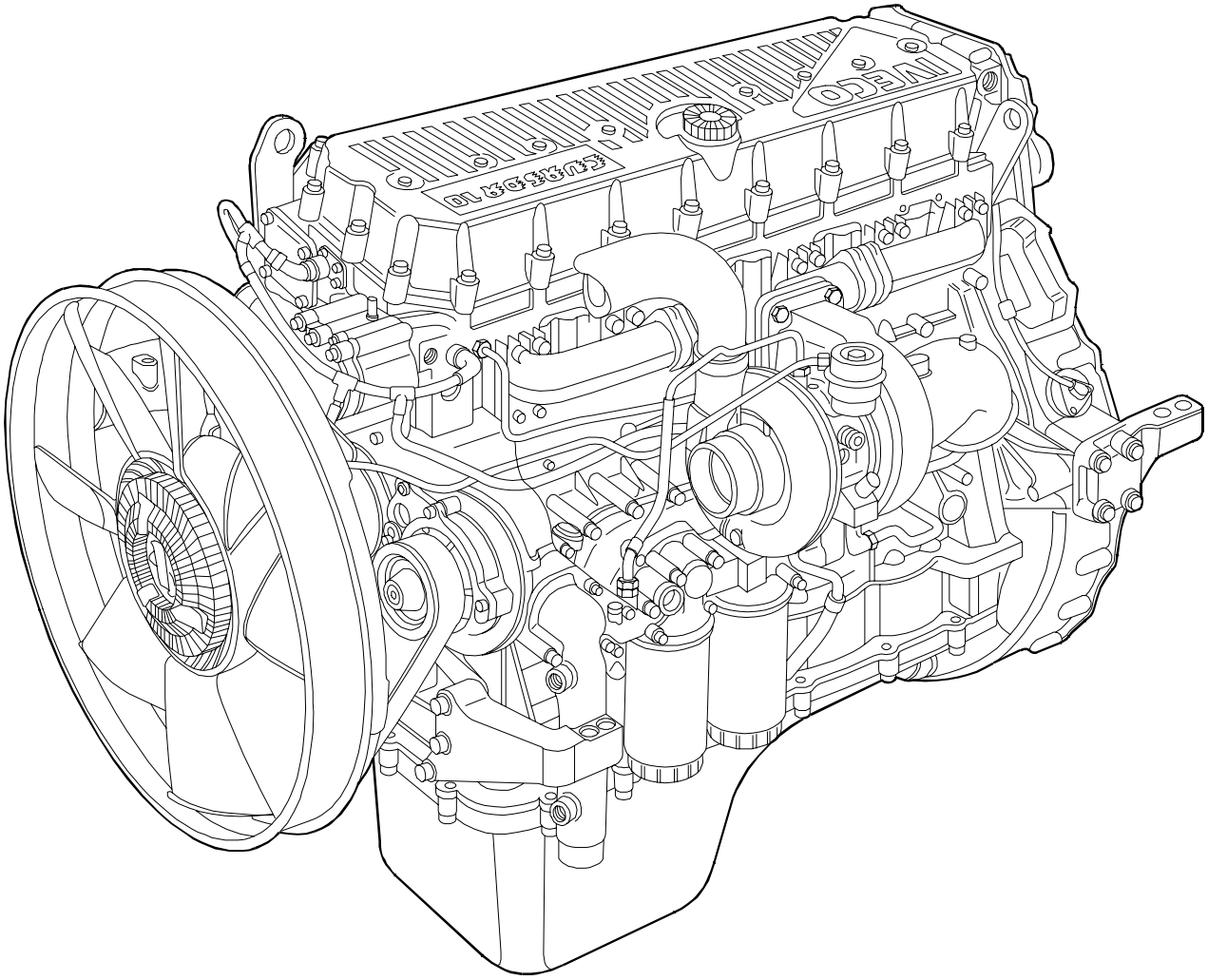
The fuel flows back through the open valve (1), the injector holes and the passage (4) into the cylinder head.

The time for which the solenoid valve stays energized, appropriately calculated by the electronic control unit, is the duration of injection (delivery) and it depends on the working conditions of the engine.

