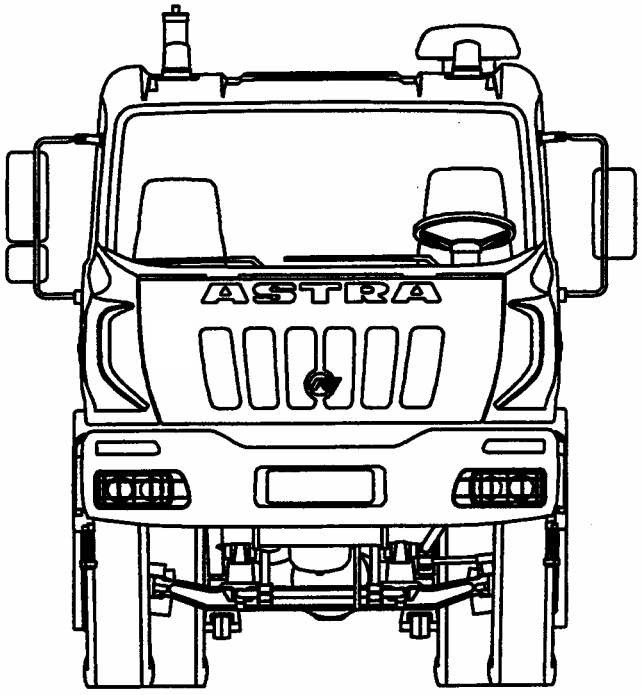
WORKSHOP MANUAL

H8DEC



ASTRA

GB

The Company ASTRA VEICOLI INDUSTRIALI reserves the right to make any modifications to vehicles for technical or commercial reasons at any time; the information, descriptions and illustrations contained in this publication are therefore updated at the time of approval for printing.
This Workshop Manual deals with optional equipment which cannot be present on your vehicle, and alternative equipment as well (e.g. mechanical and automatic gearbox).
Moreover, the regulations in force in certain countries affect the standard equipment of the vehicle.
This publication could therefore contain information and illustrations not corresponding to the vehicle version provided on a particular market.

ASTRA Veicoli Industriali
Product Logistics
Via Caorsana, 79 - 29100 PIACENZA (Italy)
Tel. 0523/5431 - Fax 0523/543459

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Prepared by SIPAL S.p.A. - TORINO (Italy)

INDEX OF SECTIONS

INTRODUCTION

SECTION I

SECTION 1

Introduction

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PREFACE

Definitions adopted in the current Manual

The Company ASTRA VEICOLI INDUSTRIALI, Via Caorsana, 79 - 29100 PIACENZA (Italy) is hereinafter called *Manufacturer.*

The current WORKSHOP MANUAL is hereinafter called *Manual.*

The equipment dealt with in the current Manual is hereinafter called *vehicle*.

The operator directly or indirectly involved in vehicle repair is hereinafter called *operator.*

Introduction

The current Manual applies essentially to authorised workshop technical staff.

This Manual provides technical information but cannot replace a thorough professional experience.

This Manual contains all data and information required to perform correct checking and setting up operations as well as repair and overhaul operations.

Read this Manual right through before performing any operation on the vehicle.

Compliance with the provided information and the use of the recommended tools guarantee correct repair and avoid damages to operators.

You will frequently see that parts of the text are highlighted as shown below:

Failure to heed and/or correctly carry out procedures, technical information and precautions given may cause injury.

Failure to heed and/or correctly carry out procedures, technical information and precautions given may cause damage to the vehicle.

Procedures, technical information and precautions which must be highlighted.

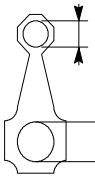
Failure to heed and/or correctly carry out procedures, technical information and precautions given may cause environmental damages.

This Manual has been divided into Sections, each of which has a number and its relevant contents are indicated in the Index of Sections.

Each section features a main Unit (e.g.: engine, gears, etc.)

Where possible, the same sequence of procedures has been followed for easy reference.
Diagram 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

Graphs and symbols

	Removal Disconnection
	Re-fitting in place Connection
	Removal Dis-assembly
	Fitting in place Assembly
	Driving torque
	Driving torque + angular value
	Press or Caulk
	Regulation Adjustment
	Caution Note
	Visual check Fitting position check
	Measurement Value to find Check
	Equipment
	Face for machining Machine finish
	Interference Strained assembly
	Thickness Clearance
	Lubrication Damp Grease
	Sealant Adhesive
	Air bleeding

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

MEASURES (INTERNATIONAL SYSTEM)

Force in N (Newton)

Conversion:

1 N	=	0,1019 kg
1 kg	=	9,81 N

Power in kW (kilowatt)

Other units in use:

HP (Horsepower)

Conversion:

1 kW	=	1,36 CV
1 kW	=	1,34 HP
1 CV	=	0,736 kW
1 CV	=	0,986 HP
1 HP	=	0,746 kW
1 HP	=	1,014 CV

Torque in Nm (Newton/metre)

Conversion:

1 Nm	=	0,1019 kgm
1 kgm	=	9,81 Nm
1 kgm	=	10 Nm *

Specific consumption in g/kWh (grams per kilowatthour)

Other unit in use:

g/CVh (grams per horsepower-hour)

Conversion:

1 g/kWh	=	0,736 g/CVh
1 g/CVh	=	1,36 g/kWh

Pressure in kPa (kilopascal)

Other units in use:

kg/cm^2 (kilograms per square centimeter)

Atm (metric atmosphere)

psi (pounds per square inch)

Conversion:

1 kg/cm^2	=	1 Atm
1 kg/cm^2	=	98,1 kPa
1 kg/cm^2	=	0,981 bar
1 kg/cm^2	=	1 bar *
1 kg/cm^2	=	14,22 psi
1 bar	=	100 kPa
1 bar	=	1,02 kg/cm^2
1 bar	=	14,51 psi
1 psi	=	6,9 kPa
1 psi	=	0,069 bar
1 psi	=	0,0703 kg/cm^2
1 kPa	=	0,145 psi
1 kPa	=	0,0102 kg/cm^2
1 kPa	=	0,01 bar

Conversion values for British units

0,1 mm	=	3,937 mils
1 mm	=	0,039 inch
1 m	=	3,281 ft.
1 km	=	0,621 miles
1 cm^3	=	0,06 1 cu. in.
1 l	=	1,759 pts (0,88 imp.qts)
1 bar	=	14,5038 psi
1 g	=	0,035 oz. (0,564 dr.)
1 kg	=	2,205 lbs.

(in case of differences in temperature 1 °C = 1.8 °F)

(*) Nm and bar are converted according to the ratios 10:1 and 1:1.

STANDARD TIGHTENING TORQUES

Screws and nuts with metric thread

Diameter x Pitch d x p (mm)	SCREW – CLASS 8.8				SCREW – CLASS 10.9				SCREW – CLASS 12.9			
	UN-COATED	DACRO-MET GAL-VANISED	CADMIUM PLATED	PHOSPHA-TE COA-TED	UN-COATED	DACRO-MET GAL-VANISED	CADMIUM PLATED	PHOSPHA-TE COATED	UN-COATED	DACRO-MET GAL-VANISED	CADMIUM PLATED	PHOSPHA-TE COATED
3 x 0,5	0,12	0,12	0,11	0,09	0,17	0,16	0,15	0,13	0,21	0,19	0,18	0,15
4 x 0,7	0,28	0,26	0,24	0,20	0,39	0,37	0,34	0,29	0,47	0,44	0,41	0,35
5 x 0,8	0,56	0,52	0,48	0,40	0,79	0,74	0,67	0,57	0,94	0,88	0,80	0,68
6 x 1	1,0	0,9	0,8	0,7	1,3	1,3	1,2	1,0	1,6	1,5	1,4	1,2
8 x 1,25	2,3	2,2	2,0	1,7	3,3	3,1	2,8	2,3	3,9	3,7	3,3	2,8
8 x 1	2,5	2,4	2,1	1,8	3,5	3,3	3,0	2,5	4,3	4,0	3,6	3,0
10 x 1,5	4,7	4,4	4,0	3,3	6,5	6,1	5,6	4,7	7,9	7,4	6,7	5,6
10 x 1,25	5,0	4,7	4,2	3,5	7,0	6,5	5,9	4,9	8,4	7,9	7,1	5,9
12 x 1,75	8,0	7,5	6,8	5,7	11,3	10,6	9,6	8,0	13,6	12,7	11,5	9,6
12 x 1,25	9,0	8,4	7,5	6,2	12,6	11,8	10,6	8,7	15,1	14,1	12,7	10,4
14 x 2	12,8	12,0	10,9	9,1	18,0	16,9	15,3	12,8	21,6	20,2	18,4	15,3
14 x 1,5	14,1	13,1	11,9	9,7	19,8	18,5	16,7	13,6	23,8	22,2	20,0	16,4
16 x 2	19,8	18,5	16,8	13,9	27,9	26,1	23,6	19,5	33,5	31,3	28,3	23,4
16 x 1,5	21,5	20,0	18,0	14,6	30,2	28,2	25,3	20,6	36,3	33,8	30,4	24,7
18 x 2,5	27,2	25,4	23,1	19,2	38,2	35,8	32,4	27,0	45,8	42,9	38,9	32,4
18 x 1,5	31,4	29,2	26,2	21,1	44,1	41,1	36,8	29,7	53,0	49,3	44,2	35,7
20 x 2,5	38,4	36,1	32,7	27,0	54,3	50,8	46,0	38,0	65,2	61,0	55,2	45,6
20 x 1,5	43,9	40,9	36,5	29,4	61,7	57,5	51,4	41,3	74,1	68,9	61,6	49,5
22 x 2,5	53,9	49,0	44,6	36,2	75,9	68,8	62,8	51,0	91,0	82,6	75,3	61,1
22 x 1,5	59,0	54,8	48,9	39,1	82,9	77,1	68,8	55,0	99,5	92,5	82,6	66,1
24 x 3	66,7	62,4	56,4	46,6	93,8	87,7	79,3	65,5	112,5	105,2	95,2	78,6
24 x 2	74,2	69,1	61,9	50,0	104,4	97,2	87,1	70,3	125,3	116,7	104,5	84,4
27 x 3	98,7	92,2	83,1	68,2	138,8	129,6	116,9	95,9	166,5	155,5	140,2	115,0
27 x 2	108,4	100,8	90,1	72,4	152,4	141,8	126,7	101,8	182,9	170,2	152,1	122,2
30 x 3,5	133,7	124,9	112,7	92,8	188,0	175,6	158,5	130,5	225,6	210,7	190,2	156,5
30 x 2	151,6	141,0	125,8	100,6	213,2	198,2	176,9	141,5	255,9	237,9	212,2	169,8

Maximum tightening torques for metric threads in daNm

GENERAL SPECIFICATIONS

SECTION 2

SECTION 2

General specifications

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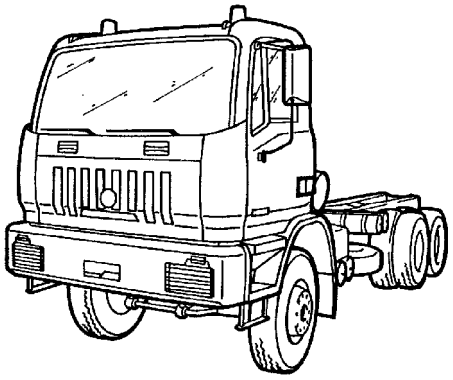
COMPOSITION OF THE MODELS

UNITS \ MODELS			4x4		6x4		6x6		8x4	
			HD8 44.36	HD8 44.42	HD8 64.38	HD8 64.42	HD8 66.38	HD8 66.42	HD8 84.38	HD8 84.42
ENGINE	F3B WG (380 CV)		o		o		o		o	
	F3B VG (420 CV)			o		o		o		o
CLUTCH		Single disc 17"	o	o	o	o	o	o	o	o
MAN. GEARBOX	MECHANICAL	ZF 16 S 1620TD	o		o		o		o	
		ZF 16 S 2320TD		o		o		o		o
TRANSFER		TC 1800	o				o			
		TC 2200		o				o		
AXLE		ASTRA 9820			o	o			o	o
FRONT DRIVE AXLE	1st FRONT	D 1385 AE 032/5985	o	o			o	o		
	SINGLE REAR	R 8284 B027 (451391/1)	o	o						
	TANDEM REAR	INTERMEDIATE R 9189 BB033 (453291)			o	o	o	o	o	o
		REAR R 8298 B052 (453291)			o	o	o	o	o	o
HYDRAULIC POWER STEERING		ZF 8098.955	o	o	o	o	o	o		
		ZF 8099.955							o	o

4x4 = Two axle vehicles with front axle and rear driving axle.
6x4 = Three axle vehicles with two rear driving axles.
6x6 = Three axle vehicles with front axle and two rear driving axles.
8x4 = Four axle vehicles: first and second steering axles, third and fourth driving axles

POSITION OF VEHICLE IDENTIFICATION DATA

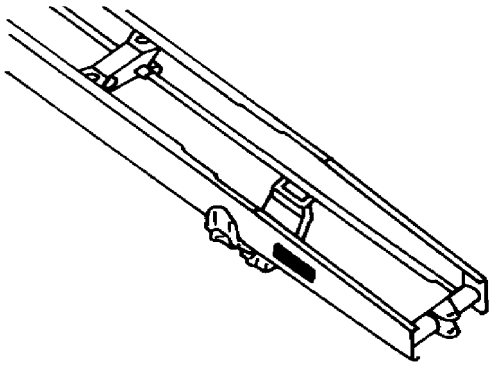
Figure 1



Model identification plate

Located on the side walls of the cab.

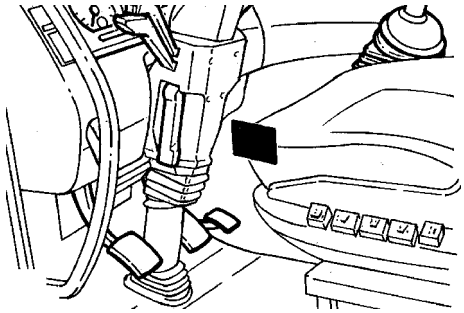
Figure 2



Chassis

Punch marked at the front end of the right–hand side member.
(see following page)

Figure 3



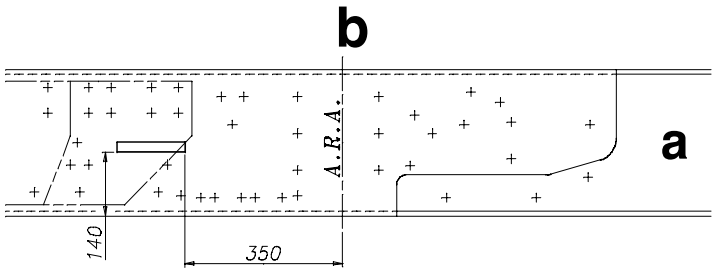
Manufacturer's plate

Data for vehicle identification according to EEC regulations, on the left–hand side of the engine cover.
(see following page)

Chassis punching

1) right side member – front end
2) rear axle – front leaf spring

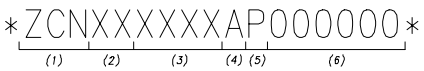
Figure 4



Vehicle registration number

1) World–wide identification of manufacturers (Astra Veicoli Industriali S.p.A.)
2) Type of vehicle
3) Vehicle features
4) Year of construction: (Y=2000; 1=2001; 2=2002; 3=2003; g 9=2009; A=2919; ecc.)
5) Production facility (P=Piacenza)
6) Chassis number

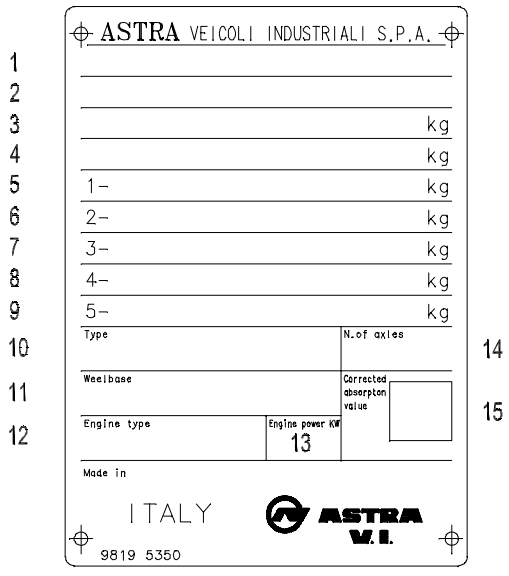
Figure 5



Vehicle identification plate

1) Type approval number markings
2) Vehicle chassis punch markings
3) Overall vehicle weight
4) Overall tractor + trailer/semitrailer weight
5) Maximum admissible weight 1st axle
6) Maximum admissible weight 2nd axle
7) Maximum admissible weight 3rd axle
8) Maximum admissible weight 4th axle
9) Maximum admissible weight on fifth wheel (tractor versions only)
10) Vehicle commercial denomination
11) Axle spacing
12) Engine type
13) Engine power
14) Number of axles
15) Grade of smoke

Figure 6

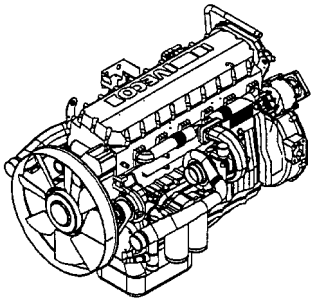


POSITION OF ASSEMBLY IDENTIFICATION DATA

Main assemblies mounted on vehicle are identified by a serial number which can be found on the concerned assembly in the positions shown on drawings.

Assembly identification data must always be indicated when ordering spare parts.

Figure 7

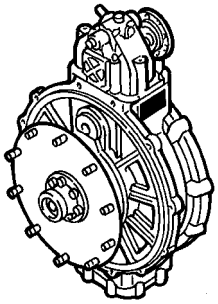


Engine

Engine type and serial number are shown on engine plate.

- ❑ engine F3BWG

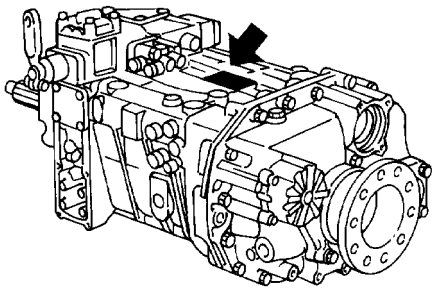
Figure 8



Engine dependent power take-off

Power take-off type and serial number are shown on power take-off box plate.

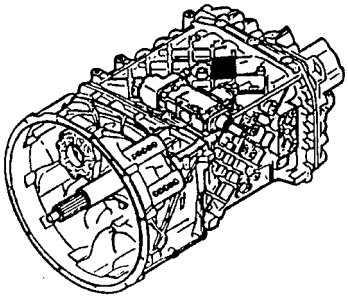
Figure 9



Gearbox 16S 1620 TD

Gearbox type and serial number are shown on gearbox plate.

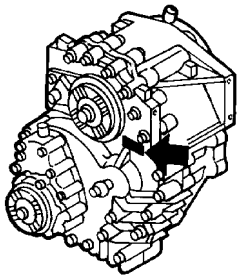
Figure 10



Gearbox 16S 2320 TD

Gearbox type and serial number are shown on gearbox plate.

Figure 11



Distributor-reducer (transfer)

Transfer type and serial number are shown on transfer case plate

Figure 12

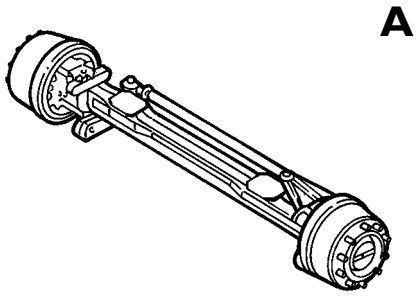


Figure 13

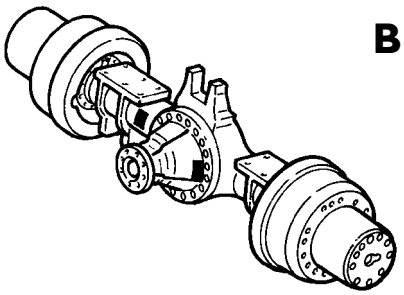


Figure 14

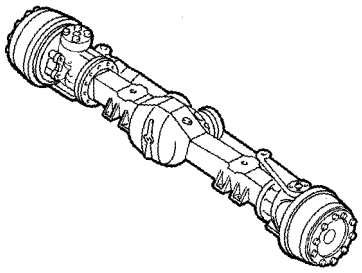
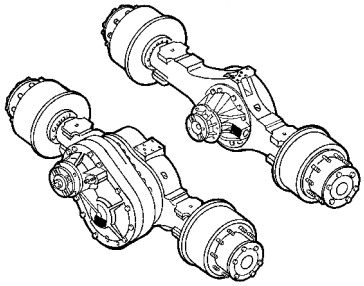


Figure 15

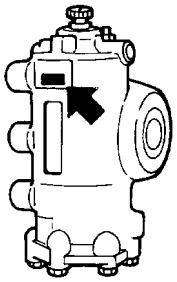


Front and rear drive axles

Axle type and serial number are shown on axle casing.

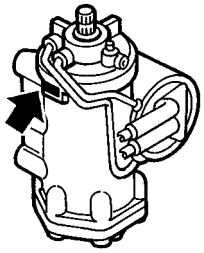
- ❑ axles (A)
- ❑ front axle (B)
- ❑ single rear axle (C)
- ❑ tandem rear axles

Figure 16



A

Figure 17



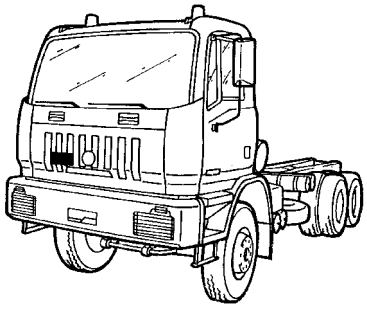
B

Power steering boxes

Power steering type and serial number are shown on power steering box plate.

- ❑ 2-axle and 3-axle vehicles (A)
- ❑ 4-axle vehicles (B)

Figure 18



Cab

- ❑ Two-seater cab

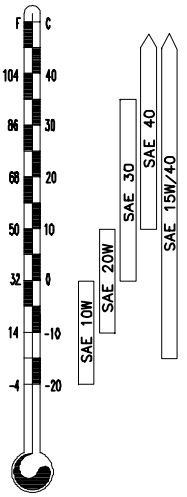
LUBRICANT AND HYDRAULIC FLUID TABLES

FL Italia H8D ASTRA Veicoli Industriali

LUBRICANT AND HYDRAULIC FLUID TABLES

	ORGAN TO BE LUBRICATED		QUANTITY KG	QUANTITY LT	REPLACE HRS.	REQUESTED SPECIFICATIONS		RECOMMENDED LUBRICANTS
*	ENGINE OIL SUMP (+ FILTRES)	ENGINE F2B	20,7 (+2,3)	23 (+2,5)	400	MIL-L-2104E lev. API CF4	ACEA E2	URANIA TURBO
					IN ALTERNANCE WITH BOTH ENGINE			
		ENGINE F3B	25,2 (+2,3)	28 (+2,5)	800 Each year	MIL-L-2104E lev. API CF	ACEA E3 e/o E5	URANIA LD5
	GEARBOX WITH ZF INTARDER	16S2XXX	15,3	17	1600 Each year	MIL-L-2104E lev.		URANIA[C] SAE 30
	GEARBOX WITH PTO ZF NMV221		11,7	13				
	GEARBOX WITH ZF INTARDER AND PTO ZF NMV221		16,7	18,5				
	GEARBOX WITH CONVERTER ZF WSK400	16 S 221		27,5		MIL-L-2104 C/D/E		URANIA C
	AUTOMATIC GEARBOX	6 HP 902	23,4	26		ATF DEXRON II D		TUTELA GI/A
	SEMIAUTOMATIC GEARBOX EUROTRONIC	12AS2301		12	240000 Km Every 2 years	ZF TE-ML 02D		TUTELA TRUCK GEAR FE(SAE 75W80)
	GEARBOX	16S1620	8,45	9,5	1600 Each year	MIL-L-2105 API GL 3		TUTELA ZC90 SAE 80W/90
		16S2XXX	9,8	11				
	INTEGRAL POWER TAKE-OFF		2,67	3				
	TRANSFER	TC 1800	5,8	6,5				
		TC 2200	5,5	6,2		ATF DEXRON II D		TUTELA GI/A
	FRONT AXLE		4,5	5	1600	MIL-L-2105D API GL 5		TUTELA W140/M-DA SAE 85W/140
	FRONT REDUCERS RACH		0,68	0,75				
	INTERMEDIATE AXLES INCLUDING REDUCERS AND TRANSMISSION		24,6	27				
	REAR AXLE INCLUDING FINAL DRIVE		14,6	16				
▲	HYDRAULIC POWER STEERING	2/3 AXLES	7,4	8,5	4000	ATF DEXRON II D		TUTELA GI/A
		4 AXLES	16,1	18				
	CAB TILTING CONTROL		0,9	1	2400			
	CLUTCH CIRCUIT		0,5	0,5	Each year	DOT4-NHTSA116 SAE J1703		TUTELA TRUCK DOT SPECIAL
	GENERAL GRESSING		–	–	100	N.L.G.I. 2		TUTELA MR2

ENGINE OIL SAE GRADES



50041 8817

✱ For artical climate (until -30°C) use URANIA FE 5W30 oil - Specification ACEA E4

▲ For artical climate (until -30°C) use TUTELA LHM oil - Specification FIAT 9.55597 IVECO Std.18-1823

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ENGINE - F3B

SECTION 3

SECTION 3

Engine - F3B

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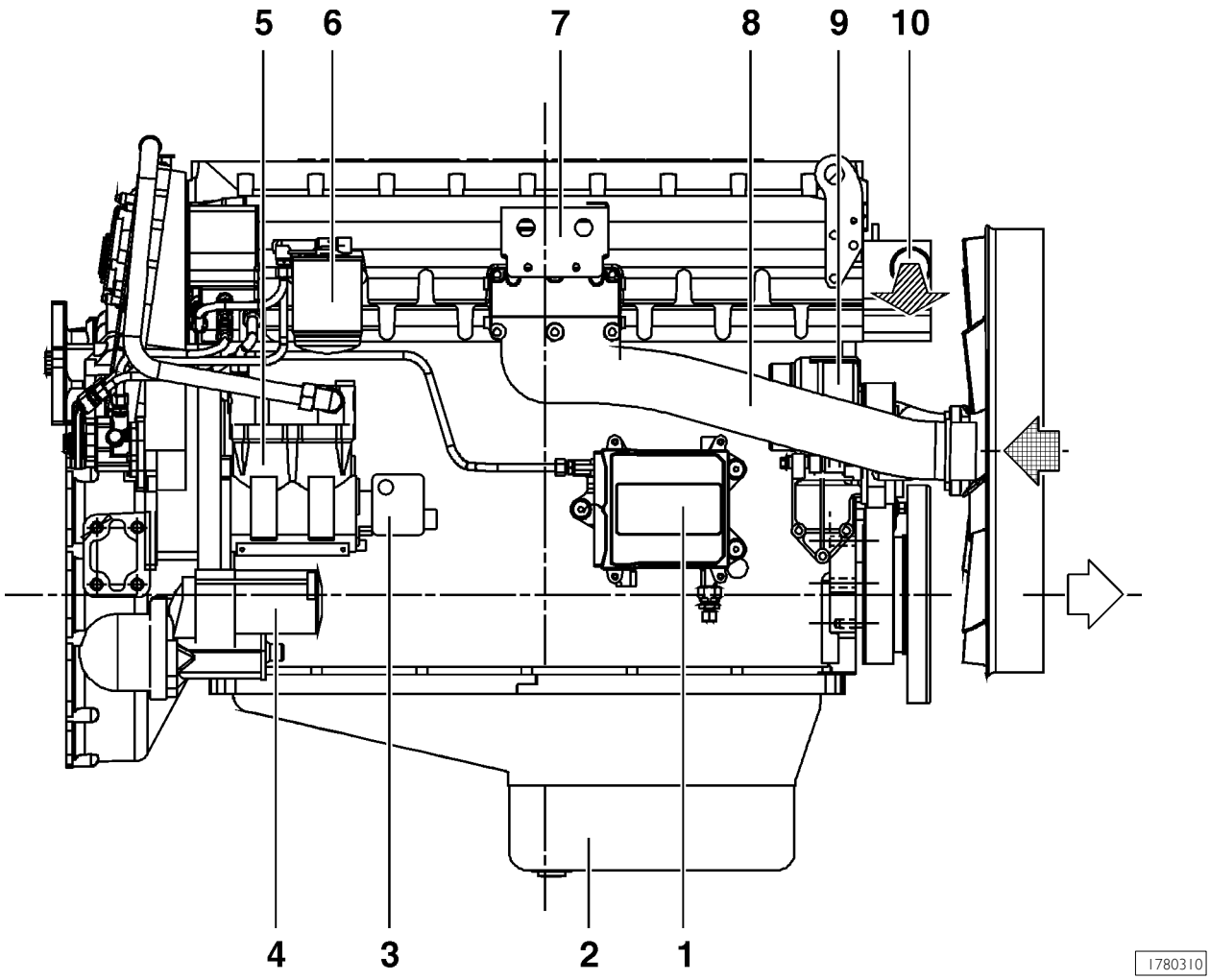
VIEWS OF THE ENGINE

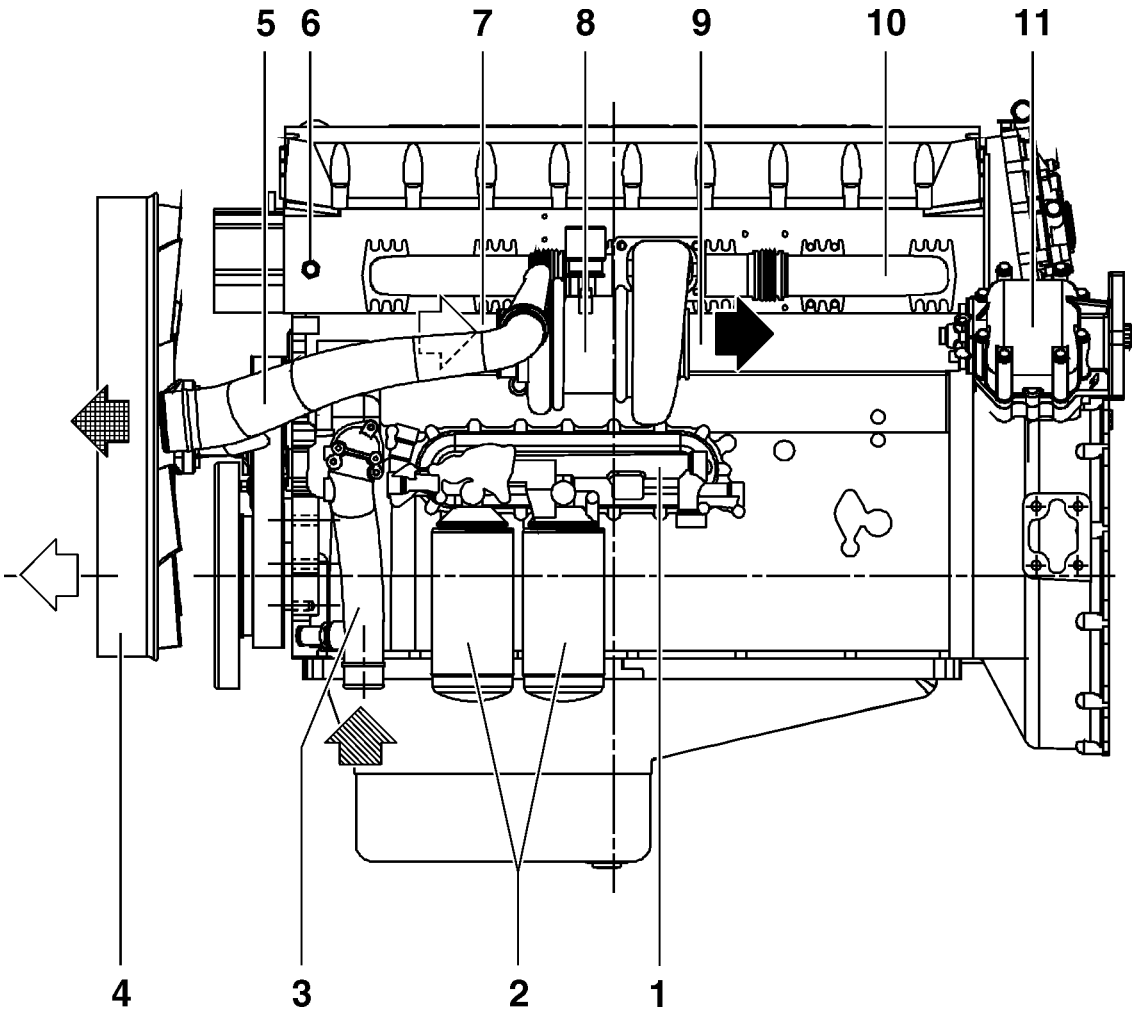
Figure 1



RIGHT SIDE

1. Engine control unit - 2. Oil sump - 3. Power steering pump on compressor - 4. Starting motor - 5. Air compressor - 6. Fuel filter on engine - 7. Engine stop and start controls - 8. Air return line from intercooler - 9. Alternator - 10. Water outlet to radiator

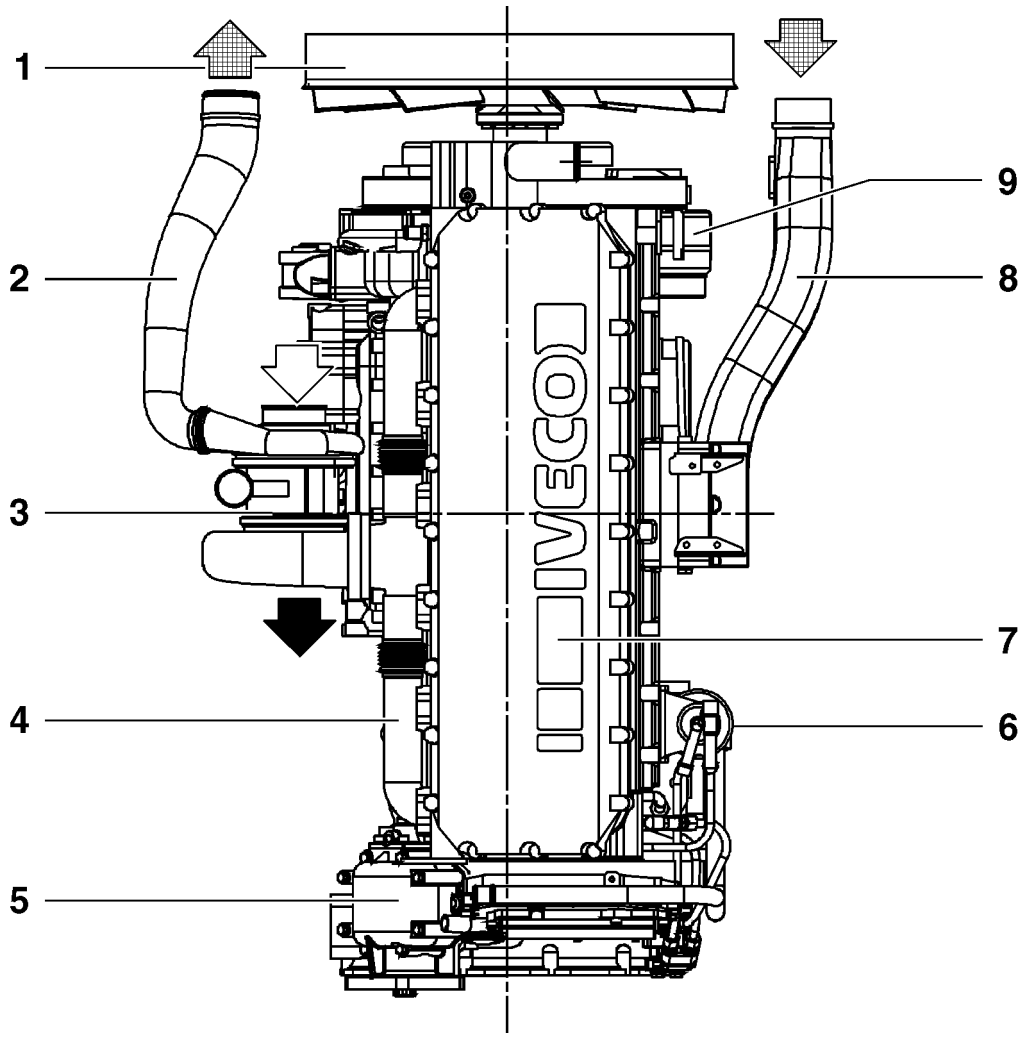
Figure 2



LEFT SIDE

1. Oil-water heat exchanger. - 2. Engine oil filter. - 3. Water delivery from radiator.- 4. Fan. - 5. Air delivery pipe to intercooler. - 6. Water delivery pipe to cab heater. - 7. Intake. - 8. Exhaust gas turbocompressor. - 9. Exhaust. - 10. Exhaust manifold. - 11. Power take-off (optional)

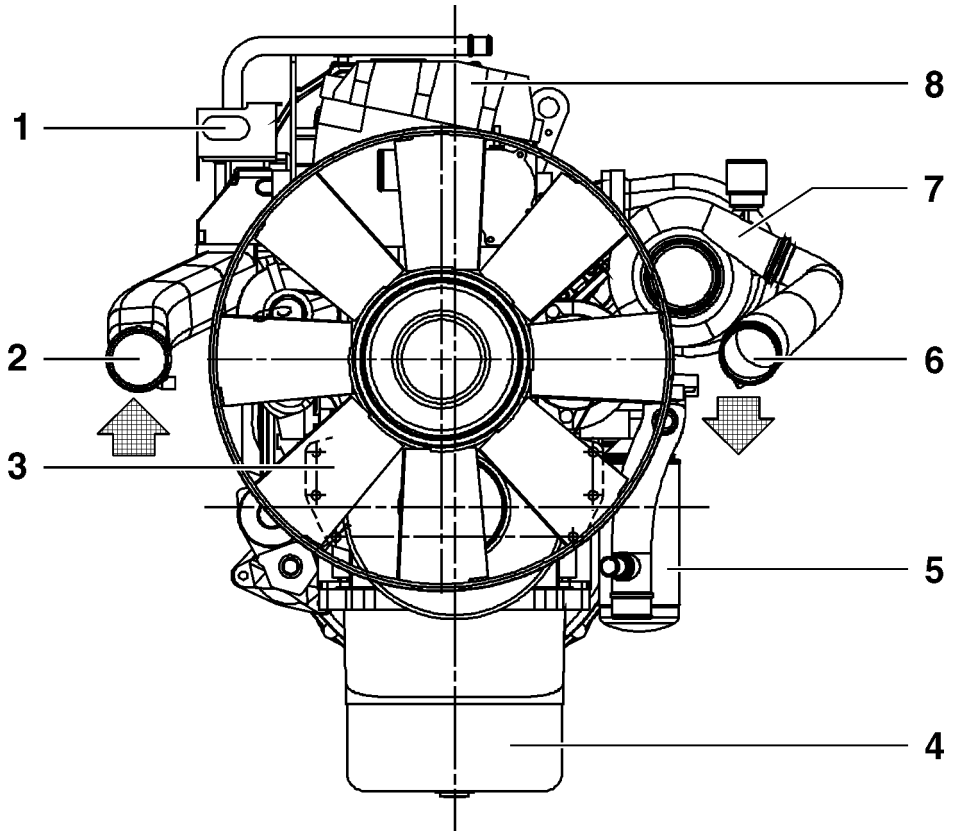
Figure 3



TOP VIEW

1. Fan - 2. Air delivery pipe to intercooler - 3. Exhaust gas turbocompressor - 4. Exhaust manifold - 5. Power take-off (optional) - 6. Fuel filter on engine - 7. Distributor cap - 8. Air return pipe from intercooler - 9. Alternator

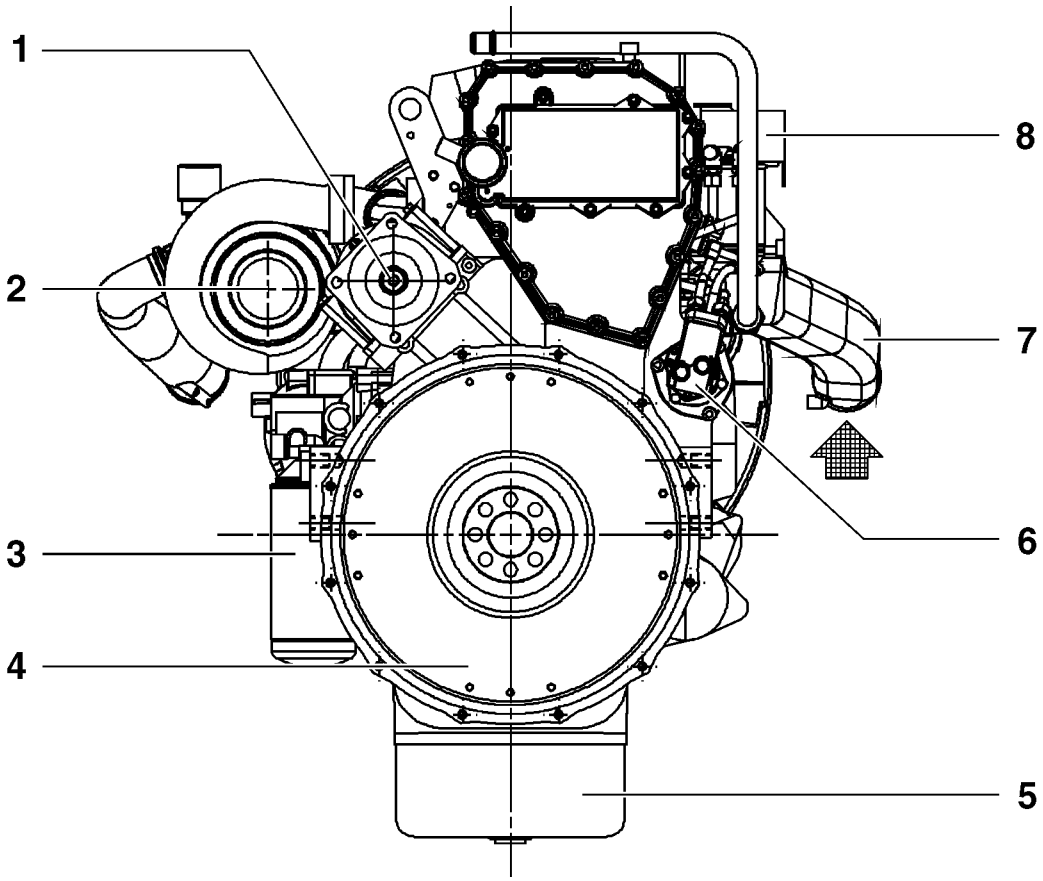
Figure 4



FRONT VIEW

1. Engine start-stop command - 2. Air return pipe from intercooler - 3. Fan - 4. Oil sump - 5. Engine oil filter - 6. Air delivery pipe to intercooler - 7. Exhaust gas turbocompressor - 8. Distributor cap

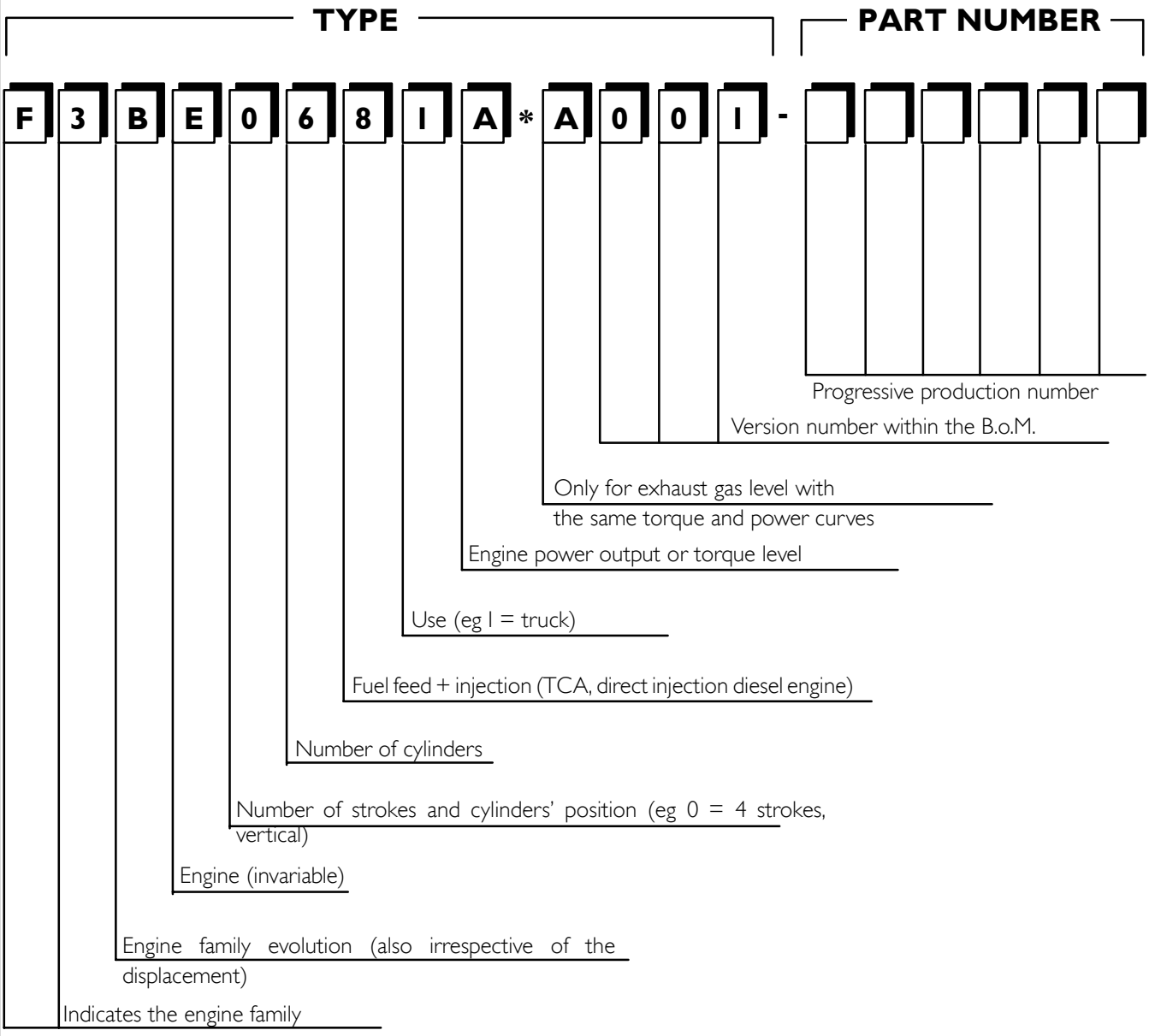
Figure 5



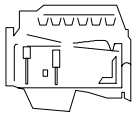
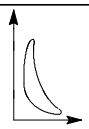
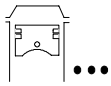
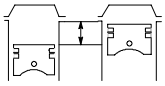
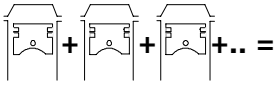
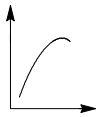
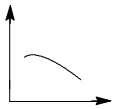
REAR VIEW

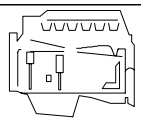
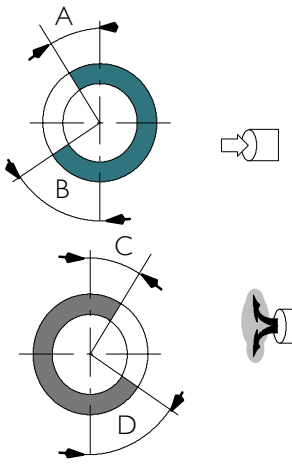
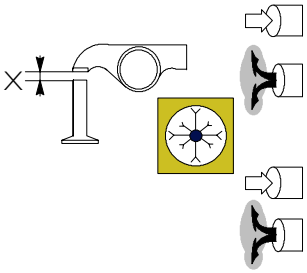
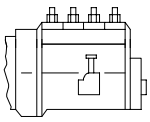
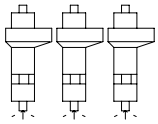
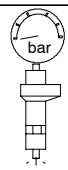
1. Power take-off (optional) - 2. Exhaust gas turbocompressor - 3. Engine oil filter - 4. Flywheel - 5. Oil sump - 6. Fuel pump - 7. Air return pipe from intercooler - 8. Engine start-stop command

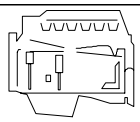
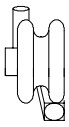
TECHNICAL SPECIFICATION