F3A Engine

VIEWS OF THE ENGINE

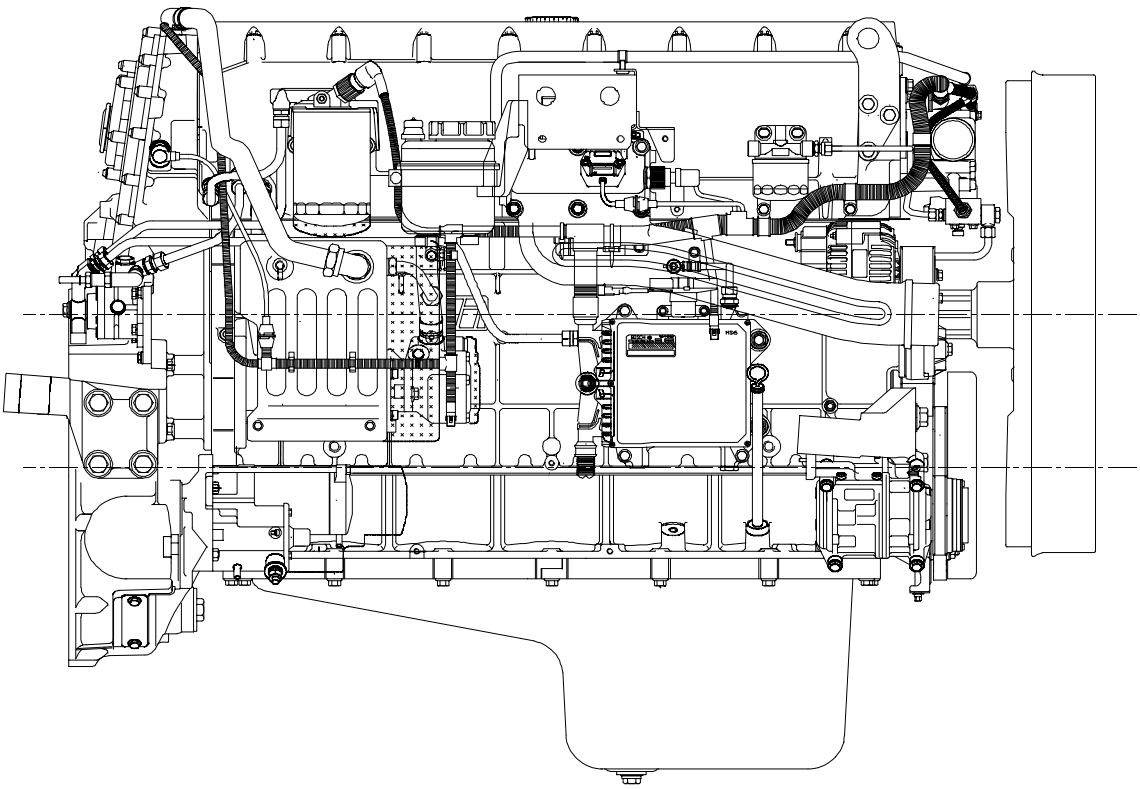
Figure 1



73835

F3A ENGINE

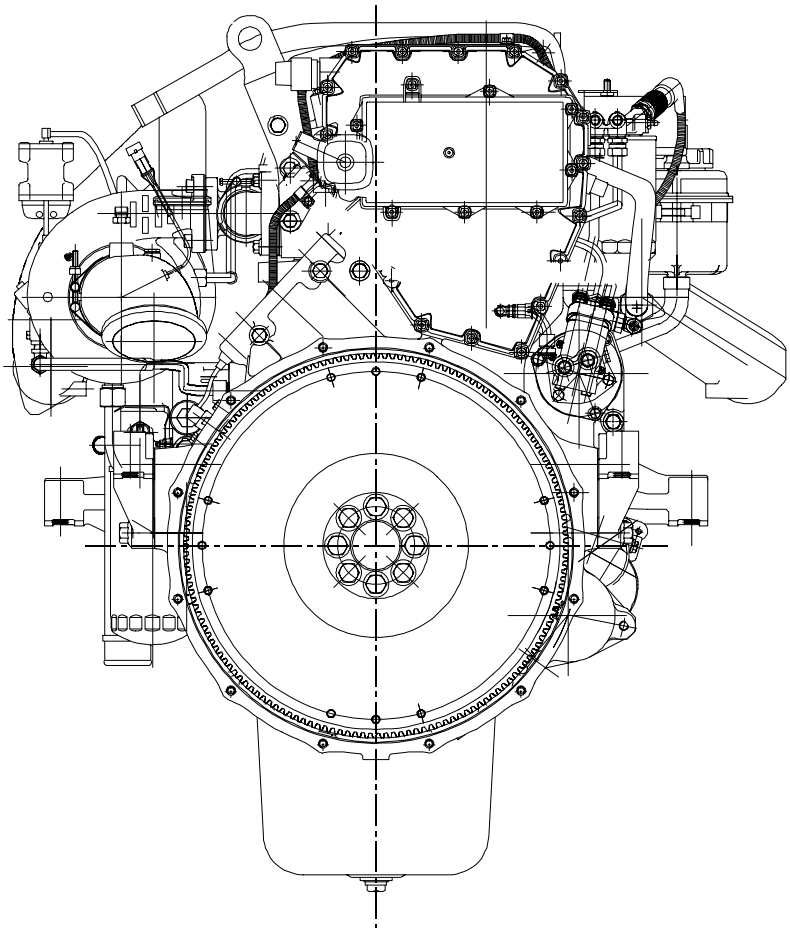
Figure 2



73526

RIGHT-HAND SIDE VIEW OF THE ENGINE

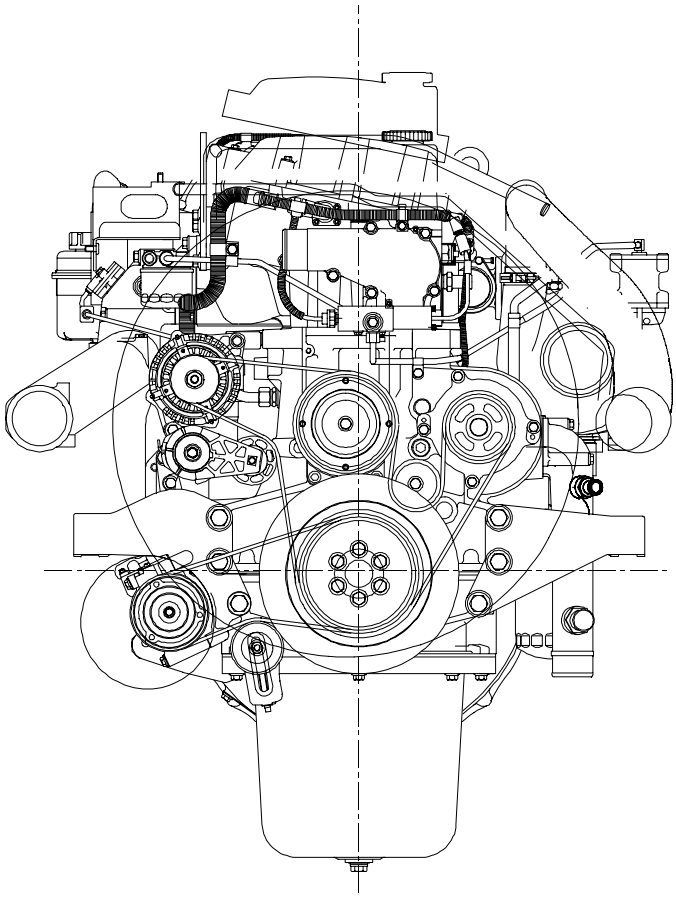
Figure 3



73527

REAR VIEW OF THE ENGINE