GENERAL CHARACTERISTICS

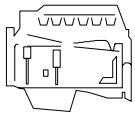
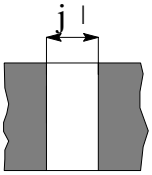
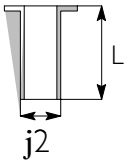
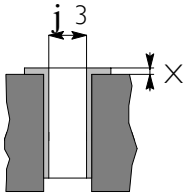
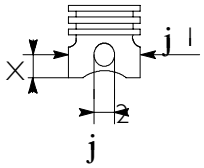
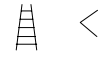
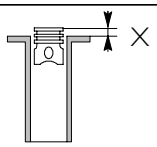
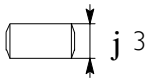
	Type		**F3B**	
	Cycle Feeding Injection		Diesel 4 strokes Turbocharged with aftercooler Direct	
	N. of cylinders		6 on-line	
	Diameter	mm	135	
	Stroke	mm	150	
	Total displacement	cm^3	12880	
ϱ	Compression ratio		16 ± 0.8	
	Max. power	kW (HP)	WG	
		rpm		
	Max. power	kW (HP)	284 380	313 420
		rpm		
	Max. power	kW (HP)	1900	1900
		rpm		
	Max. power	kW (HP)	1800 184	1900 194
		rpm	900 ÷1480	900 ÷1500
	Engine idling speed, no load	rpm	600 ± 25	
	Maximum engine speed, no load	rpm	2400	

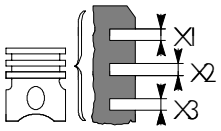
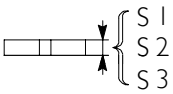
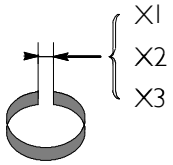
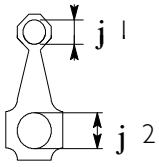
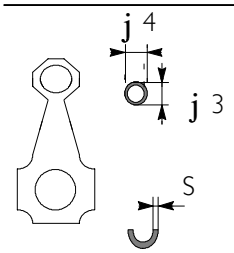
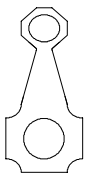
	Type	**F3B**
	VALVE TIMING opens before T.D.C. A closes after B.D.C. B opens before B.D.C. D closes after T.D.C. C	 17° 30° 51° 11°
	For timing check X { mm mm Running X { mm mm	 – – 0.35 to 0.45 0.35 to 0.45
	FEED	DIRECT INJECTION
	Injection type Bosch	With electronically regulated injectors PDE 31 pump injectors controlled by overhead camshaft
	Injection order	1 - 4 - 2 - 6 - 3 - 5
	Injection pressure bar	1500

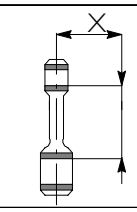
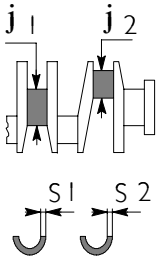
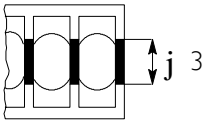
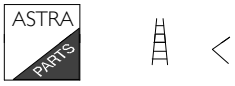
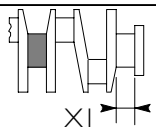
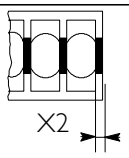
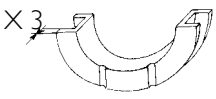
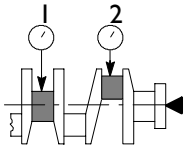
	Type	**F3B WG**
	SUPERCHARGING	Holset Wastegate
	Turbocharger type	HX55W
COOLING	COOLING	By centrifugal pump, regulating thermostat, viscostatic fan, radiator and heat exchanger
	Water pump control	By belt
	Thermostat:	N. 1
	starts to open:	~85 °C
	fully open:	–
	LUBRICATION	Forced by gear pump, pressure control valve, oil filter
 	Oil pressure, engine hot (100 °C ± 5 °C):	
	at idling speed bar	1.5
	at maximum speed bar	5
	OIL FILLING (*)	
	Total capacity at 1st filling	
	liters	35
	kg	25.5
	Capacity:	
	- engine sump min level	
	liters	20
	kg	18
 Urania Turbo LD (according to ACEA and/or E5 standard) Urania Turbo (according to ACEA E2-96)	- engine sump max level	
	liters	28
	kg	24,5
	- quantity in circulation that does not flow back to the engine sump	
	liters	7
	kg	6.3
	- quantity contained in the cartridge filter (which has to be added to the cartridge filter refill)	
	liters	3
	kg	2.7

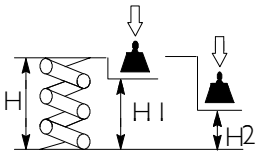
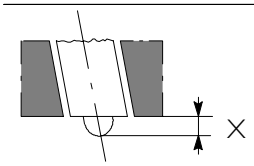
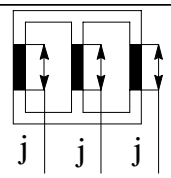
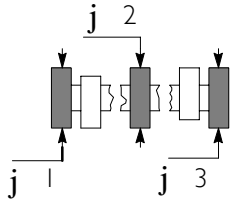
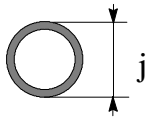
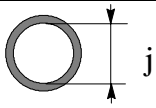
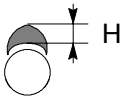
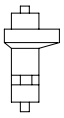
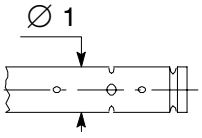
(*) For the correct type of fluid, see section 2 - HYDRAULIC FLUID AND LUBRICANTS TABLE

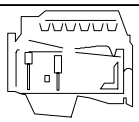
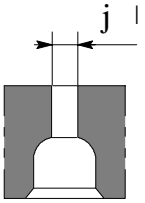
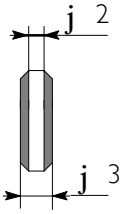
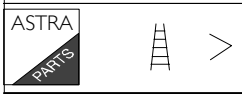
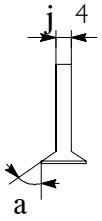
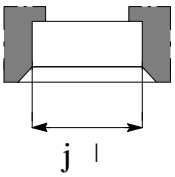
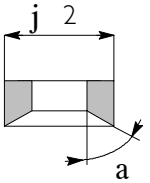
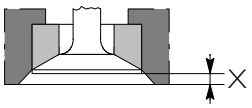
ASSEMBLY CLEARANCE DATA

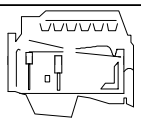
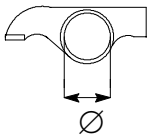
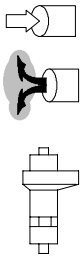
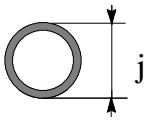
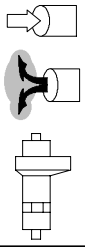
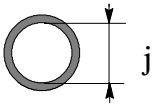
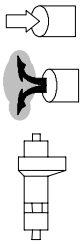
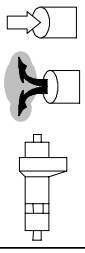
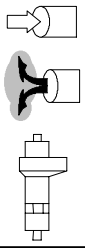
	Type	**F3B**
CYLINDER BLOCK AND CRANK MECHANISM COMPONENTS		mm
	Cylinder sleeve bore upper Ø 1 lower	 153.500 ÷ 153.525 152.000 ÷ 152.025
	Cylinder liners: outer diameter: upper Ø 2 lower length L	 153.461 ÷ 153.486 151.890 ÷ 151.915 –
	Cylinder sleeve - crankcase bore upper lower	 0.014 ÷ 0.039 0.085 ÷ 0.135
ASTRA PARTS 	Outside diameter Ø 2	–
 * Available dia. class	Cylinder sleeve inner diameter Ø 3A* inner diameter Ø 3B* Protrusion X	 135.000 ÷ 135.013 135.011 ÷ 135.024 0.045 ÷ 0.075
 * available dia. class	Pistons: measuring dimension X outside diameter Ø 1 A* outside diameter Ø 1 B* pin bore Ø 2	 20 134.881 ÷ 134.893 134.892 ÷ 134.894 54.010 ÷ 54.018
 * available dia. class	Piston - cylinder sleeve inner diameter Ø 3A* inner diameter Ø 3B*	 0.107 ÷ 0.132 0.107 ÷ 0.132
ASTRA PARTS 	Piston diameter Ø 1	–
	Pistons protrusion X	–
	Gudgeon pin Ø 3	53.994 ÷ 54.000
	Gudgeon pin - pin housing	0.010 to 0.024

	Type	F3B
		mm
	Piston ring grooves X1*	3.445 ÷ 3.475
	X2	3.05 ÷ 3.07
	X3	5.02 ÷ 5.04
	*measured on Ø of 130 mm	
	Piston rings: trapezoidal seal S1*	3.296 ÷ 3.364
	lune seal S2	2.970 ÷ 2.990
	milled scraper ring with slits and internal spring S3	4.970 ÷ 4.990
	*measured on Ø of 130 mm	
	1	0.081 ÷ 0.179
	Piston rings - grooves 2	0.060 ÷ 0.100
	Piston rings - grooves 3	0.030 ÷ 0.070
ASTRA PARTS 	Piston rings	–
	Piston ring end gap in cylinder liners:	
	X1	0.40 ÷ 0.55
	X2	0.65 ÷ 0.80
	X3	0.40 ÷ 0.75
	Small end bush housing Ø1	59.000 ÷ 59.030
	Big end bearing housing Ø2	94.000 ÷ 94.010
	Selection classes Ø2 1	94.011 ÷ 94.020
	2	94.021 ÷ 94.030
	3	
	Small end bush diameter	
	outside Ø4	59.085 ÷ 59.110
	inside Ø3	54.019 ÷ 54.035
	Big end bearing shell S	
	Red	1.965 ÷ 1.975
	Green	1.976 ÷ 1.985
	Yellow	1.986 ÷ 1.995
	Small end bush - housing	0.055 ÷ 0.110
	Piston pin - bush	0.019 ÷ 0.041
ASTRA PARTS 	Big end bearing shells	–
	Connecting rod weight	
	Class A g	g. 4661 ÷ 4694
	Class B g	g. 4695 ÷ 4728
	Class C g	g. 4729 ÷ 4762

	Type	F3B
		mm
	Measuring dimension X	125
	Max. connecting rod axis misalignment tolerance —	0.08
	Main journals Ø 1	99.970 ÷ 100.000
	Crankpins Ø 2	89.970 ÷ 90.000
	Main bearing shells S1	
	Red	3.110 ÷ 3.120
	Green	3.121 ÷ 3.130
	Yellow	3.131 ÷ 3.140
	Big end bearing shells S2	
	Red	1.965 ÷ 1.975
	Green	1.976 ÷ 1.985
	Yellow	1.986 ÷ 1.995
	Main bearing housings Ø 3	106.300 ÷ 106.330
	Bearing shells - main journals	0.060 ÷ 0.100
	Bearing shells - big ends	0.050 ÷ 0.090
	Main bearing shells	-
	Big end bearing shells	-
	Main journal, thrust bearing X1	47.95 ÷ 48.00
	Main bearing housing, thrust bearing X2	40.94 ÷ 40.99
	Thrust washer halves X3	3.38 ÷ 3.43
	Driving shaft shoulder	0.10 ÷ 0.30
	Alignment $\frac{1}{2}$	≤ 0.025
	Ovality ○ 1 - 2	0.010
	Taper ◺ 1 - 2	0.010

	Type	F3B
		mm
	Valve outside spring height: free height H under a load of: 575 ± 28 N H1 1095 ± 54 N H2	 72.40 58 45
	Injector protrusion X	0.52 ÷ 1.34
	Camshaft bush housing fitted in the cylinder head: 1 ⇒ 7 Ø	88.000 ÷ 88.030
	Camshaft journal diameter: 1 ⇒ 7 Ø	82.950 ÷ 82.968
	Camshaft bushing outer diameter: Ø	88.153 ÷ 88.183
	Camshaft bushing inner diameter: Ø	83.018 ÷ 83.085
	Bushings and housings in engine block	0.123 ÷ 0.183
	Bushings and journals	0.050 ÷ 0.135
	Cam lift:   	 9.231 9.5607 11.216
	Rocker shaft Ø 1	41.984 ÷ 42.000

	Type	F3B
CYLINDER HEADS - VALVE TRAIN		mm
	Valve guide housings in cylinder head Ø1	15.980 ÷ 15.997
	Valve guide Ø 2 Ø 3	10.015 ÷ 10.030 16.012 ÷ 16.025
	Valve guides - housings in the cylinder heads	0.015 ÷ 0.045
	Valve guide	–
	Valves: Ø 4 α Ø 4 α	9.960 ÷ 9.975 60° 30′ ± 7′ 30″ 9.960 ÷ 9.975 45° 30′ + 7′ 30″
	Valve stem and its guide	0.040 ÷ 0.070
	Housing in head for valve seat Ø1 Ø1	49.185 ÷ 49.220 46.985 ÷ 47.020
	Outside diameter of valve seat; angle of valve seat in cylinder head: Ø 2 α Ø 2 α	49.260 ÷ 49.275 60° - 30' 47.060 ÷ 47.075 45° - 30'
	Recessing of valve	0.54 ÷ 0.85 1.75 ÷ 2.05
	Between valve seat and head	0.040 ÷ 0.090

	Type	F3B
		mm
	Bushing housing in rocker arms 	45.000 ÷ 45.016 59.000 ÷ 59.019 46.000 ÷ 46.016
	Bushing outer diameter for rocker arms: 	45.090 ÷ 45.130 59.100 ÷ 59.140 46.066 ÷ 46.091
	Bushing inner diameter for rocker arms: 	42.025 ÷ 42.041 56.030 ÷ 56.049 42.015 ÷ 42.071
	Between bushings and housings 	0.074 ÷ 0.130 0.081 ÷ 0.140 0.050 ÷ 0.091
	Between rocker arms and shaft 	0.025 ÷ 0.057 0.025 ÷ 0.057 0.015 ÷ 0.087

DIAGNOSIS

Electrical faults and certain mechanical faults detected by the electronic control unit can be diagnosed by means of the Blink Code and diagnostic instruments.

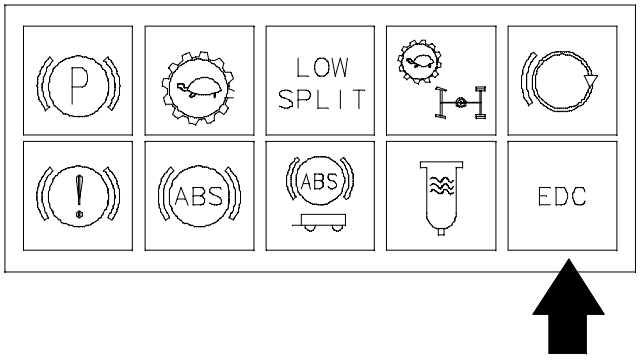
Blink Code

The EDC is designed to provide information on engine faults. The warning light comes on while the engine is running, to indicate a fault has occurred, which could be:

Warning light on	**Serious fault** Degraded system function
Warning light blinking	**Very serious fault** Degraded system function Loss of one or more safety functions and possible engine stop

Information on the type of fault is given in the form of a code by the EDC warning light consisting of a series of long or short blinks (the blink code).
To check the fault, use the diagnosis button located under the UCI compartment hatch, which has another EDC warning light operating in parallel with the one on the dashboard.

Figure 6



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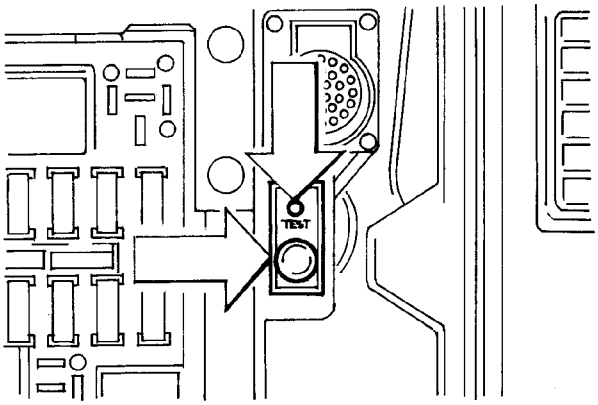
DASHBOARD WARNING LIGHTS

Fault checking/identification procedure

- ❑ Stop vehicle and switch off engine (STOP);
- ❑ Turn key to RUN (warning lights on and engine off);
- ❑ Press diagnosis button and check that the EDC warning light blinks once;
- ❑ After a short interval during which the warning light remains off, it begins to blink initially at long intervals and then shorter.

Figure 7



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EDC DIAGNOSIS BUTTON

The fault code is explained in the following pages.
For example: code 1.4 means that the warning light has given one long blink and four short ones. The procedure should be repeated until the code of the first indicated fault is repeated again.

Fault memory cancellation procedure from drivers seat

- ❑ Press the Blink Code button (with key to stop);
- ❑ turn key to RUN holding down the button;
- ❑ Wait 5 seconds;
- ❑ Turn key to stop;
- ❑ Check cancellation by reading number by means of test button.

MS 6.2 EDC electronic control unit blink code table

Blink Code	EDC warning light *	Fault
	VEHICLE AREA	
1.1	ON	Vehicle speed sensor
1.2	ON	Torque selector
1.3	OFF	Cruise control
1.4	ON	Accelerator pedal
1.5	OFF	Clutch pressure switch
1.6	ON	Brake pedal switch signal plausibility
1.7	OFF	Plausibility between brake / accelerator pedal
	ENGINE AREA	
2.1	OFF	Water temperature sensor
2.2	OFF	Air temperature sensor
2.3	OFF	Fuel temperature sensor
2.4	ON	Turbo pressure sensor
2.5	OFF	(Control unit) ambient temperature sensor
2.6	ON	Engine braking switch signal
3.5	OFF	Battery voltage
	TURBO AREA	
4.1	OFF	Turbo actuator pressure sensor
4.2	ON	Turbine revs sensor
4.3	ON	Turbine overspeed
4.4	ON	Turbo management (mechanical fault)
4.5	ON	VGT solenoid valve
4.6	BLINKING	Engine braking solenoid valve
	INJECTORS	
5.1	ON	Cylinder 1 injector fault
5.4	ON	Cylinder 4 injector fault
5.2	ON	Cylinder 2 injector fault
5.6	ON	Cylinder 6 injector fault
5.3	ON	Cylinder 3 injector fault
5.5	ON	Cylinder 5 injector fault
	ENGINE REVS SENSOR	
6.1	ON	Flywheel sensor
6.2	ON	Valve train sensor
6.4	OFF	Engine overspeed
	INTERFACE WITH OTHER CONTROL UNITS	
7.1	OFF	P.W.M. ABS/ASR interface
7.2	OFF	CAN line
7.3	OFF	CAN line (ASR management)
7.4	OFF	CAN line (gearbox data management)
	ENGINE CONTROL UNIT	
9.1	BLINKING	Faulty control unit
9.2	ON	EEPROM data incorrect
9.3	BLINKING	Immobilizer
9.4	ON	Main relay
9.5	ON	Engine stop procedure error
9.6	ON	Control unit data recording error

* Blink code warning light off — Slight fault
Blink code warning light on — Serious fault
Blink code warning light blinking — Very serious fault

DIAGNOSIS TOOLS

IT2000

Upper level diagnosis

Communicating with the control unit, this is able to carry out the following functions in detail:

1 SYSTEM DESCRIPTION

Explanation of MS 6.2 EDC system function, CONTROL UNIT PIN-OUT

2 CONTROL UNIT DATA READ-OUT

3 FAULT MEMORY READ-OUT

- Intermittent/permanent fault discrimination
- Details of fault, fault frequency, environmental conditions in which fault occurs
- Repair guide
- Diagram of circuit in question
- Details on use of UNITESTER on system in question

4 PARAMETER READING

- Measurable parameters
- Status parameters

5 FAULT MEMORY CANCELLATION

6 ACTIVE DIAGNOSIS

- Memorised data read-out

7 OTHER FAULTS

- Information is provided as to how to identify faults not directly recognised by the control unit

8 PROGRAM GUIDE

- Explanation about how to use the program

9 ENGINE TEST

- Compression
- Turbocompressor efficiency
- Engine braking efficiency
- Cylinder performance

CONTROL UNIT DIAGNOSIS

1 CONTROL UNIT DATA

2 FAULTS

- Selection: fault area
- Characteristics: design of component in question with photograph and electrical features
- Circuit diagram: cable/pin-out/connector coding
- Description: fault details, fault frequency, ambient conditions in which fault occurred
- Intervention: repair guide with access to multimeter/oscilloscope function, integrated with use of system dedicated adapters
- Cancellation: cancelling fault memory

3 PARAMETERS

- Status parameters
- Measurable parameters

4 ACTIVE DIAGNOSIS

- Memorised data read-out

5 SYSTEM (description of function / PIN OUT / other faults not directly diagnosed by control unit)

ENGINE DIAGNOSIS (ENGINE TEST)

These tests are carried out directly and automatically by the tester, including engine start/stop cycles (except for vehicles undergoing first phase Field Test)

- Compression
- Turbocompressor efficiency
- Engine braking efficiency
- Cylinder performance

AUXILIARY FUNCTIONS

- TRADITIONAL ELECTRICAL SYSTEM DIAGNOSIS
- LOCATION OF CABLE BREAK / SHORT CIRCUIT
- COMPONENT TEST (RELAYS / DIODES / FUSES)

TROUBLESHOOTING

Introduction

An effective diagnosis can be made above all using the electronic diagnosis tools (IT2000) developed by Iveco.

When the vehicle arrives at the workshop, the information provided by the driver should be given due consideration, although the first thing to do is to connect the IT2000 and carry out a complete diagnosis:

- Fault memory reading
- Parameter reading
- Engine test
- Etc.

It is useful to print out the results, especially if Help Desk assistance is required.

In this case, note that the Help Desk may not accept requests for assistance based only on Blink Code.

The Blink Code is a tool that can be useful in certain cases (vehicle broken down on the road, no Modus/IWT/IT2000), but must not substitute diagnosis with the Iveco tools because the code only offers general indications.

Another factor important in troubleshooting is experience.

To get around a possible lack of experience of the repair mechanic with respect to this new electronic system (there being no previous systems of the kind to use as reference, the following pages offer a TROUBLESHOOTING GUIDE developed by Training in collaboration with the experts who designed and developed the MS 6.2 EDC control unit.

However, it has to be stressed that not even Troubleshooting can replace the IT2000, although it is an extra help in that it concentrates the experience of the people who have a profound knowledge of the system.

The Troubleshooting guide consists of two distinct sections:

- The first looks for mechanical faults with Blink Code and regards faults that can be directly identified by the MS6.3 control unit. These faults are mainly of an electrical – electronic nature;
- The second looks for mechanical faults by symptoms, and describes possible faults that cannot be recognised by the electronic control unit. These faults are mainly of a mechanical – hydraulic nature.

Troubleshooting does not substitute diagnosis with Iveco electronic diagnosis tools, but is intended as a supplement to the same.

BLINK CODE	EDC WARNING LIGHT	POSSIBLE CAUSE	POSSIBLE ANOMALIES	ADVISED TESTS OR INTERVENTIONS	NOTES
1.1	On	Defective vehicle speed sensor. Tachigraph not functioning. Faulty tachigraph needle behaviour	Vehicle speed no longer limited, can be surpassed in case of poor resistance to advancement. Juddering in high gears	Flight recorder detects long time at low speed. Check wiring, connections, component	Control unit replacement value: 5 kph
1.2	On	Defective multi-state switch. No reduction in Economy mode		Check wiring, connections, component	
(1.2)	(On)	Multi-state switch blocked in one position No switching between normal and economy operation	Remains in last selected mode	Check wiring, connections, component	
1.3	Off	Defective cruise control. No reaction after turning CC/PTO switches	Cruise Control / PTO not functioning	Check wiring, connections, component	Switch signals not plausible (pressed together)
1.4	On	Accelerator pedal: defective powering or signal not plausible. Idle at 1000 rpm and faulty engine reaction to accelerator pedal			Can be varied with warm engine by CC switch (Set + / Set -)
1.4	On	Accelerator pedal: defective powering or signal not plausible. Idle at 1000 rpm and faulty engine reaction to accelerator pedal			Can be varied with warm engine by CC switch (Set + / Set -)

BLINK CODE	EDC WARNING LIGHT	POSSIBLE CAUSE	POSSIBLE ANOMALIES	ADVISED TESTS OR INTERVENTIONS	NOTES
1.5	Off	Defective clutch switch . CC/PTO not functioning	Juddering on gear change	Check wiring, connections, component	
1.6	On	Brake switch plausibility. No reaction after turning CC/PTO switch	Cruise control / PTO not functioning	Check wiring, connections, component	
1.7	Off	Accelerator pedal sensor / brake switch plausibility			No reaction from system
2.1	Off	Defective coolant temperature sensor. Excessive starting time in cold conditions	Greater combustion noise due to high injection advance	Active diagnosis of pre-heating element. Parameter reading. Check wiring, connections, component	Absence of overheating protection, replacement value = 0°C
2.2	Off	Turbo air temperature sensor defective	If sensor indicates lower temperature than real, error not memorised and engine achieves better performance but with black smoke	Parameter reading. Check wiring, connections, component	Replacement value = 20°C
2.3	Off	Defective fuel temperature sensor		Parameter reading. Check wiring, connections, component	No injection flow-rate correction, but driver does not notice. Replacement value = 970 mbar
2.4	On	Defective turbo pressure sensor. Reduced power	Temporary black smoke in significant quantities	Modus parameter reading: if replacement value appears at idle, fault is confirmed	

BLINK CODE	EDC WARNING LIGHT	POSSIBLE CAUSE	POSSIBLE ANOMALIES	ADVISED TESTS OR INTERVENTIONS	NOTES
2.5	Off	Defective ambient pressure sensor		Contact Help Desk for control unit replacement because sensor built-in to the same	Less accurate VGT function at high altitude, but driver does not notice. Replacement value = 970 mbar
(2.6)	(On)	Engine braking command switches or selector switch. Engine brake not functioning in all three selected modes		Modus parameter reading. Check wiring, connections, component	
(2.6)	(On)	Engine braking switch blocked closed. Engine braking enabled only above 900 rpm		Active diagnosis of engine braking solenoid valve	Fuel injection interrupted by ECU, engine speed drops to 800 rpm, fuel injection again interrupted by ECU
(2.6)	(On)	Engine braking switch blocked open		Engine test on engine braking. Active diagnosis of engine braking solenoid valve	Engine braking functions when activated by Modus or by other two selection modes (accelerator – brake)
3.5	Off	Battery voltage too low or fault in voltage recognition	Possible pre-heating and starting problems	Test batteries	EDC operates with replacement value of 28V
4.1	Off	Faulty VGT pressure sensor capsule. Poor performance at low speeds and on acceleration	Possible reduction in engine braking power	Engine test: Check wiring, connections, component. Check arrival of compressed air to capsule. Check function of shut-off valve on chassis.	If capsule pressure increases during VGT test but , visually, the actuator does not move, it is seized.

BLINK CODE	EDC WARNING LIGHT	POSSIBLE CAUSE	POSSIBLE ANOMALIES	ADVISED TESTS OR INTERVENTIONS	NOTES
4.1	Off	Rotating parts of turbo-compressor totally seized. Poor performance at low speeds and on acceleration	Reduced engine braking power	Engine test: engine check-up	Capsule memorises turbine revs sensor error, even if it functions correctly
(4.1)	(Off)	VGT command solenoid blocked or seized closed. Noise indicates faulty turbo behaviour (speed does not follow accelerator pedal)	Poor vehicle acceleration	Engine test: VGT. Turbine actuator active diagnosis	
(4.2)	(Off)	VGT mechanism blocked closed. Reduced power with engine speed below 1200 rpm.	Black smoke with normal function, after acceleration. Engine brake disengaged by control unit in braking mode with high engine speeds	Engine test: engine brake and VGT. Turbine actuator active diagnosis	Power reduced by control unit due to excessive turbine speed
4.2	On	Faulty turbo speed sensor. Reduced power and speed		Engine test: check wiring, connections, component	
4.3	On	Turbine overspeed or excessive turbo pressure. Reduced power	Poor engine brake efficiency	Engine test	Fuel flow reduction during turbine over-revving
4.4	On	VGT monitoring of control unit. Reduced power		Engine test	Deviation of VGT variable geometry beyond set thresholds

BLINK CODE	EDC WARNING LIGHT	POSSIBLE CAUSE	POSSIBLE ANOMALIES	ADVISED TESTS OR INTERVENTIONS	NOTES
(4.1) (4.4)	(Off) (On)	No compressed air delivery to VGT valve or insufficient pressure. Poor performance at low speeds and in acceleration	Possible reduction in engine braking efficiency	Engine test: active diagnosis: turbine actuator. Check compressed air delivery to capsule. Check function of shut-off valve on chassis If not functioning check connections, wiring, component and passage. If shut-off valve functions, check air line from shut-off to capsule and line connection to capsule. Check mechanical efficiency of VGT command solenoid valve.	
(4.1) (4.4)	(Off) (On)	VGT mechanism in turbine blocked half open. Poor performance at low and medium speeds and in acceleration	Possible reduction in engine braking efficiency	Engine test: VGT, engine brake. Turbine actuator active diagnosis	If external VGT command mechanisms function but VGT test indicates fault, fault should be sought in turbo internal mechanisms.
4.5	On	Electrical problem with VGT solenoid valve. Significant power reduction at low speed and in acceleration	Reduction in engine braking efficiency	Engine test: Check wiring, connections and component	
4.6	Blinking	Engine brake solenoid valve. Engine brake not functioning		Engine test: check wiring, connections and component	If engine brake does not function with engine test, solenoid valve is not powered by vehicle wiring
5.x	On			Engine test (if fault is present): Check wiring, connections and component (header cable as well)	

BLINK CODE	EDC WARNING LIGHT	POSSIBLE CAUSE	POSSIBLE ANOMALIES	ADVISED TESTS OR INTERVENTIONS	NOTES
6.1	On	Faulty flywheel sensor. Reduced engine speed and power	Engine start may take longer than usual	Modus fault memory reading. Check wiring, connections and component	
6.2	On	Camshaft sensor. Reduced engine power and speed	Engine start may take longer than usual	Modus fault memory reading Check wiring, connections and component	
(6.1 – 6.2)	(On)	Camshaft phonic wheel offset due to loose screws. Engine does not start or stops. Restart impossible.	Reduced power with motor running (after recommended intervention)	Disconnect camshaft sensor. If engine starts, taking longer that usual, phonic wheel is offset.	
6.4	Blinking	Engine has reached 3800 rpm (motoring) for any reason		Fault memory reading. Read flight recorder to confirm engine overspeed.	
7.1	Off	Two cable ABS/ASR interface problems ASR not functioning		Check vehicle wiring	
7.4	Off	CAN gearbox command interruption. Gearbox command does not function via CAN			
(9.1)	(Blinking)	Faulty EDC control unit Engine stops or does not start		Contact Help Desk for control unit replacement	No diagnosis possible. This error may not be memorised, depends on control unit condition.

BLINK CODE	EDC WARNING LIGHT	POSSIBLE CAUSE	POSSIBLE ANOMALIES	ADVISED TESTS OR INTERVENTIONS	NOTES
9.2	On	Faulty control unit (EEPROM memory). Reduced engine speed and power	Fault memory cancelled, diagnosis possible only for current faults	Contact Help Desk for possible replacement of control unit	
9.4	On	Main relay faulty or blocked closed. EDC lamp stays on when key turned to OFF but engine stops.	EDC power remains on after turning key to off, danger of flattening battery	Check wiring, connections and component	Fault is memorised only after subsequent starting
9.5	On	ECU power frequently interrupted (5 times): Main relay faulty or engine stop by battery cut-off switch.		Check main relay, wiring and component. Investigate possible driver habits regarding stopping engine without turning key	Problem solves only with subsequent switch-off procedure and correct data memorising.
9.6	On	ECU stop test fail. Reduced engine speed and power	Internal control unit test procedure to check power stages. Could memorise other errors related to various actuator power stages.	Contact Help Desk for possible replacement of control unit	

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TROUBLESHOOTING BY SYMPTOMS

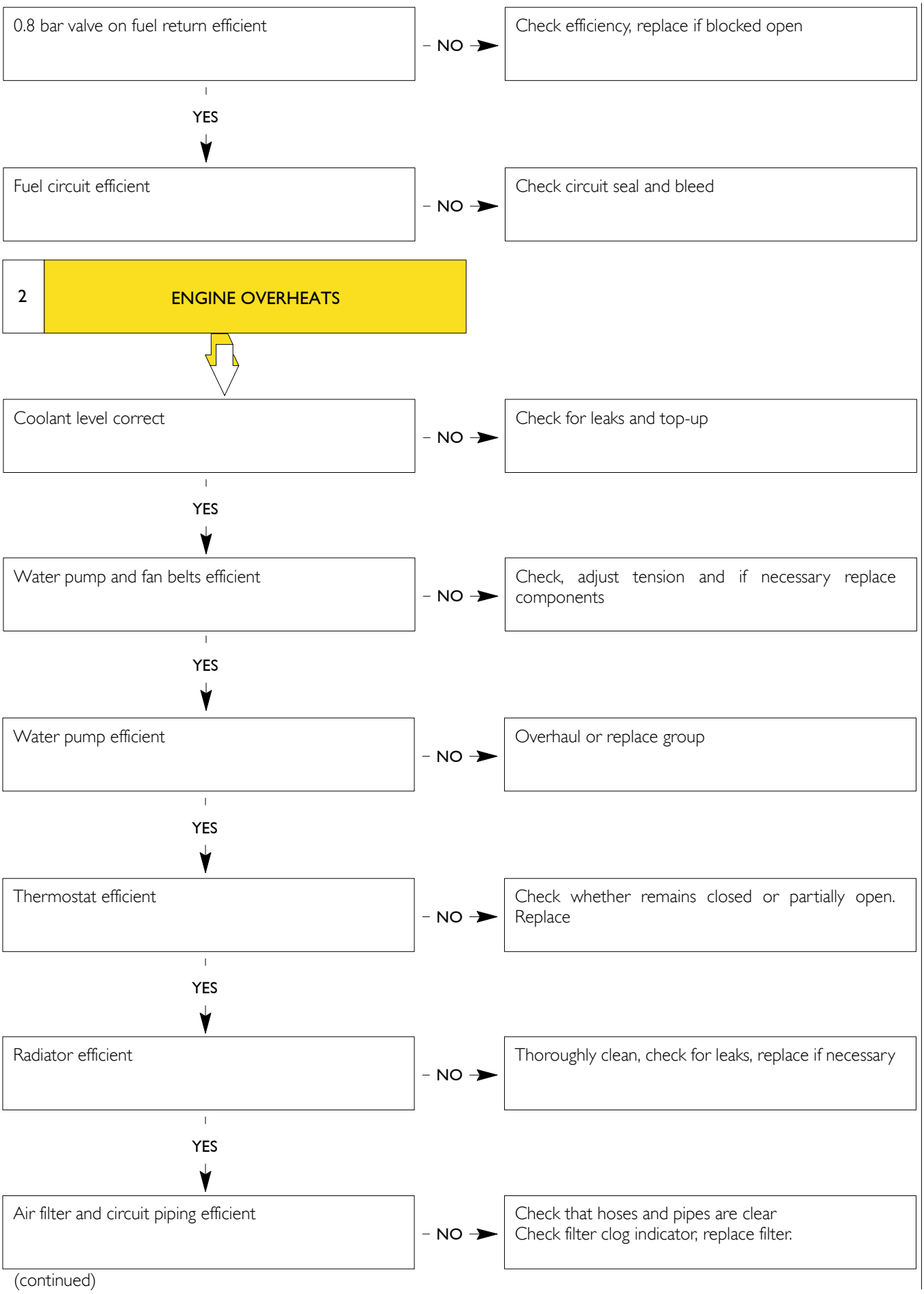
Main engine operating anomalies:

1 - The engine does not start;
2 - The engine is excessively heated;
3 - The engine lacks efficiency;
4 - The engine has grey smokes (tending to white);
5 - The engine has blue smokes;
6 - Poor engine braking efficiency;
7 - The engine stops;
8 - Excessive fuel consumption;
9 - Excessive or insufficient oil pressure.

1 ENGINE DOES NOT START

Battery efficient	– NO →	Pre-heating element always on Check alternator efficiency Check battery terminal connections
YES ↓		
Starter motor efficient	– NO →	Carry out checks / replace
YES ↓		
Air heater efficient	– NO →	Check power supply and earth connection Check heater relay by active diagnosis
YES ↓		
Main relay efficient	– NO →	Check fuses Check relay by active diagnosis
YES ↓		
Fuel pump efficient	– NO →	Check efficiency checking pressure at filter
YES ↓		
Fuel prefilter - filter efficient	– NO →	Check for clogging / replace

(continued)


0.8 bar valve on fuel return efficient
NO
Check efficiency, replace if blocked open
YES
Fuel circuit efficient
NO
Check circuit seal and bleed
2
ENGINE OVERHEATS
Coolant level correct
NO
Check for leaks and top-up
YES
Water pump and fan belts efficient
NO
Check, adjust tension and if necessary replace components
YES
Water pump efficient
NO
Overhaul or replace group
YES
Thermostat efficient
NO
Check whether remains closed or partially open. Replace
YES
Radiator efficient
NO
Thoroughly clean, check for leaks, replace if necessary
YES
Air filter and circuit piping efficient
NO
Check that hoses and pipes are clear
Check filter clog indicator, replace filter.

(continued)

Cylinder head gasket efficient – NO → Check water pressure and replace head gasket

YES

Fan efficient – NO → Replace

3 ENGINE LACKS POWER

Fuel circuit efficient – NO → Check whether tank filter, prefilter and fuel filter are clogged. Replace.
Check whether 0.8 bar valve on fuel return from head is blocked open (low pressure) or closed (high temperature). Replace
Check for circuit leaks and fuel pump efficiency

YES

Injectors efficient – NO → Injector pump may seize or fuel leak from O-ring.
Carry out engine test and proceed as per instructions given

YES

Engine air intake circuit efficient – NO → Remove obstruction on circuit and replace air filter if clogged.
Check clogged cartridge indicator

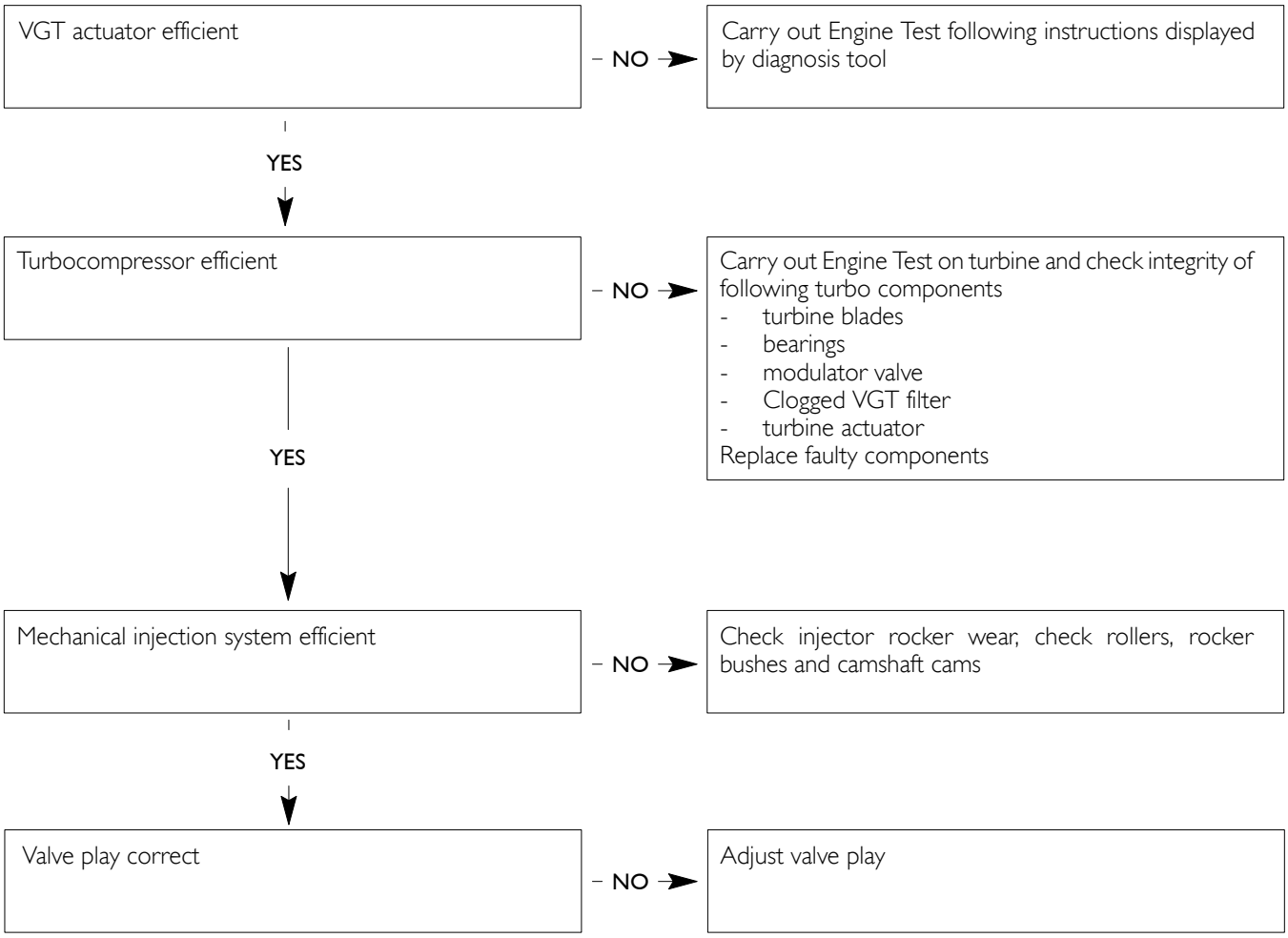
YES

Exhaust gas circuit efficient – NO → Eliminate leaks on exhaust manifold

YES

Correct running temperature – NO → Check cooling system

(continued)


VGT actuator efficient
NO
Carry out Engine Test following instructions displayed by diagnosis tool
YES
Turbocompressor efficient
NO
Carry out Engine Test on turbine and check integrity of following turbo components
- turbine blades
- bearings
- modulator valve
- Clogged VGT filter
- turbine actuator
Replace faulty components
YES
Mechanical injection system efficient
NO
Check injector rocker wear, check rollers, rocker bushes and camshaft cams
YES
Valve play correct
NO
Adjust valve play

4 ENGINE EMITS GREY/WHITE SMOKE

Head gasket efficient
- NO → Grind head and replace gasket

YES ↓

Injector sheathes efficient
- NO → Replace sheathes

YES ↓

Turbocompressor cooling circuit seal efficient
- NO → Overhaul turbo

YES ↓

Good quality fuel
- NO → Check for water in tank and eliminate

5 ENGINE EMITS BLUE SMOKE

Piston rings efficient
- NO → Overhaul pistons - cylinder

YES ↓

Turbo lubrication circuit efficient
- NO → Overhaul turbo

YES ↓

Valve oil seals efficient
- NO → Replace valve guide gaskets

6 POOR ENGINE BRAKING EFFICIENCY

Engine braking components efficient

– NO → Check correct function of engine brake actuator cylinders and command solenoid
Check cylinder command oil piping seal
Check exhaust valve play

YES

Turbocompressor efficient

– NO → VGT blocked open
Faulty VGT actuator (seepage from tie rod)
Faulty modulator valve
Incorrect air supply to modulator valve
Replace faulty components

7 ENGINE STOPS

Fuel in tank

– NO → Bleed group after filling tank

YES

Tank filter, pre-filter and engine fuel filter efficient

– NO → Clean tank filter and replace filter and prefilter

YES

Tank fuel lines correctly connected

– NO → Inverting the pipes may cause vehicle to stop after 200 - 300 km even if tank has fuel because piping that feeds engine has less scavenge.
Invert pipes.

8 EXCESSIVE FUEL CONSUMPTION

Air filter efficient
- NO → Replace

YES

Tank and fuel lines efficient.
- NO → Eliminate any leaks and replace worn parts

9 OIL PRESSURE INSUFFICIENT OR EXCESSIVE

Pressure regulator valve operates correctly
- NO → Check and if necessary replace

YES

Oil pump and delivery piping efficient
- NO → Check and if necessary replace.

YES

Main bearings and big ends efficient
- NO → Replace bearings and if necessary grind crankshaft

YES

Engine oil SAE viscosity correct
- NO → Change engine oil with suitable viscosity oil

TIGHTENING TORQUES

PART			TORQUE	
			Nm	kgm
Capscrews, undercrankcase to crankcase ♦				
Outside screws M12x1.75	First phase: preliminary tightening		30	(3)
Inner screws M 18x2	Second phase: preliminary tightening		120	(12)
Inner screws	Third phase: angle locking		60°	
Inner screws	Fourth phase: angle locking		55°	
Outer screws	Fifth phase: angle locking		60°	
Piston cooling nozzle union ♦			35±2	(3.5)
Heat exchanger fixing screws to the block ♦				
preliminary tightening			11.5±3.5	(1.15±0.35)
tightening			19±3	(1.9±0.3)
Spacer oil sump fixing screws to undercrankcase ♦			24,5±2,5	(2.4±0.25)
Fixing screws to oil sump ♦				
preliminary tightening			38	(3.8)
tightening			45	(4.5)
Gearbox fixing screws to the block M 12x1.75 ♦			63±7	(6.3)
Control unit fastening screws on engine block			24±2.5	(2.4±0.25)
Cylinder head fixing screws ♦				
First phase	preliminary tightening		60	(6)
Second phase	preliminary tightening		120	(12)
Third phase	angle locking		90°	
Fourth phase	angle locking - screws	4 - 5 - 12 - 20 - 21	45°	
Fourth phase	angle locking - screws	1- 2 - 3 - 6 - 7 - 8 - 9 - 10 - 11 14 - 15 - 16 - 17 - 18 - 19 - 22 23 - 24 - 25 -26	65°	
Rocker shaft fixing screws ♦				
First phase	preliminary tightening		100	(10)
Second phase	angle locking		60°	
Lock nut for rocker adjustment screw ♦			39±5	(3.9±0.5)
Injector blocking brackets screws ♦			26	(2.6)
Plastic cover fastening screws			8.5±1.5	(0.85±0.15)
Shoulder plate fixing bolts to head ♦			19±3	(1.9±0.3)
Engine mounting bracket screws on head				
First phase	pre-torque		120	(12)
Second phase	tightening to angle		45°	

♦ Lubricate with UTD oil before installation

• Lubricate with graphitized oil before installation

PART		TORQUE	
		Nm	(kgm)
Engine mounting bracket fastening screws on flywheel casing			
First phase	pre-torque	100	(10)
Second phase	tightening to angle	60°	
Camshaft cog fastening screws: ♦			
First phase	pre-torque	60	(6)
Second phase	tightening to angle	60°	
Phonic wheel fastening screws to camshaft cog		8,5±1,5	(0,85±0,15)
Exhaust manifold fastening screws: •			
	pre-torque	32,5	(3,2)
	full torque	45	(4,5)
Big end cap fastening screws♦		19	(1,9)
Viti fissaggio cappello di biella : ♦			
Prima fase	preserraggio	60	(6)
Seconda fase	chiusura ad angolo	60°	
Big end cap fastening screws: ♦			
First phase	pre-torque	120	(12)
Second phase	tightening to angle	60°	
Third phase	tightening to angle	30°	
Flywheel damper: ♦			
First phase	pre-torque	70	(7)
Second phase	tightening to angle	50°	
Intermediate gear pin fastening screws: ♦			
First phase	pre-torque	30	(3)
Second phase	tightening to angle	90°	
Link rod fastening screws for pulley wheel adjustment		24,5±2,5	(2,45±0,25)
Oil pump fastening screws		24,5±2,5	(2,45±0,25)
Crankshaft front gasket casing fastening screws		24,5±2,5	(2,45±0,25)
Fuel pump / filter bracket fastening screws		19	(1,9)
Control unit mounting screws		19±3	(1,9±0,3)
Turbocompressor screws and nuts •			
	pre-torque	35	(3,5)
	full torque	46	(4,6)
Vite fissaggio gruppo termostato		19±3	(1,9±0,3)
Viti fissaggio pompa acqua		25	(2,5)
Thermostat group fastening screws		30	(3)
Water pump fastening screws		30	(3)
Fan hub spacer fastening screws		100	(10)
Fan bracket engine block fastening screws		26±3	(2,6±0,3)
Air conditioner automatic belt tensioner fastening screws		50±5	(5±0,5)
Auxiliary organs fixed pulley engine block fastening screws		105±5	(10,5±0,5)
Starter motor fastening screws		74±4	(7,4±0,4)
Air heater fastening screws		30±3	(3±0,3)
Air compressor fastening screws		74±4	(7,4±0,4)