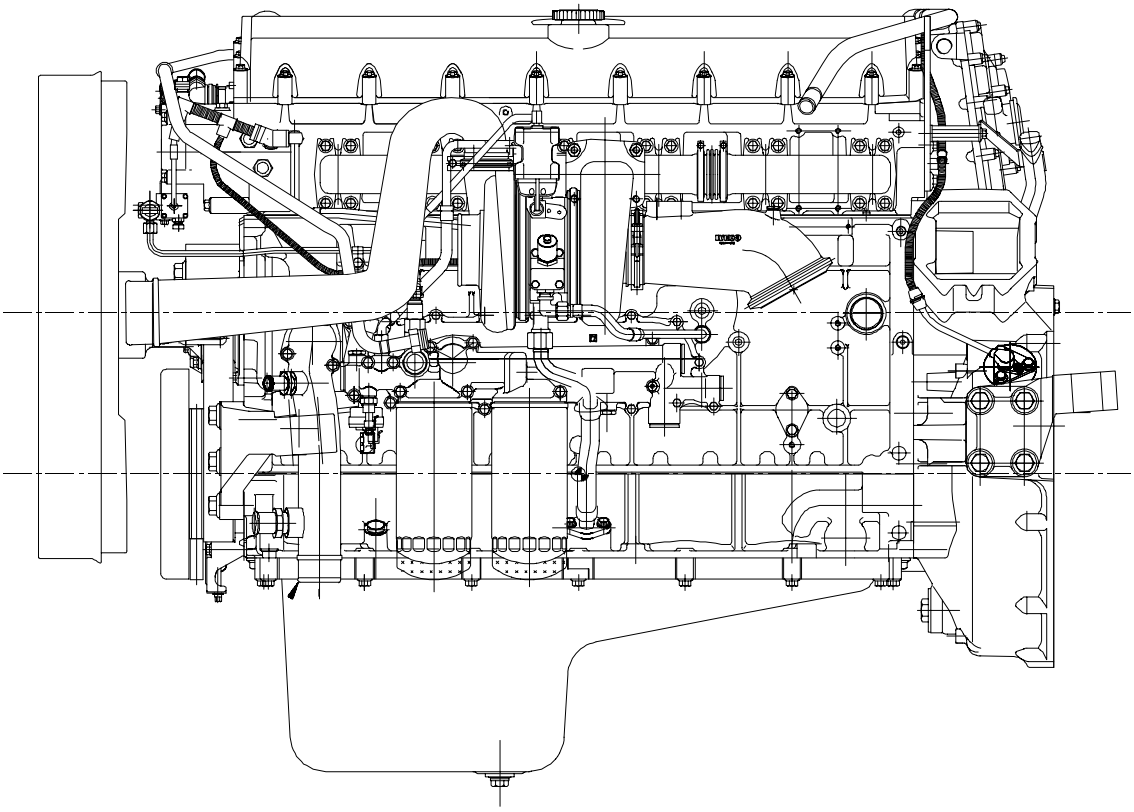
Figure 4



73528

RIGHT-HAND SIDE VIEW OF THE ENGINE

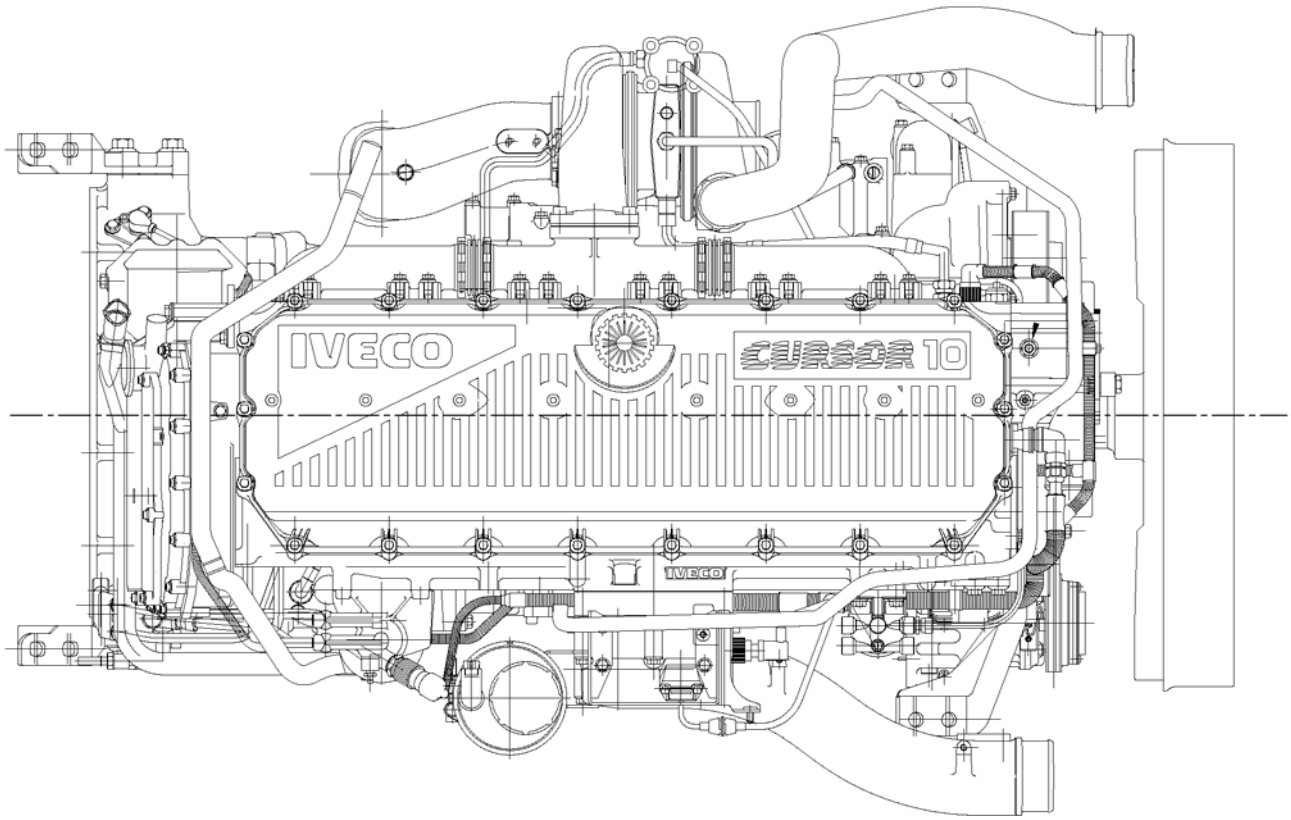
Figure 5



73529

LEFT-HAND SIDE VIEW OF THE ENGINE

Figure 6

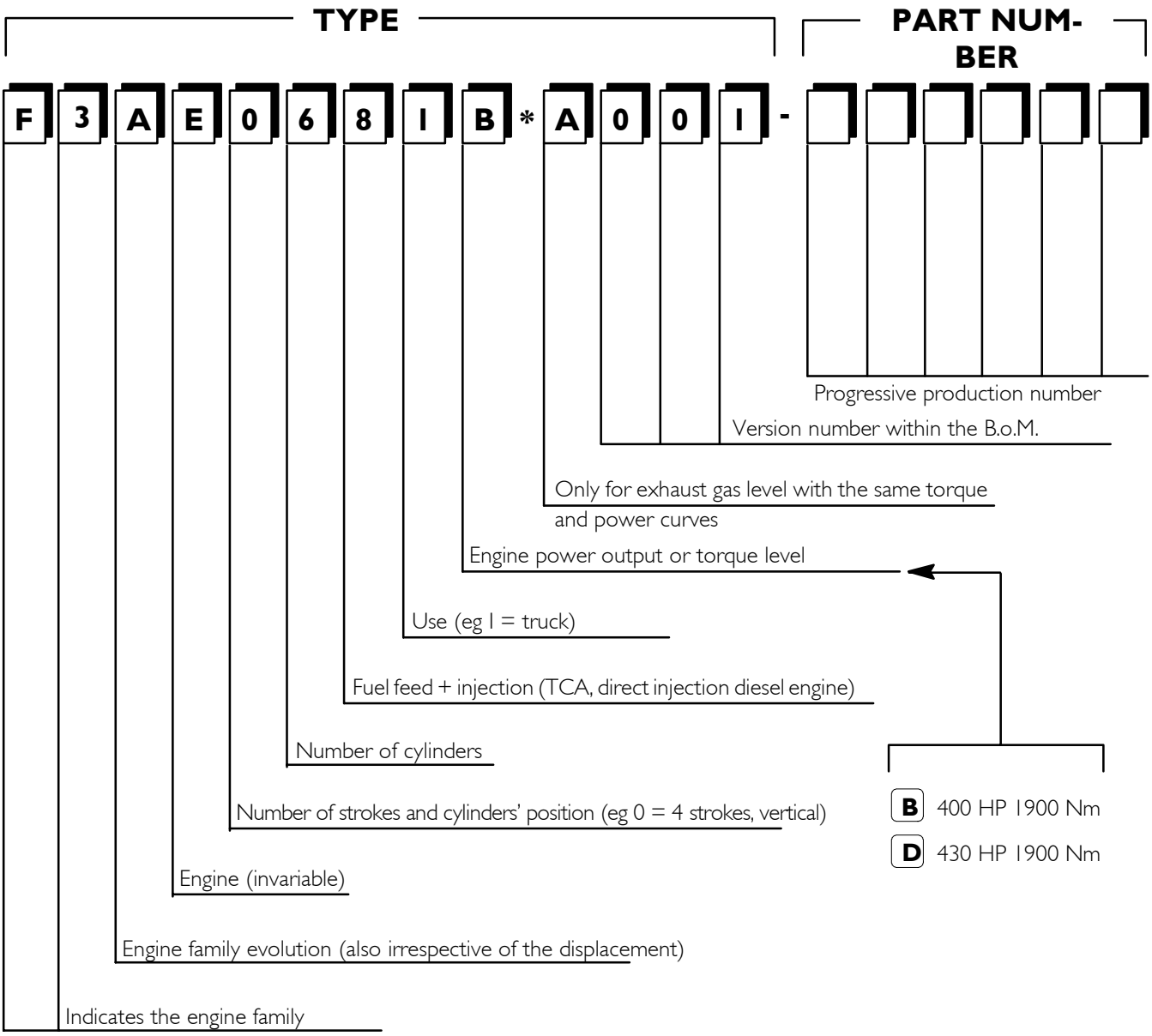


73834

VIEW OF THE ENGINE FROM ABOVE