♦ Lubricate with UTD oil before installation

• Lubricate with graphitized oil before installation

PART	TORQUE	
	Nm	(kgm)
Air compressor command cog fastening nut ♦	170±10	(17±1)
Alternator fastening screws: M 10x1,5 l = 35 mm	30±3	(3±0,3)
M 10x1,5 l = 60 mm	44±4	(4,4±0,4)
Servosteering pump fastening screws	46,5±4,5	(4,65±0,45)
Air conditioning compressor support fastening screws	24,5±2,5	(2,5±0,25)
Cover fastening screws	24,5±2,5	(2,5±0,25)
Clogged filter sensor fastening	55±5	(5,5±0,5)
Fuel / water temperature sensor fastening	35	(3,5)
Thermometric transmitter / switch fastening	25	(2,5)
Air temperature transmitter fastening	35	(3,5)
Pulse transmitter fastening	8±2	(0,8±0,2)
Injector connector fastening	1,36±1,92	(0,13±0,19)
Engine brake solenoid valve fastening	32	(3,2)

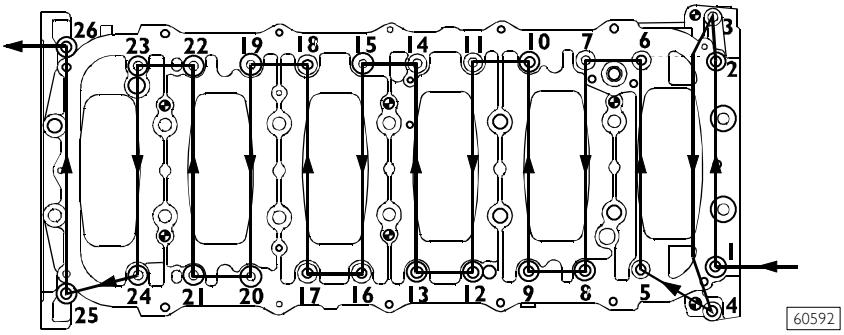
♦ Lubricate with UTD oil before installation

• Lubricate with graphitized oil before installation

TIGHTENING ORDER OF GEARBOX TO ENGINE BLOCK FASTENING SCREWS

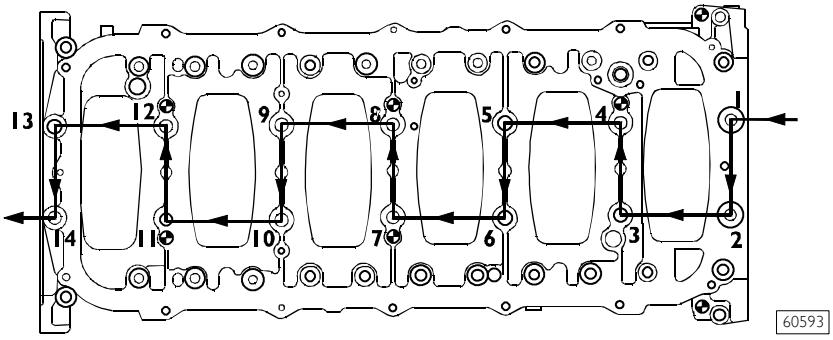
Figure 8

FRONT SIDE



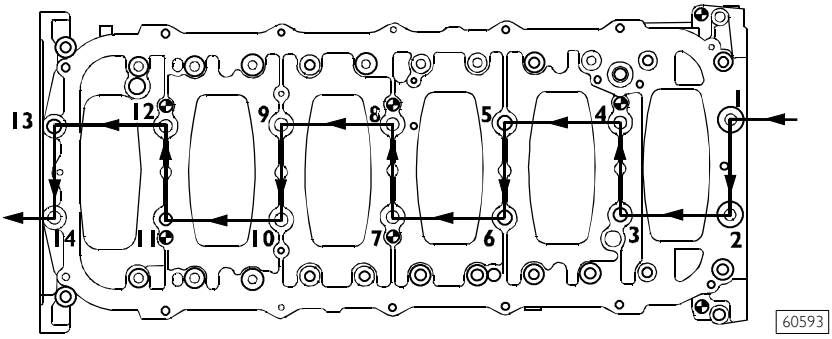
stage 1:
pretightening,
outer screws
30 Nm

FRONT SIDE



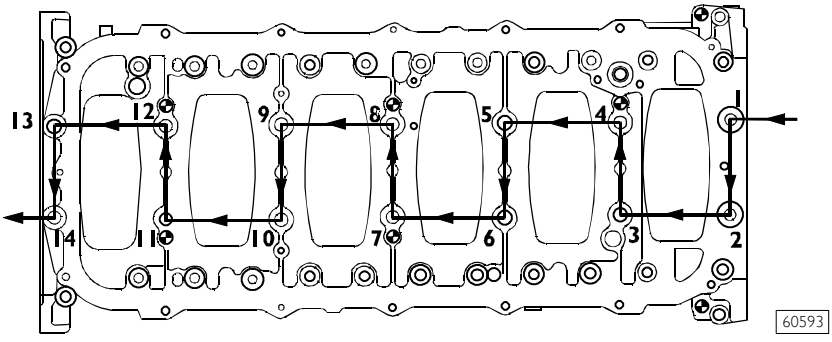
stage 2:
pretightenig,
inner screws
120 Nm

FRONT SIDE



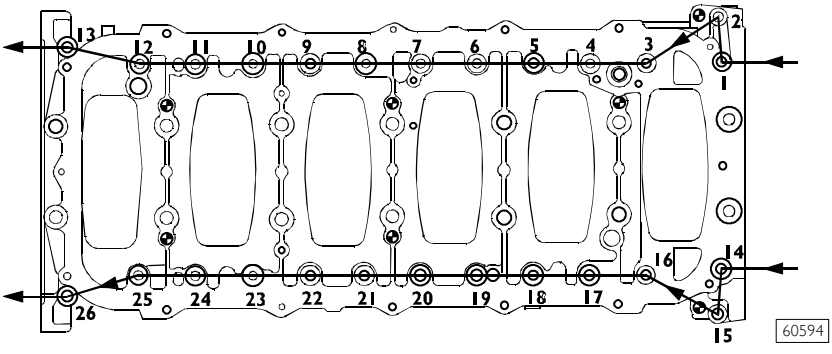
stage 3:
angle, inner
screws
60°

FRONT SIDE



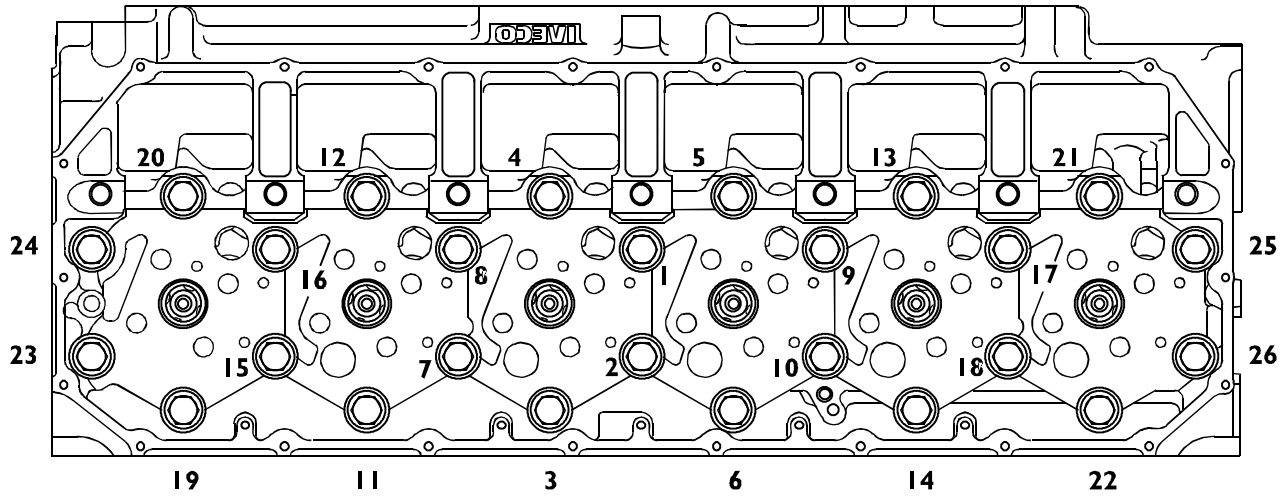
stage 4:
angle, inner
screws
55°

FRONT SIDE



stage 5:
angle, outer
screws
60°

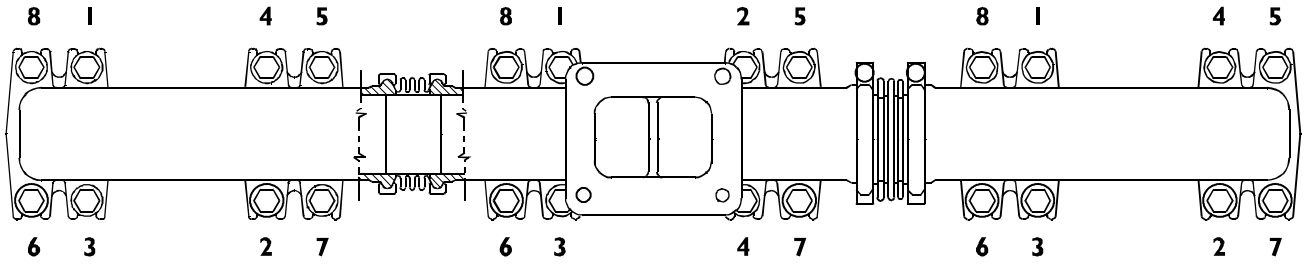
Figure 9



60580

DIAGRAM OF CYLINDER HEAD FIXING SCREWS TIGHTENING SEQUENCE

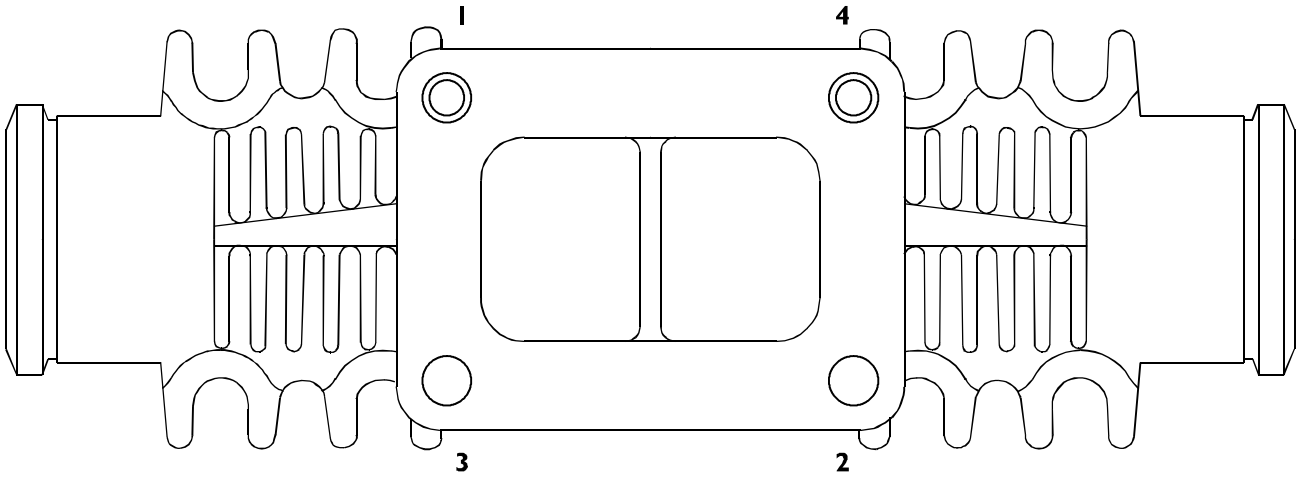
Figure 10



60581

DIAGRAM OF EXHAUST MANIFOLD FIXING SCREWS TIGHTENING SEQUENCE

Figure 11



60582

DIAGRAM OF TURBOCHARGER FIXING SCREWS AND NUTS TIGHTENING SEQUENCE

Figure 12

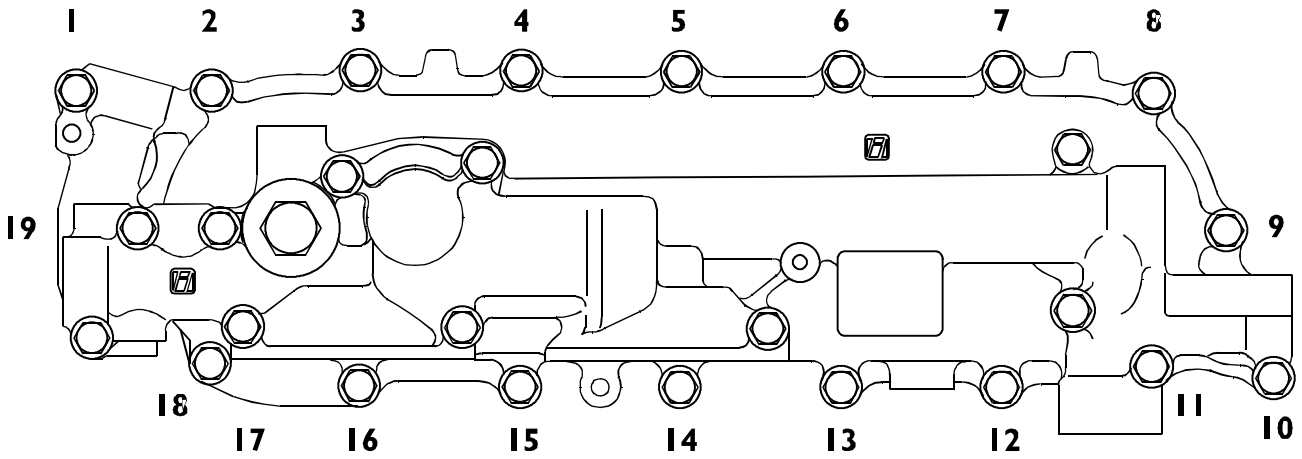


DIAGRAM OF TIGHTENING SEQUENCE FOR HEAT EXCHANGER SCREWS

Figure 13

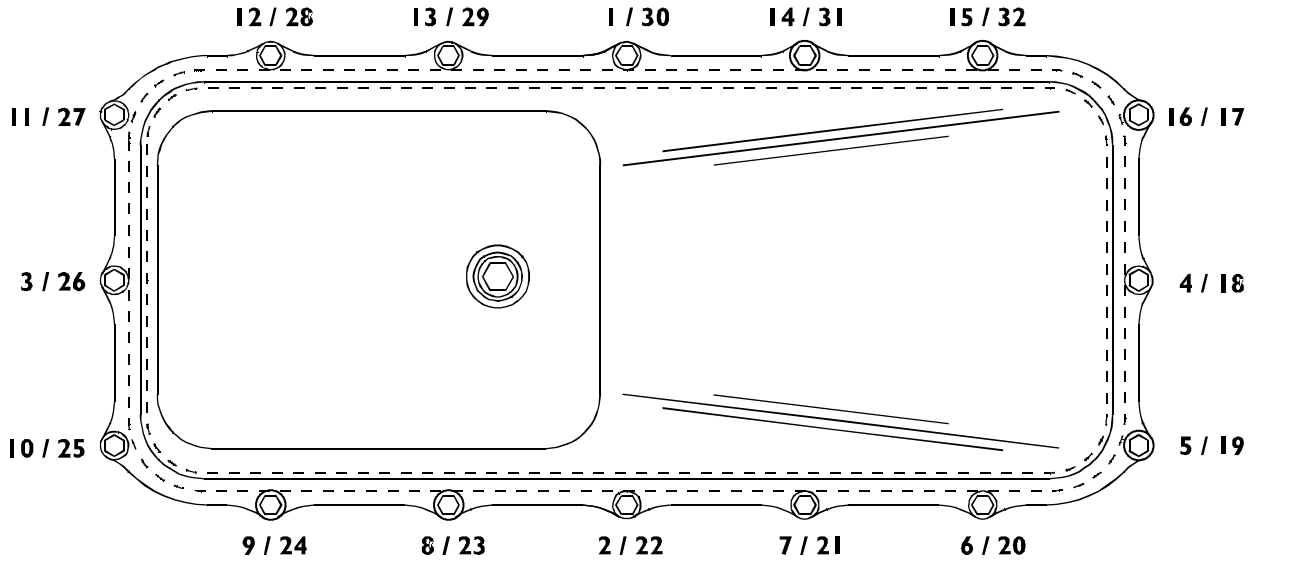
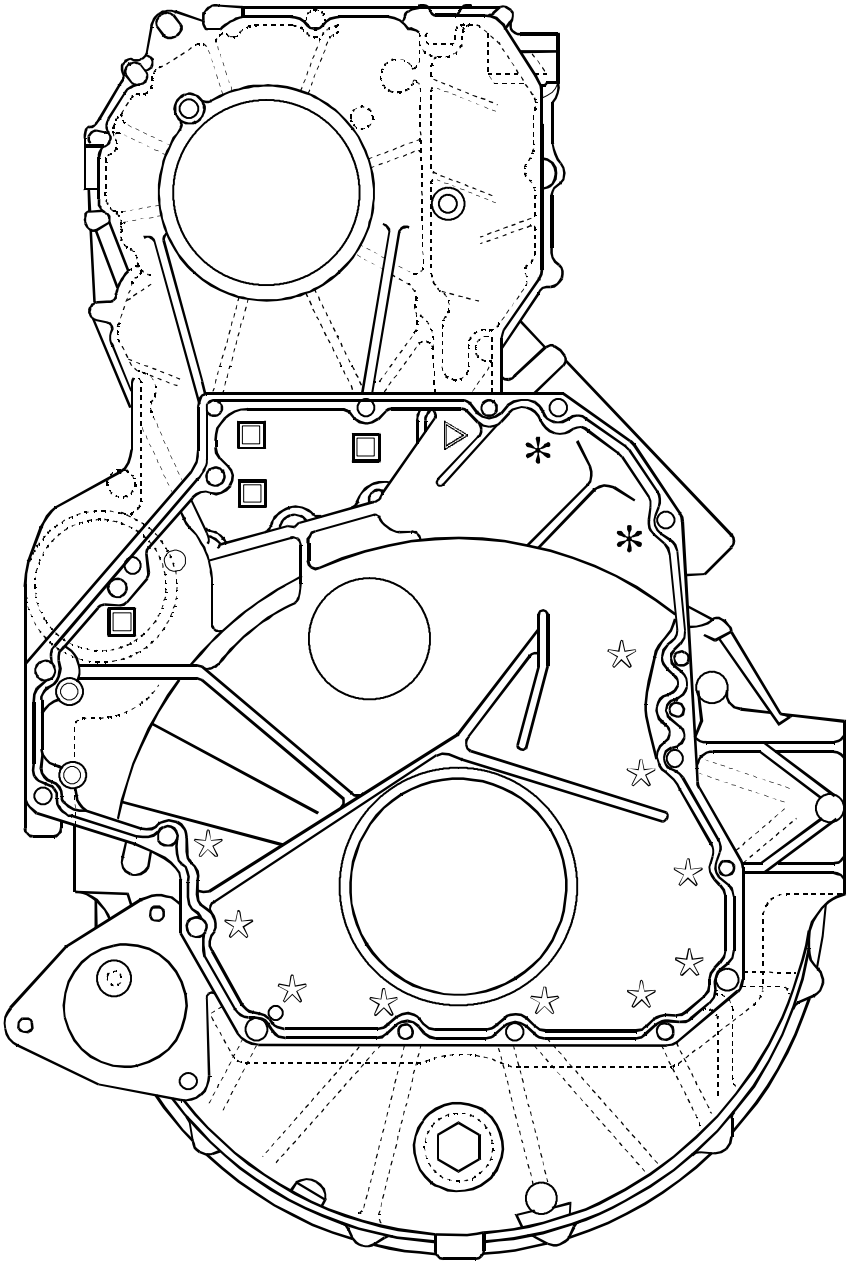


DIAGRAM OF TIGHTENING SEQUENCE FOR ENGINE OIL SUMP SCREWS

Figure 14

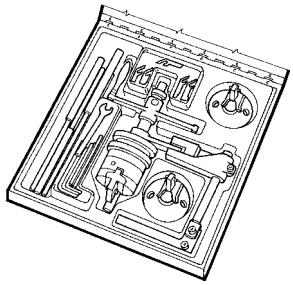
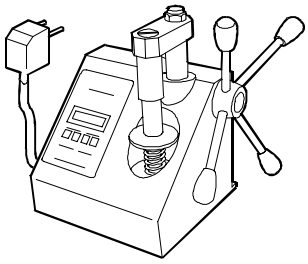
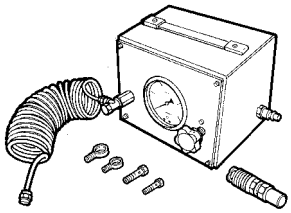
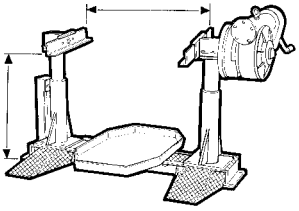
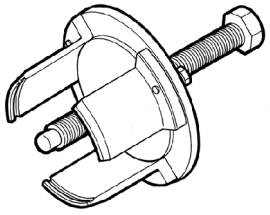
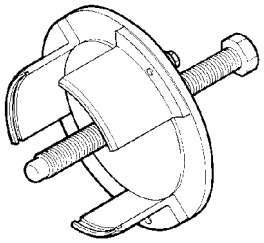


60633

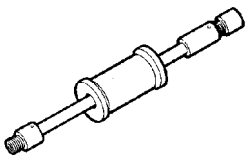
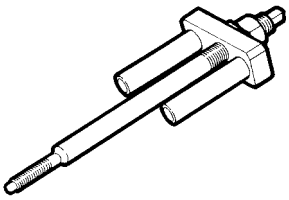
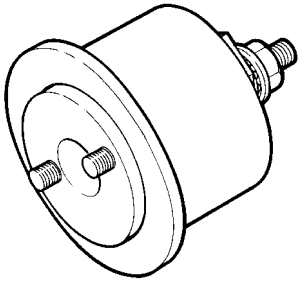
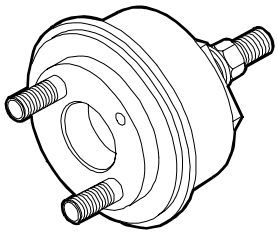
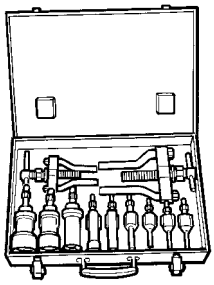
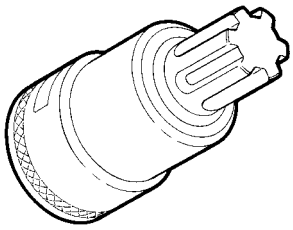
Tightening order

- ✡ no. 10 M12 x 1.75 x 100
- ◎ no. 2 M12 x 1.75 x 70
- □ no. 4 M12 x 1.75 x 35
- △ no. 1 M12 x 1.75 x 120
- ✳ no. 2 M12 x 1.75 x 193

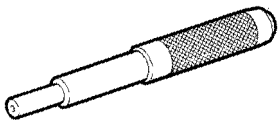
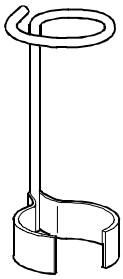
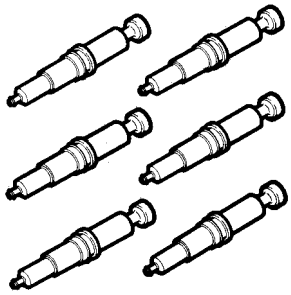
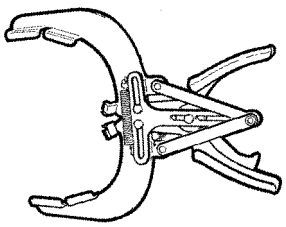
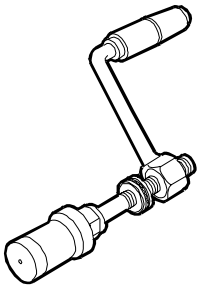
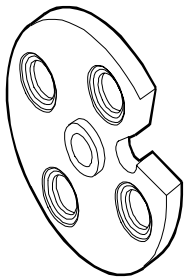
TOOLS

TOOL NO.		DESCRIPTION
99305019		Full-optional tool-kit to rectify valve seat
99305047		Rotary telescopic stand (range 2000 daN, torque 375 daNm)
99309002		Tool for bench calibration of L.D.A device
99322230		Rotary telescopic stand (range 2000 daN, torque 375 daN/m)
99340053		Extractor for crankshaft front gasket
99340054		Extractor for crankshaft rear gasket

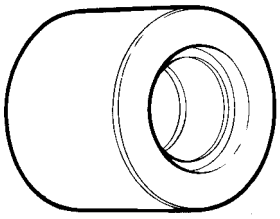
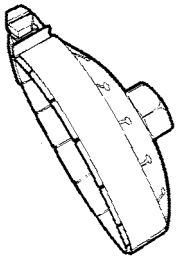
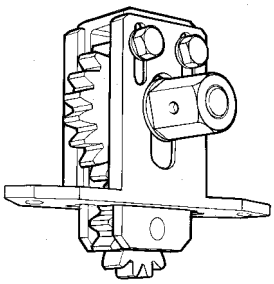
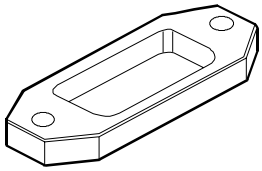
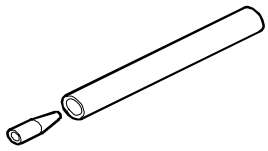
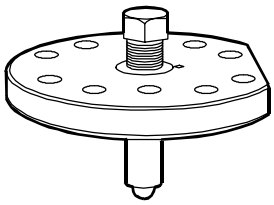
TOOLS

TOOL NO.		DESCRIPTION
99340205		Percussion extractor
99342149		Extractor for injector-holder
99346250		Tool to install the crankshaft front gasket
99346251		Tool to install the crankshaft rear gasket
99348004		Universal extractor for 5 to 70 mm internal components
99350072		Box wrench for block junction bolts to the underblock

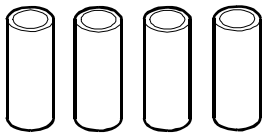
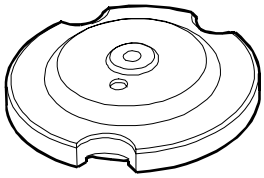
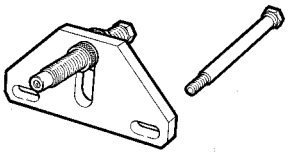
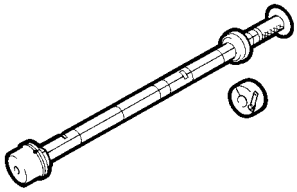
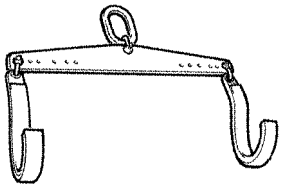
TOOLS

TOOL NO.		DESCRIPTION
99360143		Box wrench for block junction bolts to the underblock
99360144		Tools (12+6) for holding sliding blocks for rockers adjusting screws during disassembly reassembly rockers shaft
99360180		Injector housing protecting plugs (6)
99360184		Pliers for assembling and disassembling piston split rings (105-106 mm)
99360261		Tool to take down-fit engine valves (to be used with special plates)
99360263		Plate for take down-fit engine valves (to be used with 99360261)

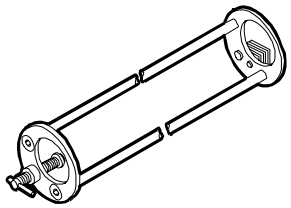
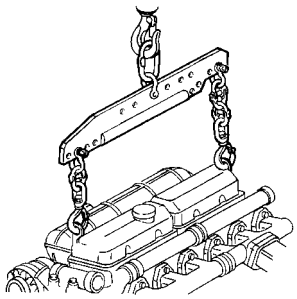
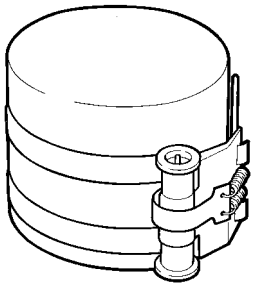
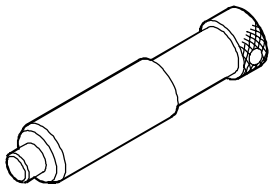
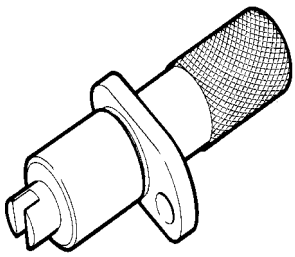
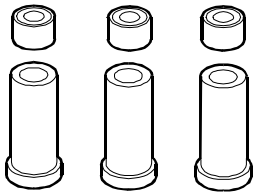
TOOLS

TOOL NO.		DESCRIPTION
99360296		Tool to fit back valve guide (to be used with 99360143)
99360314		Tool to remove oil filter (engine)
99360321		Tool to rotate engine flywheel (to be used with 99360325)
99360325		Spacer (to be used with 99360321)
99360329		Tool to install gasket on valve guide
99360334		Compression tool for checking the protrusion of cylinder liners (to be used with 99370415-99395603 and special plates)

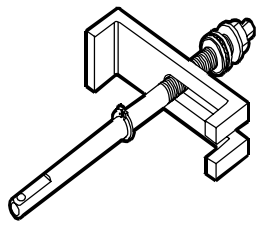
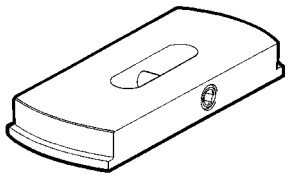
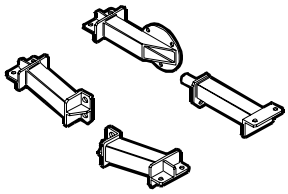
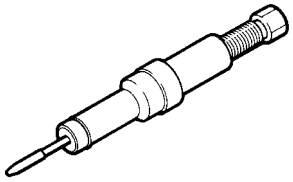
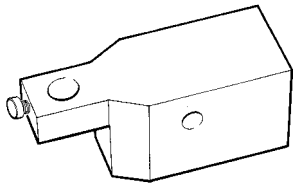
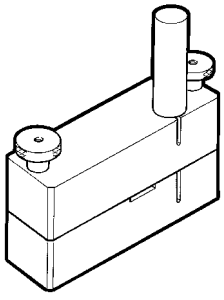
TOOLS

TOOL NO.		DESCRIPTION
99360336		Spacer (to be used with 99360334)
99360338		Cylinder liner compression plate (to be used with 99360334-99360336)
99360351		Tool to stop engine flywheel
99360499		Tool to take down and fit back camshaft bushes
99360500		Tool to lift crankshaft
99360551		Bracket to take down and fit engine flywheel

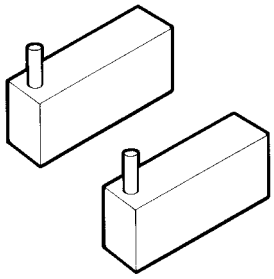
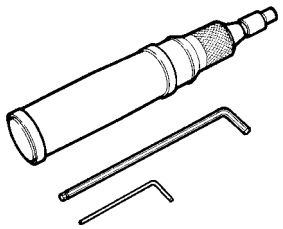
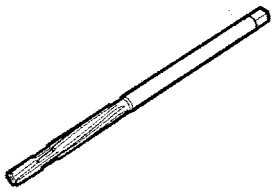
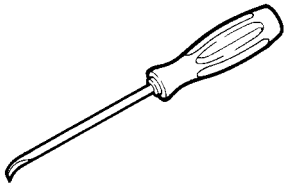
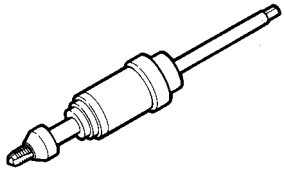
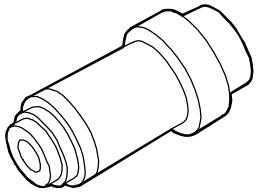
TOOLS

TOOL NO.		DESCRIPTION
99360553		Tool for assembling and installing rocker arm shaft
99360585		Swing hoist for engine disassembly assembly
99360605		Belt to insert piston in cylinder liner (60 - 125 mm)
99360612		Tool for positioning engine P.M.S.
99360613		Tool for timing of phonic wheel on timing gear
99360703		Tool to stop cylinder liners

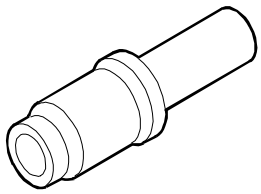
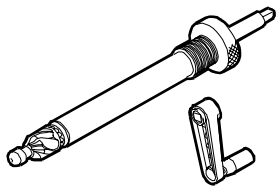
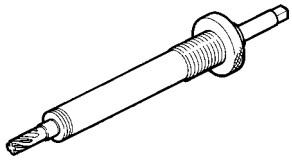
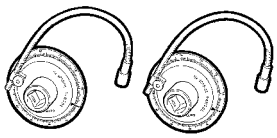
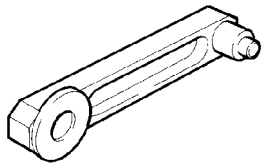
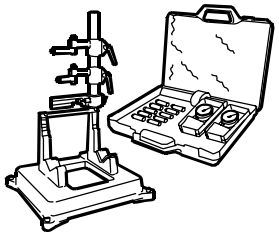
TOOLS

TOOL NO.		DESCRIPTION
99360706		Tool to extract cylinder liners (to be used with specific rings)
99360728		Ring (125 mm) (to be used with 99360706)
99361036		Brackets fixing the engine to rotary stand 99322230
99365056		Tool for injector holder heading
99370415		Base supporting the dial gauge for checking cylinder liner protrusion (to be used with 99395603)
99378100		Tool for printing engine identification plates (to be used with special punches)

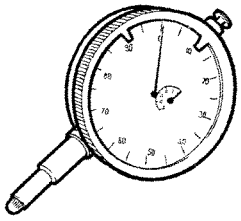
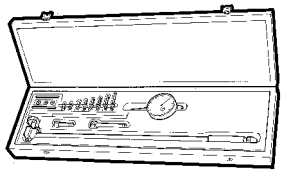
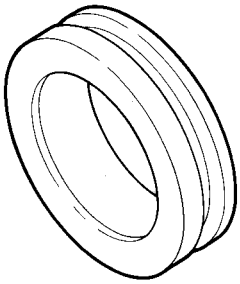
TOOLS

TOOL NO.		DESCRIPTION
99378101 **99378102** **99378103** **99378104** **99378105** **99378106**		Punches (A,B,C,D,E,F) for printing engine identification plates (to be used with 99378100)
99389834		Torque screwdriver for calibrating the injector solenoid valve connector check nut
99390330		Valve guide sleeker
99390772		Tool for removing injector holding case deposits
99390804		Tool for threading injector holding cases to be extracted (to be used with 99390805)
99390805		Guide bush (to be used with 99390804)

TOOLS

TOOL NO.		DESCRIPTION
99394015		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)
99395216		Measuring pair for angular tightening with 1/2" and 3/4" square couplings
99395219		Gauge for defining the distance between the centres of camshaft and transmission gear
99395363		Complete square to check connecting rod squaring

TOOLS

TOOL NO.		DESCRIPTION
99395603		Dial gauge (0 - 5 mm)
99395687		Reaming gauge (50 - 178 mm)
99396035		Centering ring of crankshaft front gasket cap

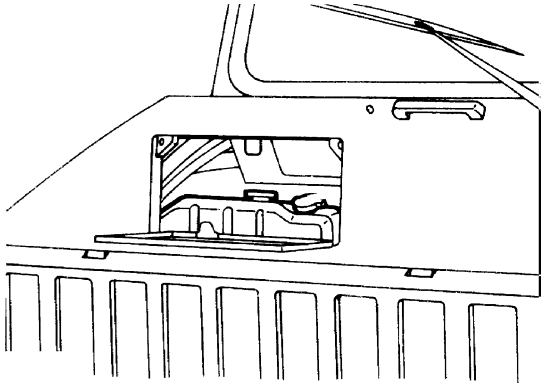
ENGINE REMOVAL - REPLACEMENT
Removal

To remove the engine group, proceed as follows:

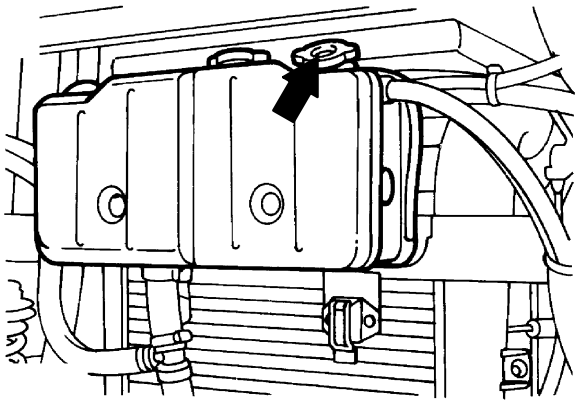
- ❑ Position the vehicle over a pit or on a vehicle lift;
- ❑ Open the battery casing and disconnect cables to eliminate any risk of short circuit.

In case of special vehicle equipment, remove part or all of the fittings to permit access to elements for disconnection and the extraction of mechanical groups to be removed.
For these operations refer to the procedures provided by the manufacturer of the equipment.

Figure 15



178NM04



178NM03

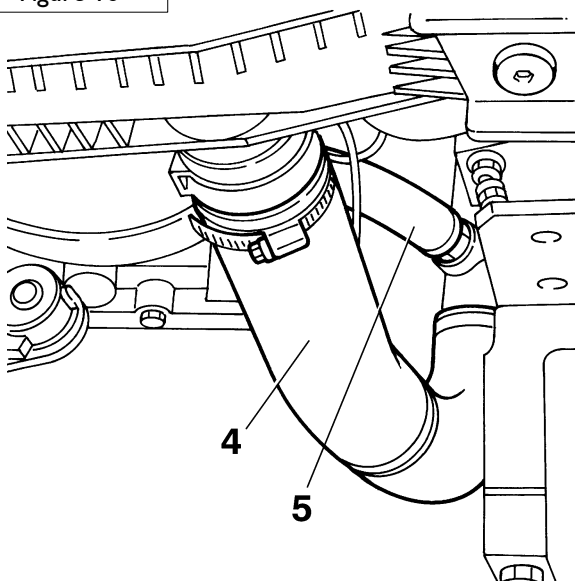
(a) single-seat cab, (b) two-seat cab

- ❑ Open the filler cap (1) on the expansion chamber
- ❑ Proceed to drain the conditioning system

For these operations refer to the procedures provided by the system manufacturer.

Do not discharge R134 fluid into the atmosphere. Even if its ozone impoverishment potential is zero, it is nevertheless a greenhouse gas.
Recovery and recycling of this substance is governed by legislation.
Always use approved refrigerant recovery and recharging equipment.
Do not mix different refrigerant fluids in the same equipment.

Figure 16



1780301

Place a suitable container under the engine and drain off the engine coolant by disconnecting the radiator hose from the pump (4).

It is forbidden to dispose of exhausted fluid incorrectly or via the public drainage system.

- ❑ It is forbidden to dispose of exhausted fluid incorrectly or via the public drainage system.
- ❑ Tip the cab.
- ❑ Disconnect all power take off electrical and pneumatic connections as indicated in SECTION 5 (only for versions with built-in power take off).
- ❑ Unscrew the propeller shaft flange screws and remove it as indicated in SECTION 10.

Figure 17

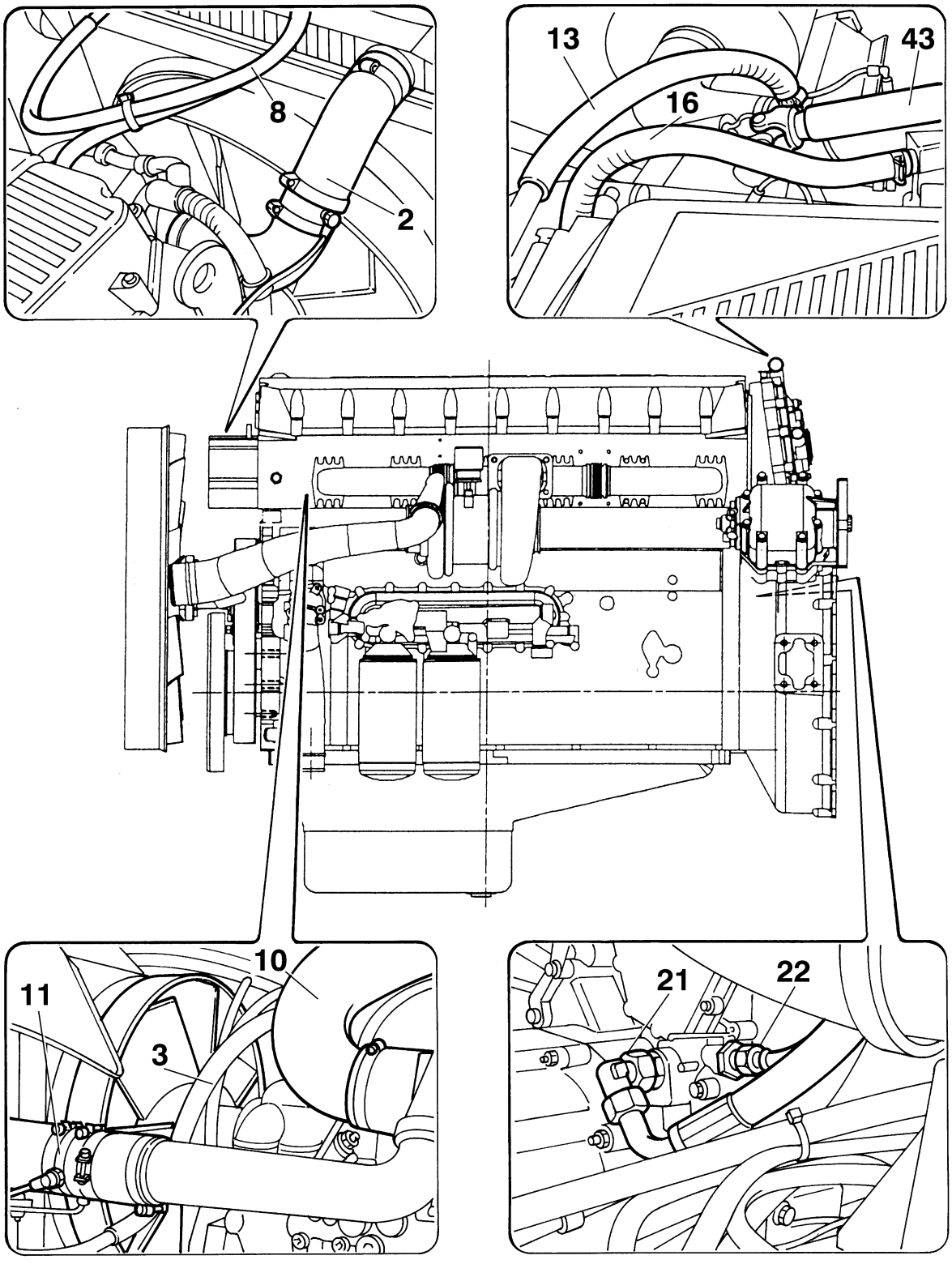
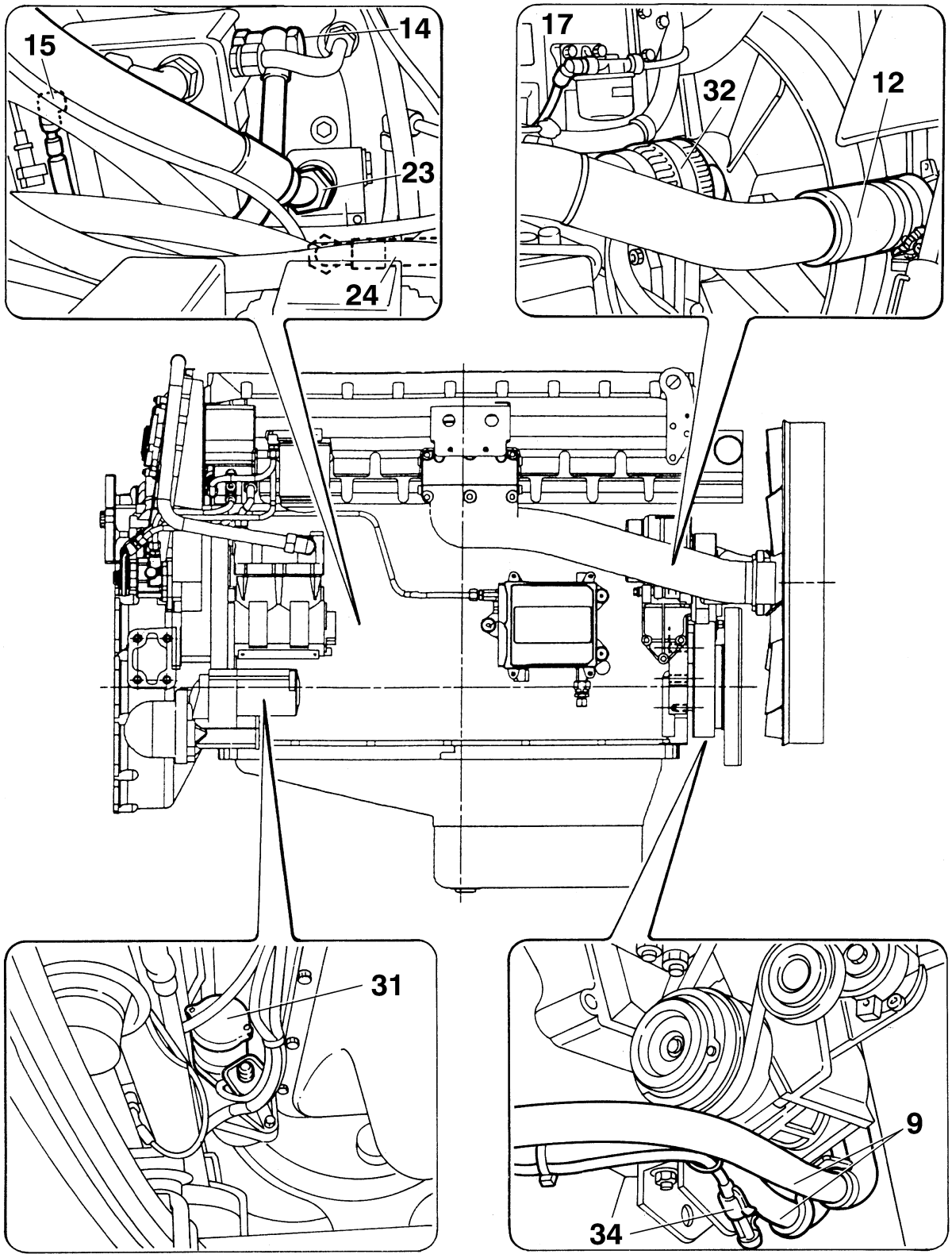


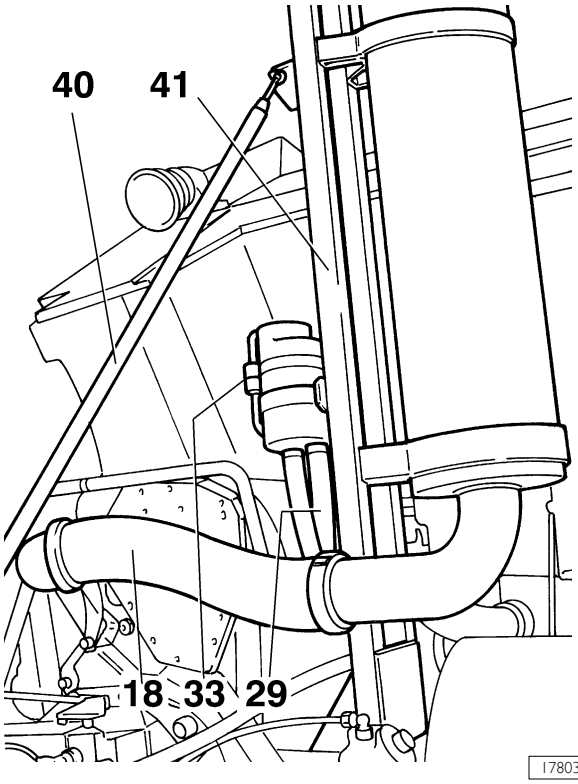
Figure 18



❑ Place a suitable container and drain the servo steering hydraulic fluid as indicated in SECTION 15;

It is forbidden to dispose of exhausted fluid incorrectly or via the public drainage system.

Figure 19



❑ Remove the exhaust pipe (18) from the turbogroup;

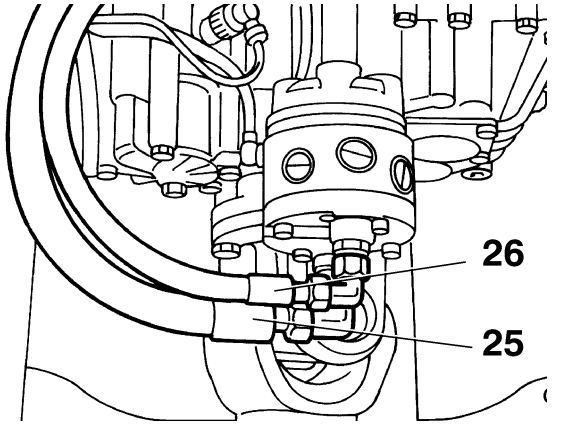
Two/three-axle versions

❑ Disconnect all hydraulic lines:
- from the servo steering reservoir (29);
- servo steering pump intake on compressor (23);
- servo steering pump delivery on engine (24).