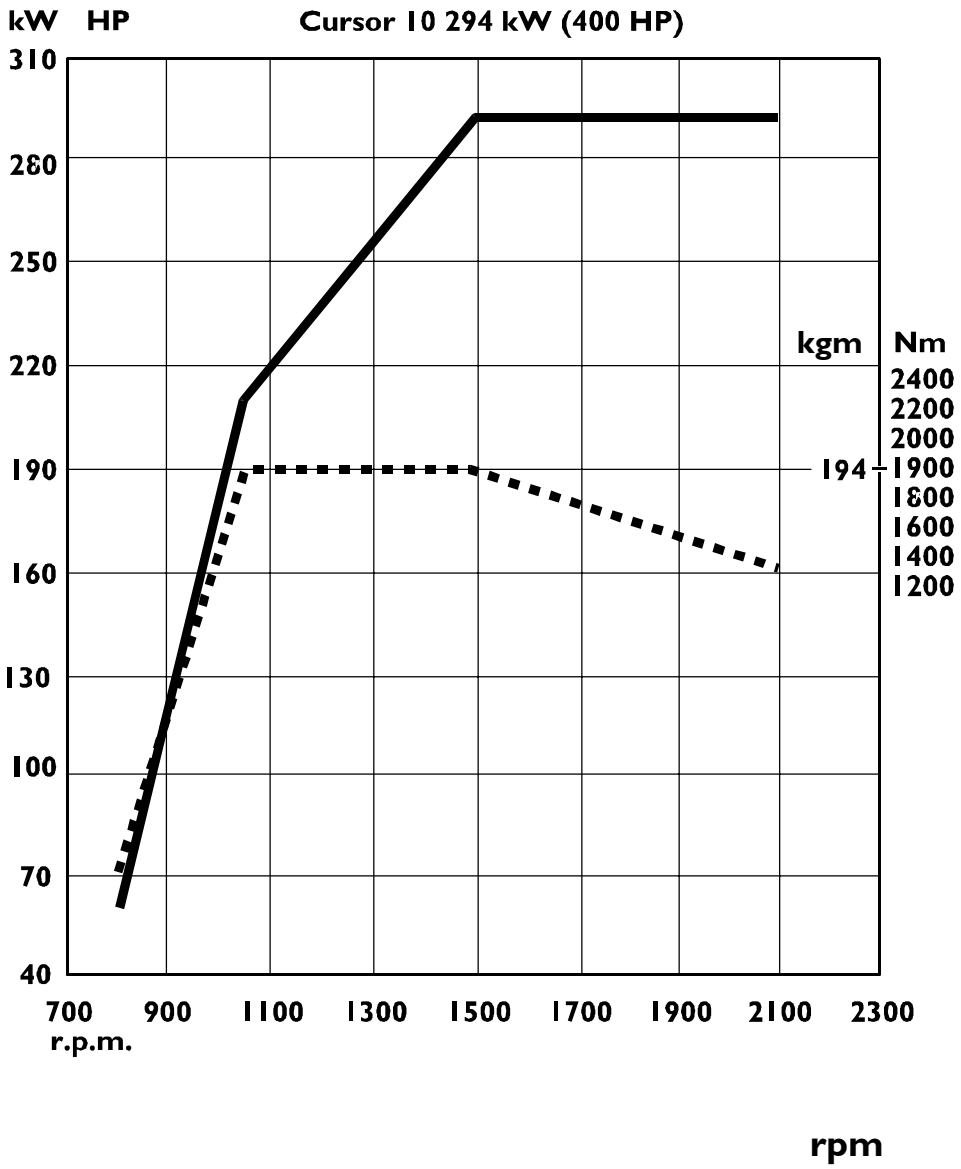
TECHNICAL DESIGNATION

ENGINE



CHARACTERISTIC CURVES

Figure 7

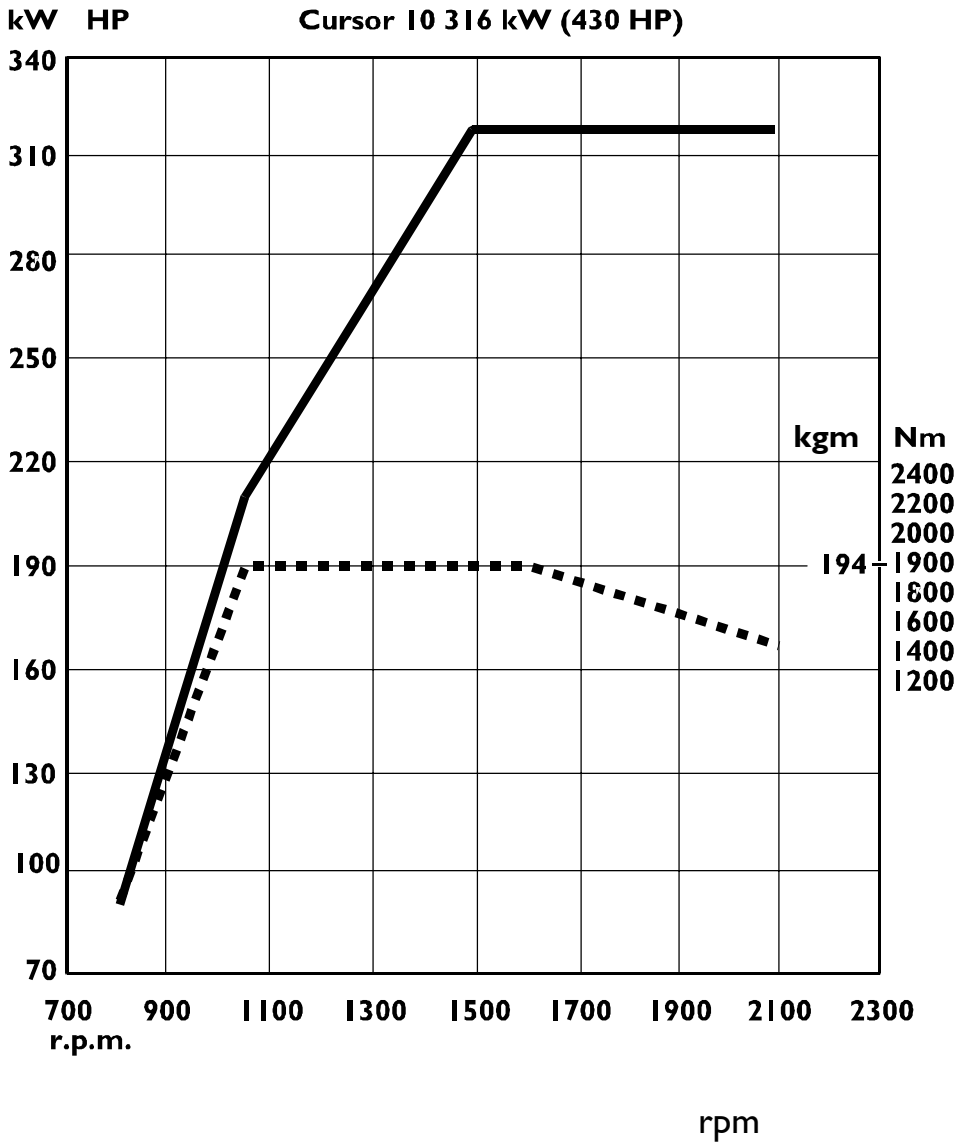


CHARACTERISTIC CURVES OF ENGINE F3AE 0681B

Max OUTPUT 294 kW	**400 HP**	**at 2100 rpm**
Max TORQUE 1900 Nm	**194 kgm**	**at 1050 ÷ 1480 rpm**