Four-axle versions

❑ Disconnect all hydraulic lines:
- from the servo steering reservoir (29);
- servo steering pump intake on engine (21);
- servo steering pump delivery on engine (22);
- servo steering pump intake on compressor (23);
- servo steering pump delivery on engine (24);
- servo steering pump intake (25) and delivery (26) on gearbox.

Figure 20



All versions:

❑ Remove the stay (40) and mounting bracket (41) complete with exhaust silencer

❑ Disconnect all transmission electrical, pneumatic and hydraulic connections and proceed to remove the transmission group as indicated respectively in SECTION 6 (manual gearbox)

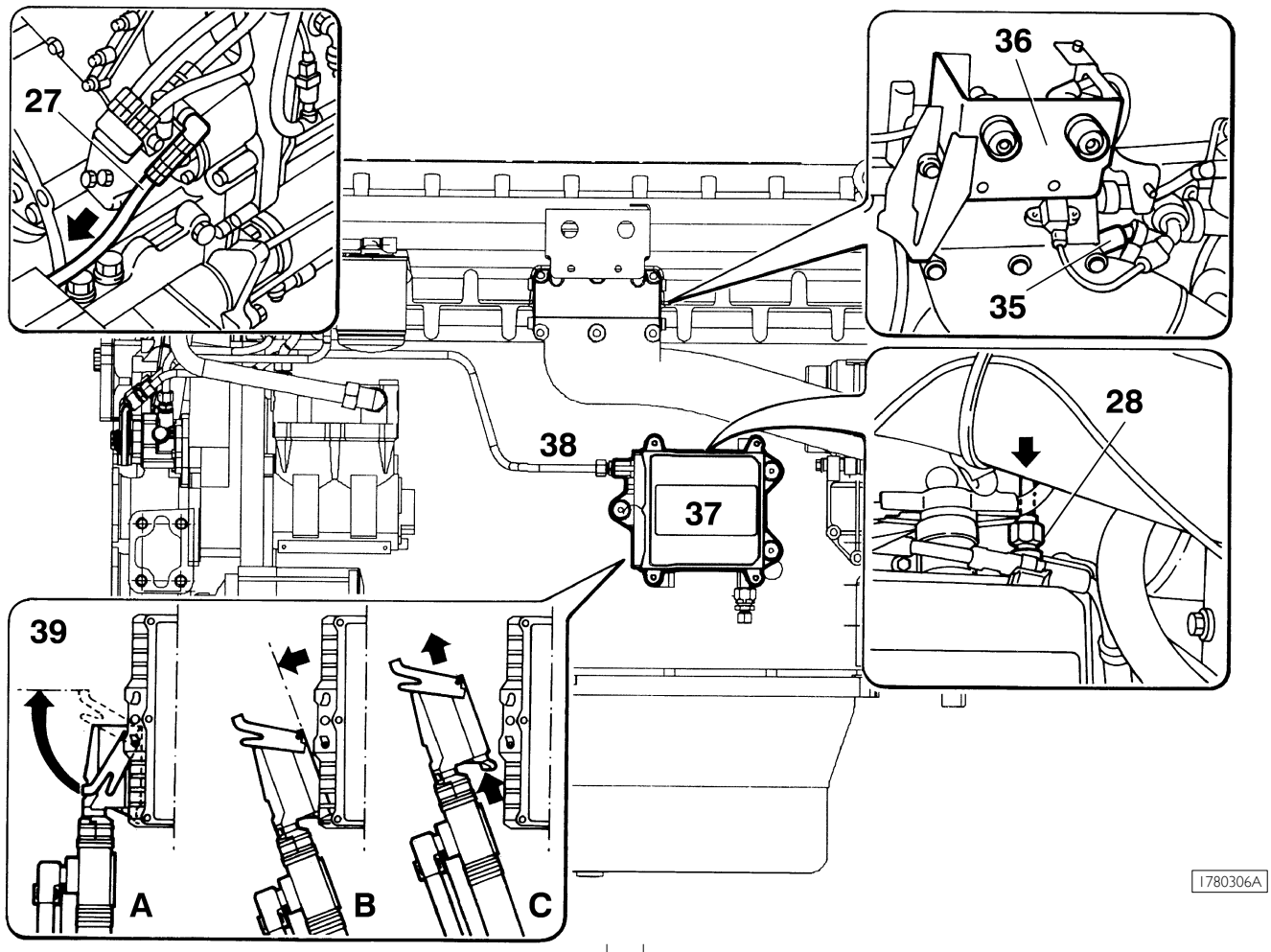
❑ Disconnect / remove engine coolant piping:
- from thermostat to radiator (2);
- from thermostat to cab heater (3);
- from expansion chamber to intake pump (5);
- vent pipe from engine to expansion chamber (8);

During this operation some residual coolant may leak from engine.

❑ Disconnect air conditioning system refrigerant fluid piping (9) from compressor;

❑ Remove air piping:
- from air filter to turbogroup (10)
- from turbogroup to intercooler (11)
- from intercooler to intake manifold (12)
- compressor intake (13);
- compressor delivery (14);
- tank - compressor connector (15);
- engine breather (16);
- waste-gate pilot (17) (VGT versions only);

Figure 21



- ❑ Disconnect electrical connections:
  - from starter motor (31);
  - from alternator (32);
  - from servosteering oil level indicator (33);
  - from air conditioner compressor (34);
  - from diagnostics cable (35);
- ❑ Remove the start/stop button mounting (36) unscrewing fastenings;
- ❑ Disconnect the lower connector (39) of the engine control unit (36) proceeding as follows:
  A. Lift the safety catch
  B. Turn the connector to remove it from the control unit
  C. lift the connector to free it from the attachment tooth.

The upper connector (38) cannot be disconnected, except in the event of works on engine side wiring.

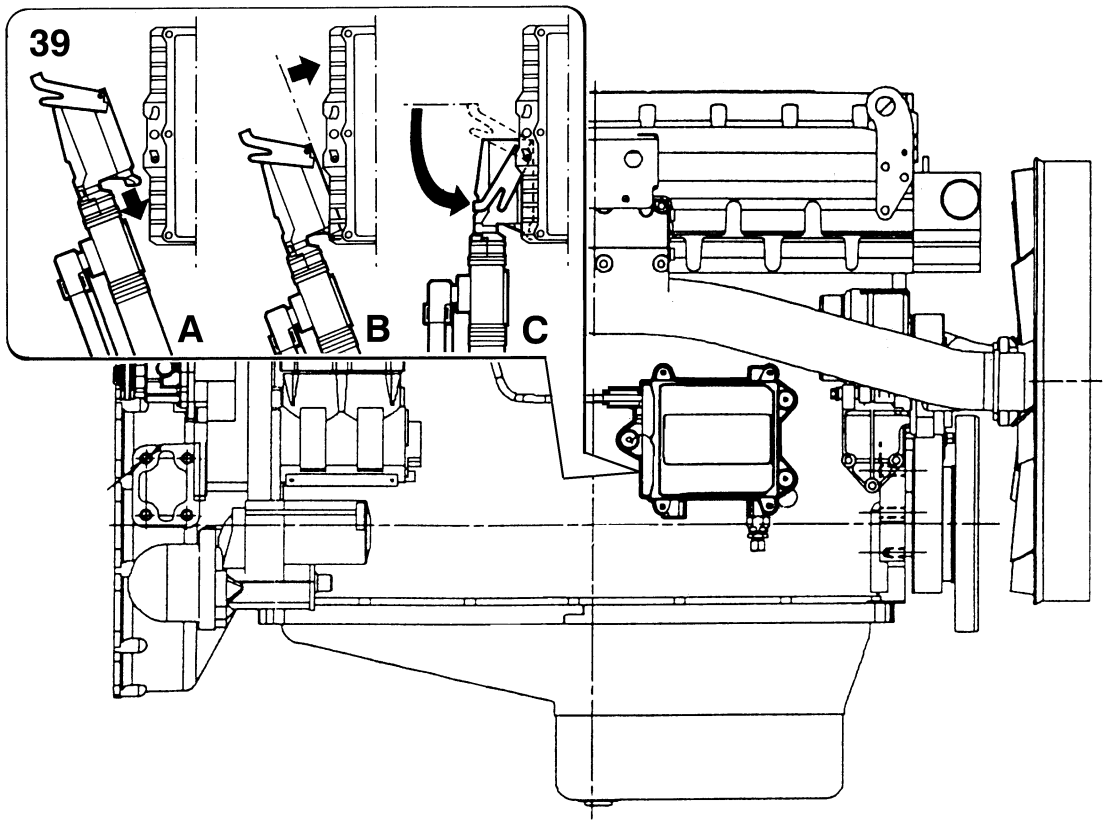
- ❑ Disconnect the fastening clamps and tip the vehicle side harness so that it does not obstruct operations;
- ❑ Disconnect the following pipes:
  - fuel return (27);
  - Fuel supply (28);
- ❑ Remove the gearshift command lever (43) and associated mechanisms, fastening the rod to the cab;
- ❑ Remove the engine oil dipstick (not illustrated) from the radiator mounting;
- ❑ Attach suitable chains or cables to the engine mounting brackets, then bring them into tension using appropriate lifting gear;
- ❑ Check with extreme care that all elements have been disconnected and that all cable/piping and wiring clamps have been freed;
- ❑ Remove the front and rear elastic engine supports from both sides;
- ❑ Carefully lift the engine group extracting it from above, and place it on a suitable bench.

Replacement

To replace the engine group, follow the removal instructions in reverse order.
Pay special attention to the manoeuvres necessary for installing the group into the engine compartment and take the following precautions:

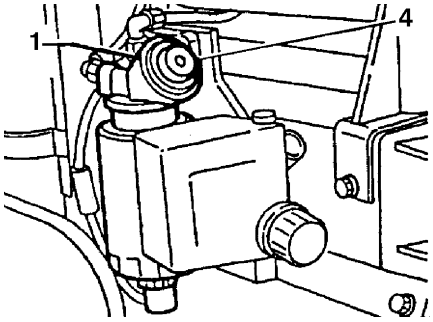
- ❑ Check the elastic engine group and gearbox supports. Replace them with new ones if any wear is evident;
- ❑ Check all exhaust piping components. Replace with new in case of wear.
- ❑ Tighten all fastenings to the specified torque.
- ❑ Fill the sump with the specified lubricant and check the level.
- ❑ Fill the cooling system with the specified coolant.
- ❑ Fill the servosteering hydraulic system with the specified fluid and subsequently start the engine and bleed the system as indicated in section 1.5.
- ❑ Connect the engine control unit lower connector (39) as follows:
  A. Insert the attachment tooth into its seat.
  B. Turn the connector to connect it to the control unit
  C. Lower the safety catch

Figure 22

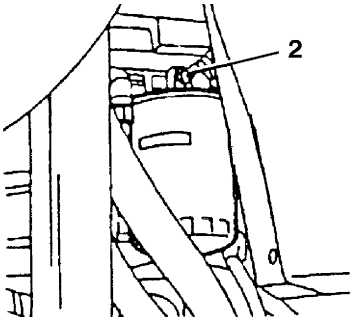


Bleeding air from supply system

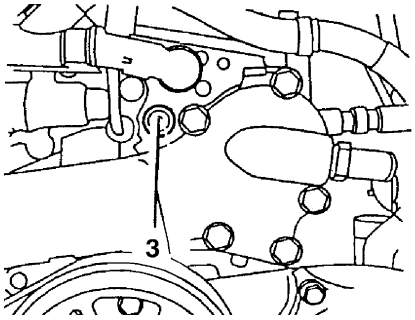
Figure 23



178NM1117



178NM1118



178NM1119

Before starting the engine bleed any air from the fuel supply system, applying the dedicated pipes to the bleed points to allow the fuel to bleed into a recipient placed below:

- ❑ Bleed screw (1) located on pre-filter.
- ❑ Bleed screw (2), located on filter support.
- ❑ Bleed screw (3), located on front of cylinder head.
- ❑ Operate the pump (4) situated on the prefilter support until bubble-free fuel flows from the screw (1). Close the screw (1).
- ❑ Repeat the operation for screw 2.
- ❑ Repeat the operation for screw 3.

In all cases prevent fuel from soiling water pump/alternator drive belts.

Checks and controls

Start the engine and allow it to run at a speed slightly above idling and wait for the engine coolant to reach thermostat opening value, then check that:

- ❑ The absence of coolant leaks from the engine cooling circuit and cab heater hoses, tighten the respective collars if necessary.
- ❑ The absence of oil leaks from the cylinder head or rocker cover, between engine block and sump or from the various lubricant circuit pipes.
- ❑ The absence of air leaks from any disconnected compressed air system connections.
- ❑ Check that the dashboard warning lights function correctly along with any other equipment disconnected when engine was removed.

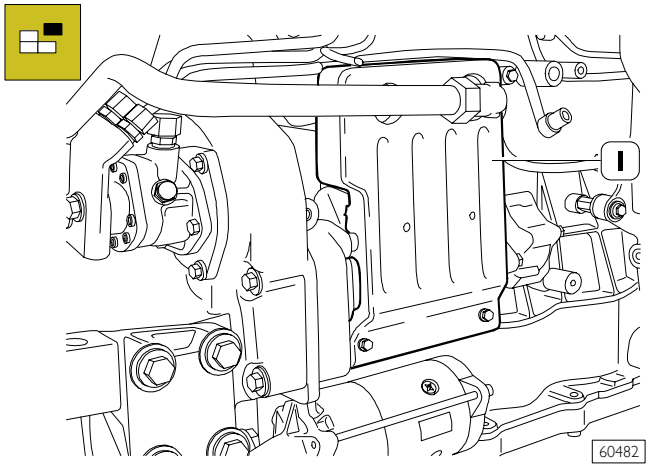
DISMANTLING THE ENGINE ON THE BENCH

Before fixing the engine on the rotary stand 99322230 remove the following components:

On the engine right-hand side

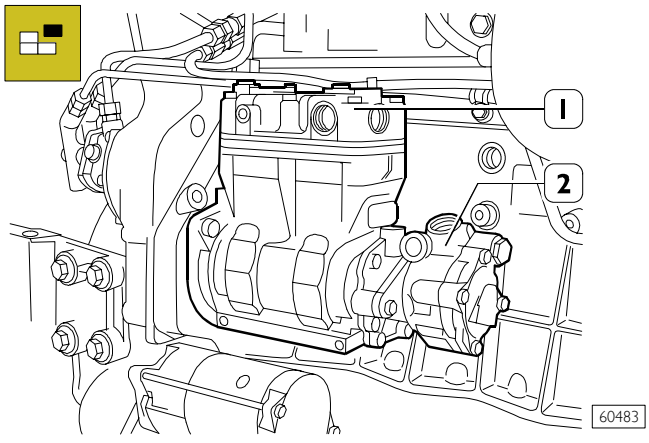
- diesel cartridge filter (1);
- power steering system tank (2);
- electric connections;

Figure 24



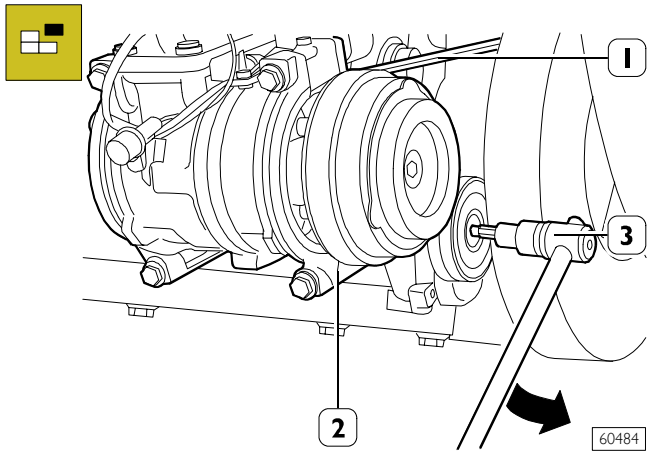
- soundproofing shield (1);
- all the pipes connecting the compressor;

Figure 25



- compressor (1) fitted with power steering pump (2);

Figure 26



- remove the air conditioner control belt (1) using a fit tool (3) and acting in the direction shown by the arrow;
- disassemble the air conditioner (2) fitted with the engine support;

On the engine left-hand side

- engine support (1)

Figure 27

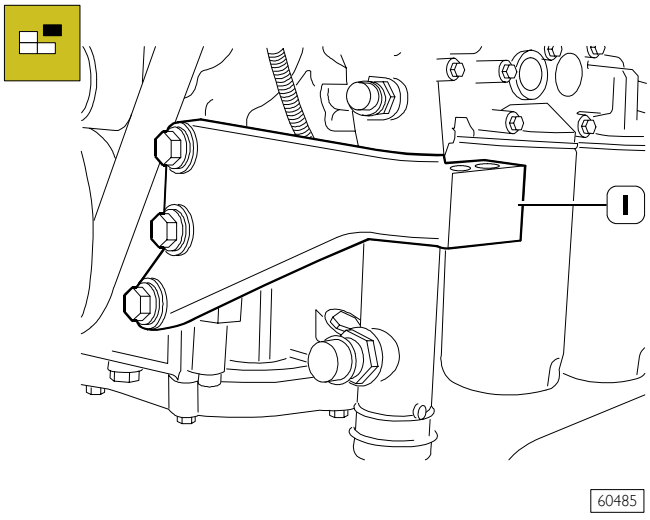
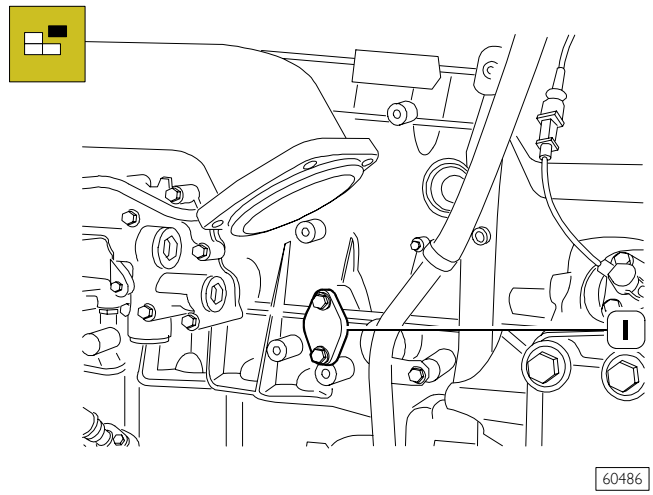
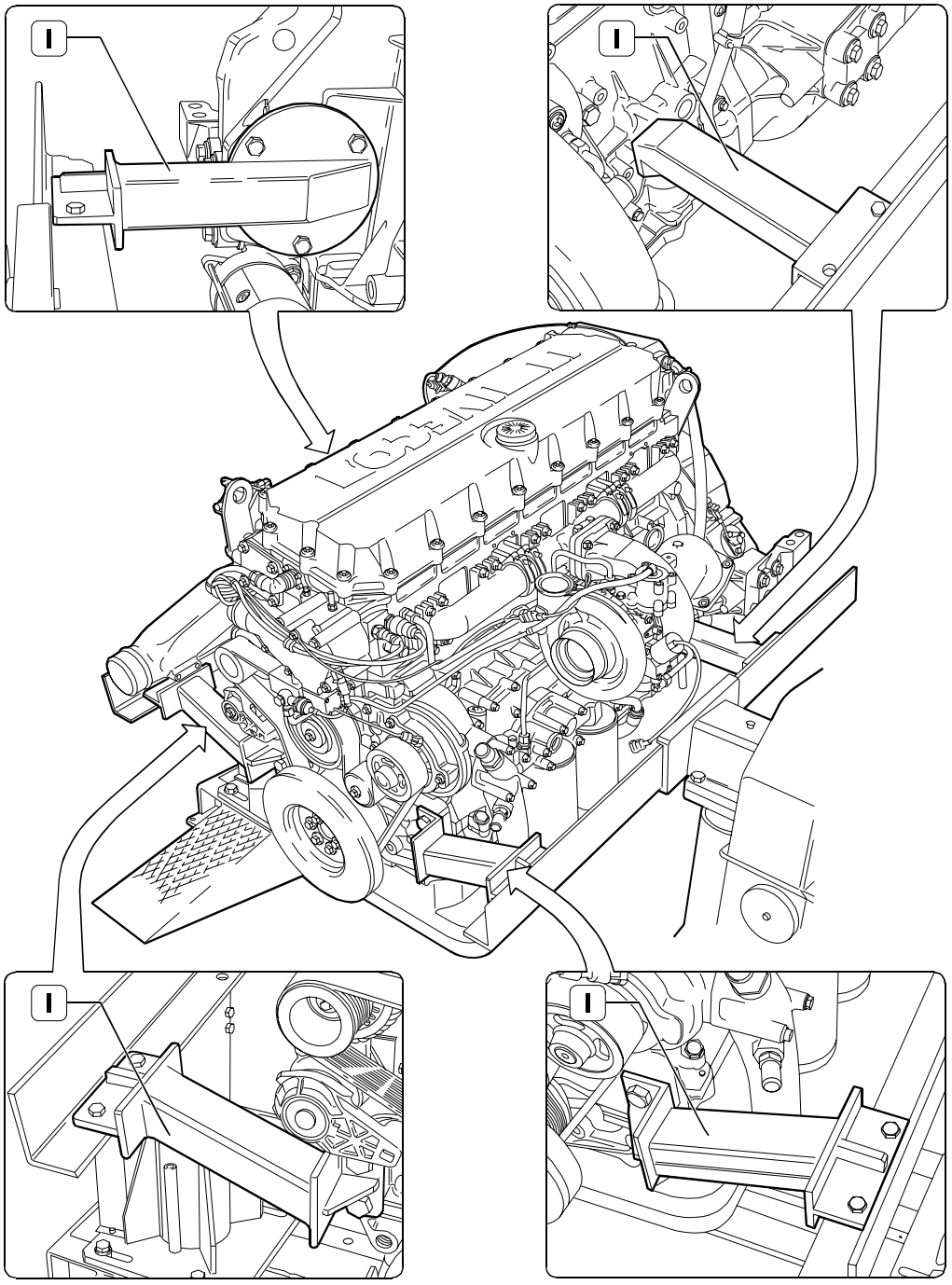


Figure 28



- oil pressure controlling valve (1);

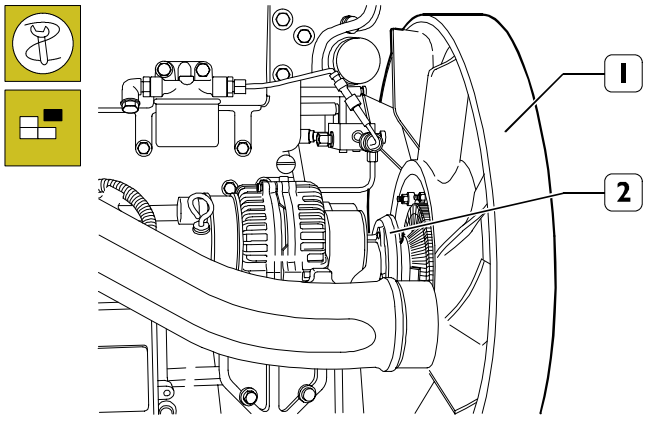
Figure 29



Fix the engine to the rotary stand 99322230, by means of brackets 99361036 (1), remove the fan.

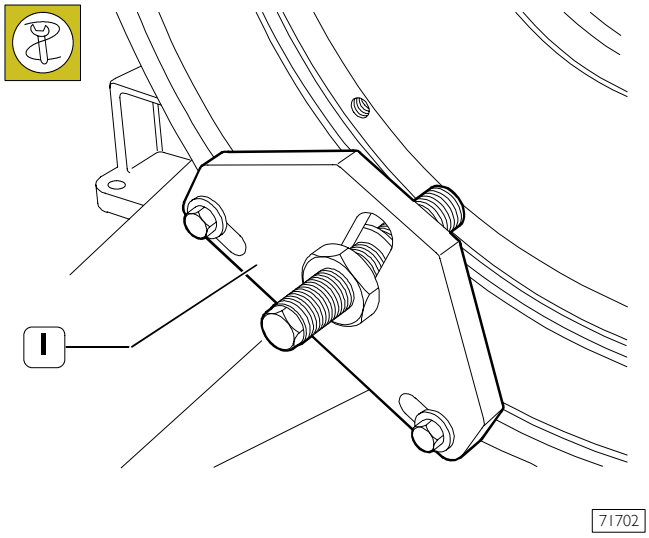
Remove all electrical wiring from the sensors and electric activators.