17

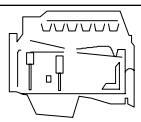
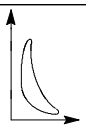
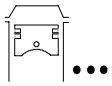
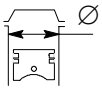
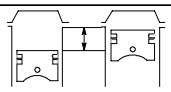
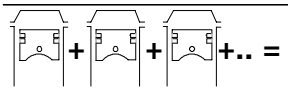
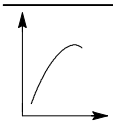
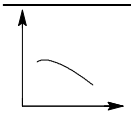
Figure 8

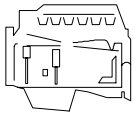
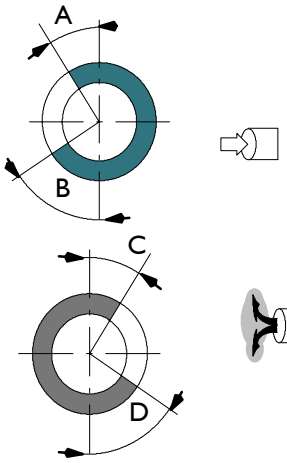
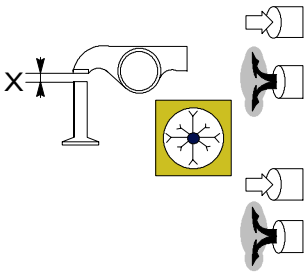
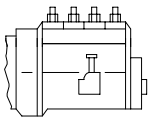
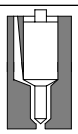
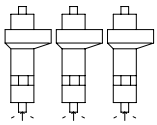


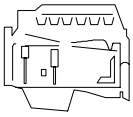
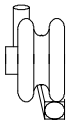
CHARACTERISTIC CURVES OF ENGINE F3A0681D

Max OUTPUT 316 kW	**430 HP**	**at 2100 rpm**
Max TORQUE 1900 Nm	**194 kgm**	**at 1050 ÷ 1590 rpm**

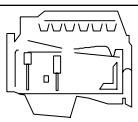
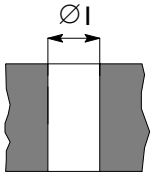
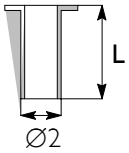
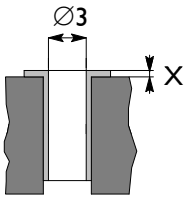
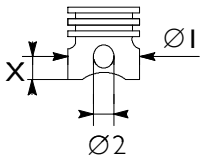
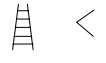
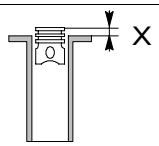
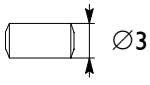
GENERAL CHARACTERISTICS

	Type		F3AE0681B	F3AE0681D
	Cycle		4-stroke Diesel engine	
	Fuel feed		Turbocharged with aftercooler	
	Injection		Direct	
	No. of cylinders		6 in line	
	Bore	mm	125	
	Stroke	mm	140	
	Total displacement	cm^3	10300	
Q	Compression ratio		17 ± 0.8	
	Max output	KW (HP)	294 (400)	316 (430)
		rpm	2100	2100
	Max. torque	Nm (kgm)	1900 (194)	1900 (194)
		rpm	1050 ÷ 1480	1050 ÷ 1590
	Engine idling speed, no load	rpm	550 ±25	
	Maximum engine speed, no load	rpm	2550 ±20	

	Type	**F3A**
	VALVE TIMING opens before T.D.C. A closes after B.D.C. B opens before B.D.C. D closes after T.D.C. C	 16° 32° 50° 9°
	For timing check X mm mm Running X mm mm	 - - 0.35 to 0.45 0.45 to 0.55
	FEED	Through fuel pump - filters
	Injection type: Bosch	With electronically regulated injectors PDE 31 pump injectors controlled by overhead camshaft
	Nozzle type	–
	Injection order	1 - 4 - 2 - 6 - 3 - 5
	Injection pressure bar Injector calibration bar	1500 290

	Type	**F3A**
	SUPERCHARGING Turbocharger type	 Variable geometry Holset HY 55 V
	LUBRICATION	Forced by gear pump, pressure control valve, oil filter
 	Oil pressure with hot engine (100°C ±5°C): at idling speed bar at maximum rpm bar	 1.5 5
	COOLING	By centrifugal pump, regulating thermostat, viscostatic fan, radiator and heat exchanger
	Water pump control	By belt
	Thermostat initial opening maximum opening	N. 1 ~84°C ±2°C 94°C ±2°C
 **Fiat Lubrificanti Urania Turbo LD (according to E3-96 standard) Urania Turbo (according to E2-96 standard)**	OIL FILLING Total capacity at 1st filling litres kg	 30 29.8
	Capacities - engine sump min level litres kg - engine sump max level litres kg - quantity in circulation that does not flow back to the engine sump litres kg - quantity contained in the cartridge filter (which has to be added to the cartridge filter refill) litres kg	 17 15.3 25 22.5 7 6.3 2.5 2.3

ASSEMBLY CLEARANCE DATA

	Type		F3A	
CYLINDER BLOCK AND CRANKMECHANISM COMPONENTS			mm	
	Bores for cylinder liners: Ø1	upper	142.000 to 142.025	
		lower	140.000 to 140.025	
	Cylinder liners: external diameter: Ø2	upper	141.961 to 141.986	
		lower	139.890 to 139.915	
	length	L	-	
	Cylinder liners - crankcase bores	upper	0.014 to 0.064	
		lower	0.085 to 0.135	
IVECO PARTS 	External diameter	Ø2	-	
 * Selection class	Cylinder sleeve			
	inside diameter	Ø3A*	125.000 to 125.013	
	inside diameter	Ø3B*	125.011 to 125.024	
	Protrusion	X	0.045 to 0.075	
	Pistons:		NUERAL	MAHLE - MONDIAL
	measuring dimension	X	18	18
	external diameter	Ø1A●	124.884 to 124.896	124.881 to 124.893
	external diameter	Ø1B○	124.895 to 124.907	124.892 to 124.904
	pin bore	Ø2	50.010 to 50.018	
 * Selection class	Piston - cylinder sleeve	A*	0.104 to 0.129	0.107 to 0.132
		B*	0.093 to 0.118	0.096 to 0.131
IVECO PARTS 	Piston diameter	Ø1	-	
	Pistons protrusion	X	0.23 to 0.53	
	Gudgeon pin	Ø3	49.994 to 50.000	
	Gudgeon pin - pin housing		0.010 to 0.024	

● Class A pistons supplied as spares.
○ Class B pistons are fitted in production only and are not supplied as spares.