Figure 30



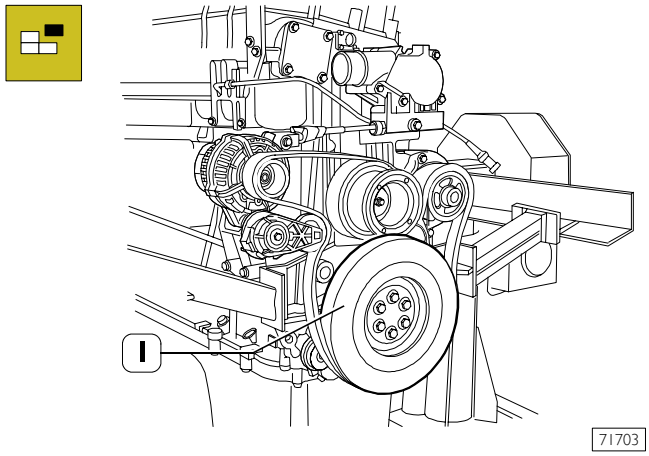
Remove the fan (1) from the flange (2).

Figure 31



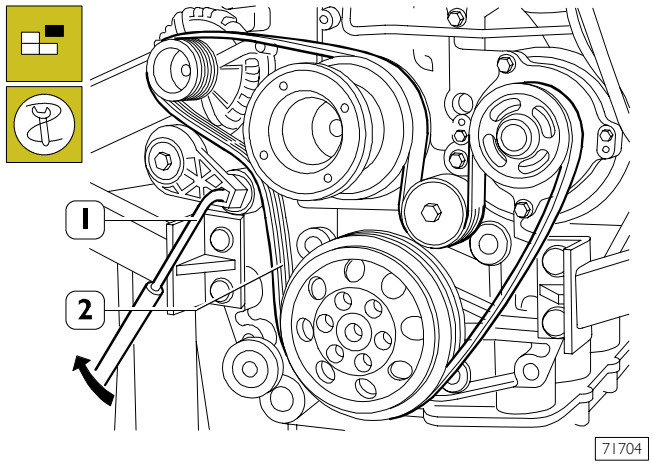
Lock the engine flywheel using tool 9936035I (1).

Figure 32



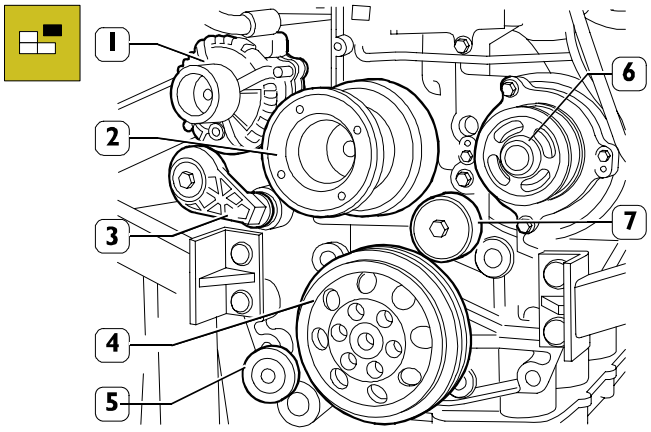
Remove the flywheel pulley (1) by removing the six Allen screws.

Figure 33



Turning the specific tool (1) clockwise, remove the auxiliaries drive belt (2).

Figure 34

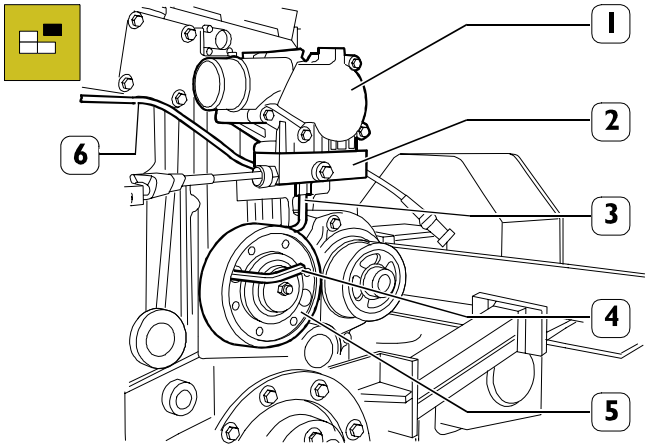


71705

Remove the following parts:

- ❑ alternator (1)
- ❑ fan flange (2)
- ❑ automatic tensioner (3)
- ❑ crankshaft pulley (4)
- ❑ water pump (6)
- ❑ air conditioner drive belt tensioner (5)

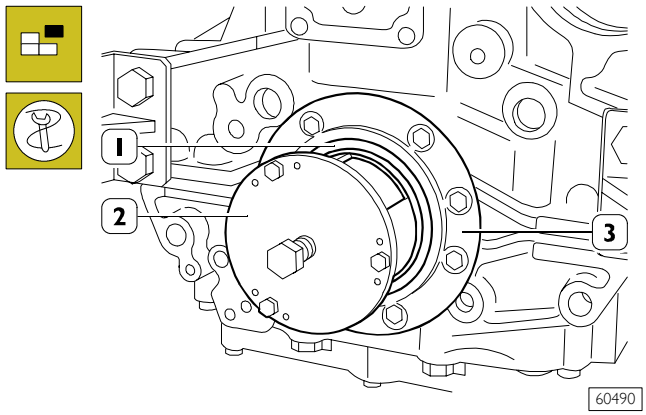
Figure 35



71706

Disconnect the pipes (3 and 6) from the V.G.T. command solenoid valve.
Remove the thermostat group (1) complete with V.G.T command solenoid (2)
Remove the pulley (5) using the Allen key (4).

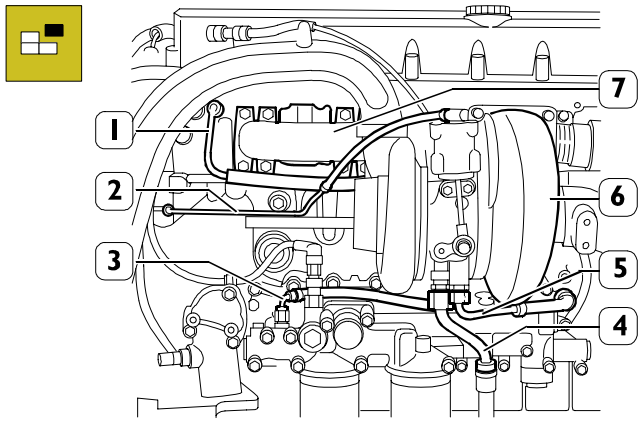
Figure 36



60490

Apply extractor 99340053 (2) and remove the crankshaft oil seal. Remove the flange (3).

Figure 37

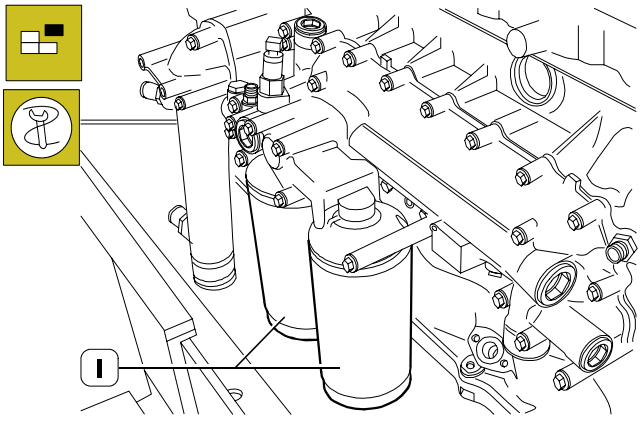


71707

Remove the following parts:

- ❑ Water delivery pipe (5)
- ❑ water return pipe (1)
- ❑ actuator command air piping (2)
- ❑ oil delivery pipe (3)
- ❑ oil return pipe (4)
- ❑ turbocompressor group (6)
- ❑ exhaust manifold (7).

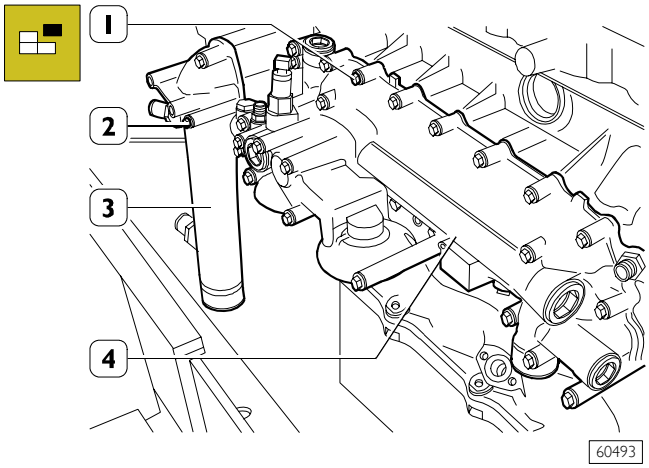
Figure 38



60492

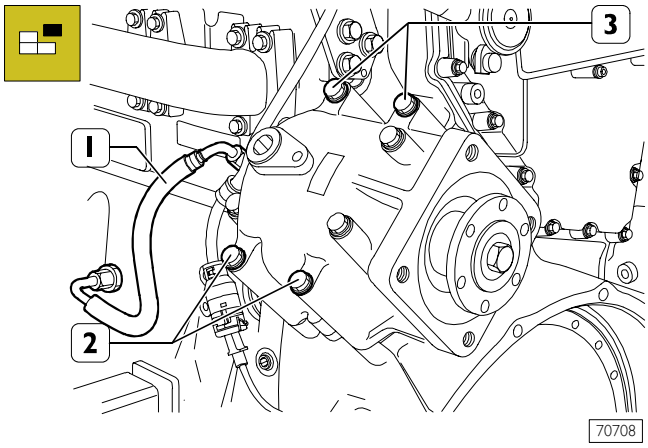
Unscrew the oil filter (1) using tool 99360314.

Figure 39



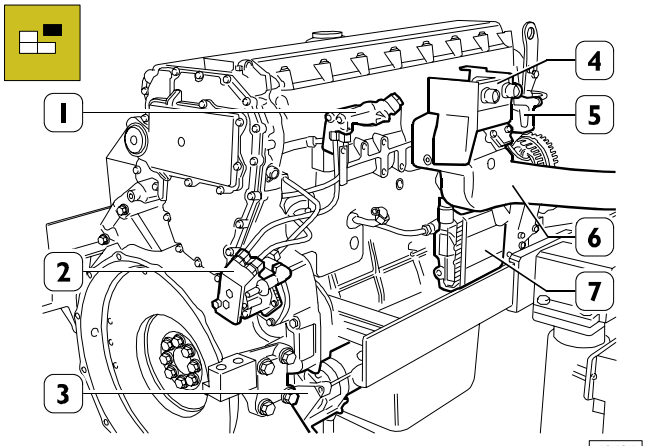
- Unscrew the screws (1) and remove the heat exchanger (4);
- unscrew the screws (2) and remove the water line (3).

Figure 40



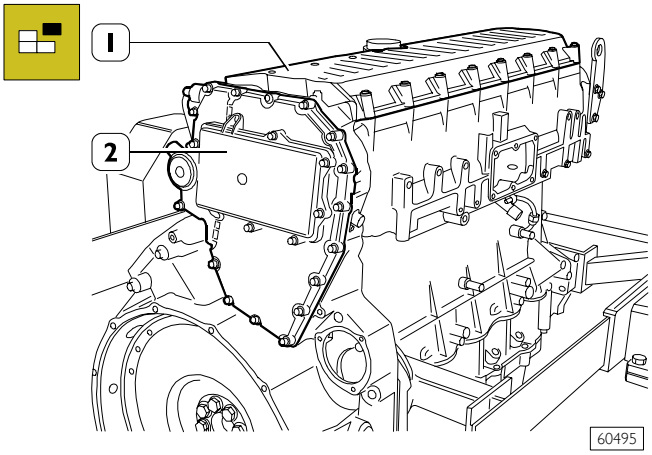
- Unscrew the screws (1) and remove the heat exchanger (4);
- unscrew the screws (2) and remove the water line (3).

Figure 41



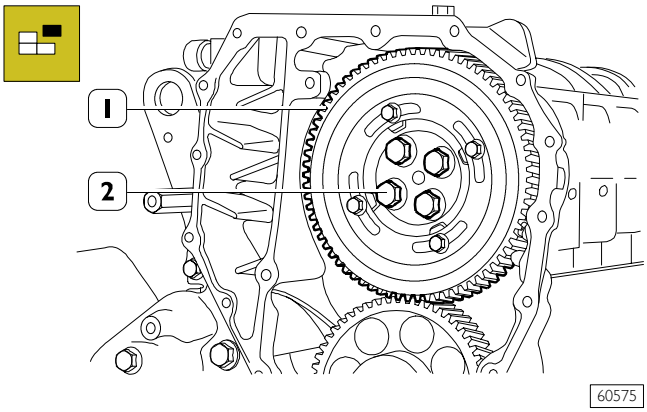
Remove the following components:
- fuel filter support (1);
- fuel pump (2) and lines;
- starter (3);
- engine starting button support (4);
- PWN valve air filter (5);
- suction manifold (6) fitted with resistance for engine pre-heating;
- control unit (7).

Figure 42



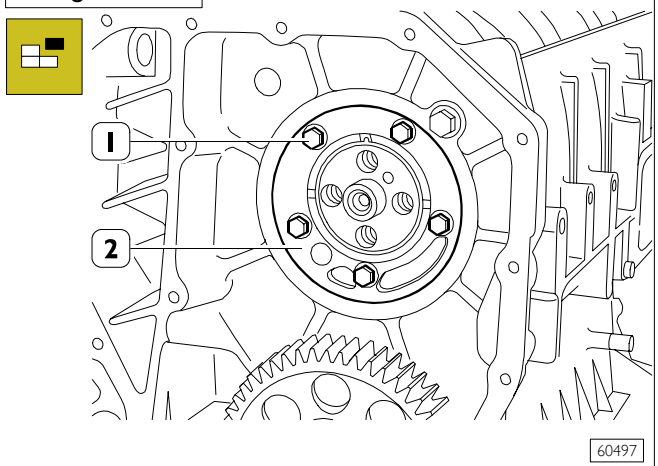
- Remove the rocker cover (1) and the timing gear cover (2)

Figure 43



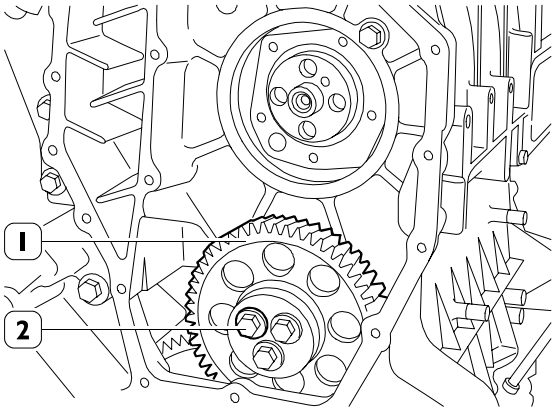
- Unscrew the screws (2) and remove the gear (1) fitted with phonic wheel.

Figure 44



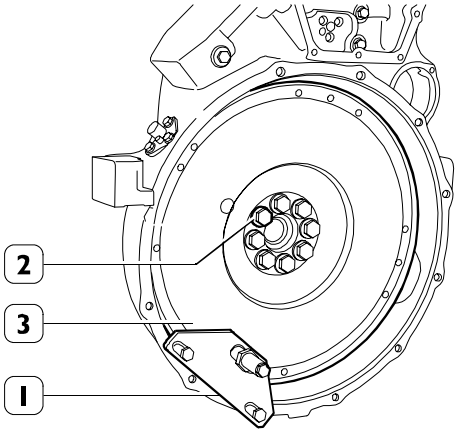
- Unscrew the screws (1); tighten one screw in a reaction hole and remove the shoulder plate (2), remove the sheet gasket.

Figure 45



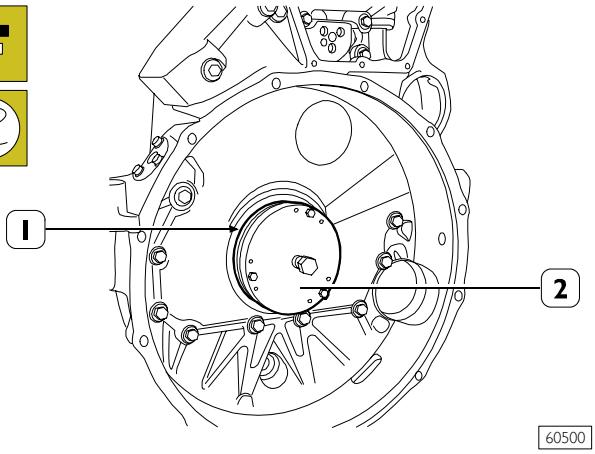
Unscrew the screws (1) and remove the transmission gear (2).

Figure 46



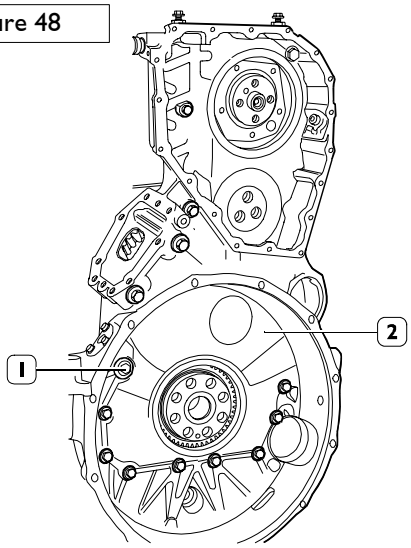
Stop the engine flywheel (3) rotation by means of tool 99360351 (1), unscrew the fixing screws (2) and remove the engine flywheel.

Figure 47



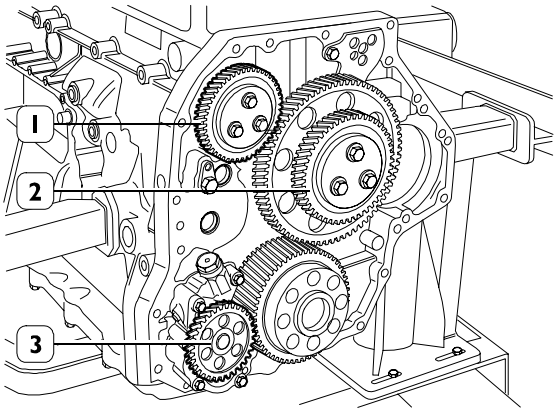
Apply the extractor 99340054 (2) and pull out the seal gasket (1).

Figure 48



Unscrew the screws (1) and take down the gearbox (2).

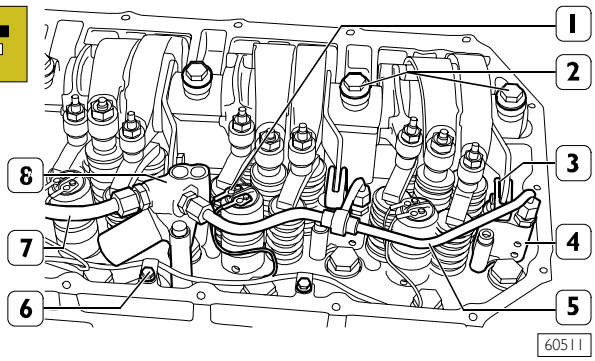
Figure 49



Remove in the following order:

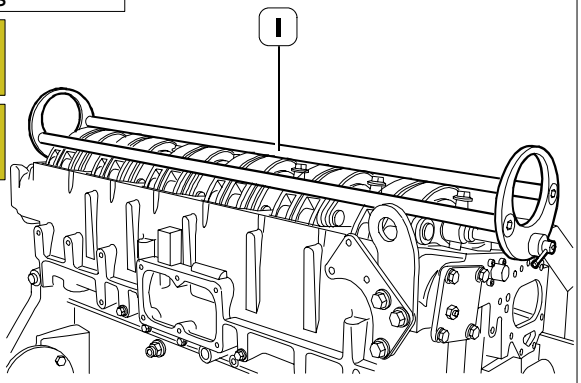
- ❑ The P.T.O. drive cog (1);
- ❑ The transmission cog (2);
- ❑ The oil pump cog (3).

Figure 50



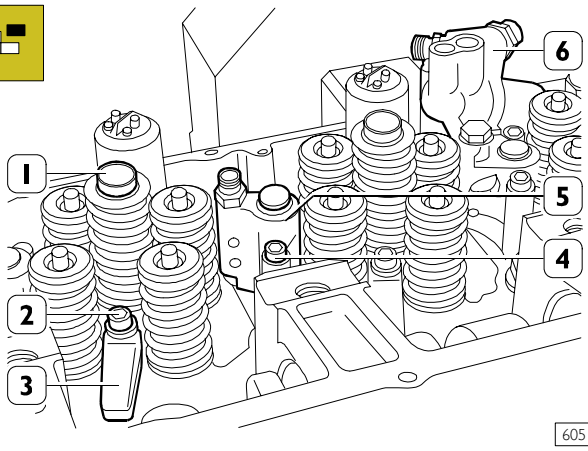
- ❑ Remove the engine brake lever retaining springs (3).
- ❑ Unscrew screws (3) to remove injector electrical connections.
- ❑ Unscrew screws (6) fastening injector wiring to the head.
- ❑ Electrically disconnect the engine brake solenoid valve (8).
- ❑ Remove the engine brake cylinder (4) feeder pipes (5 and 7).
- ❑ Remove the rocker shaft fastening screws (2).
- ❑ Unscrew screws (6) to remove injector wiring from the head. The wiring must be removed from the front.

Figure 51



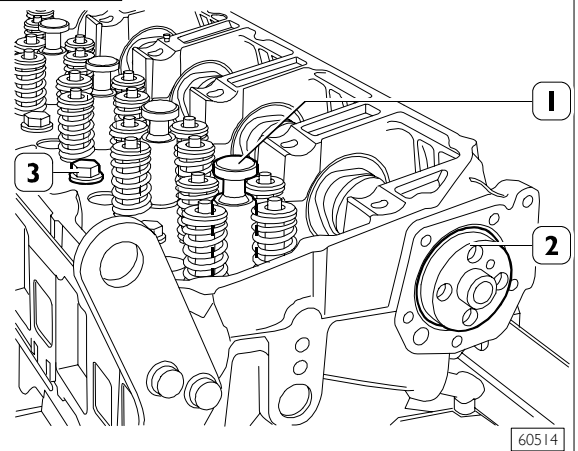
Apply tool 99360553 (1) and remove the rocker arm shaft assembly.

Figure 52



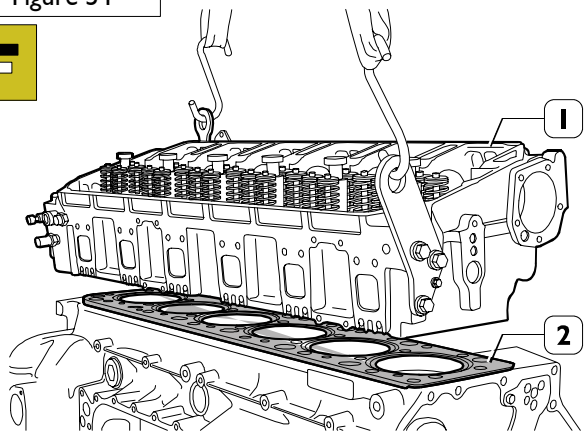
- ❑ Unscrew the screws (2) fixing the brackets (3) and remove the injectors (1).
- ❑ Unscrew the screws (4) and remove the exhaust brake pins (5).
- ❑ Unscrew the screws and remove the slave cylinder (6).

Figure 53



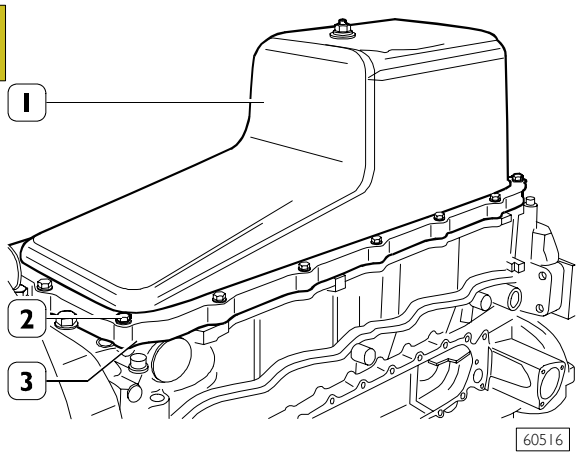
- ❑ Fit the plugs 99360180 (1) instead of injectors.
- ❑ Remove the camshaft (2).
- ❑ Unscrew the fixing screws on the cylinder head (3).

Figure 54



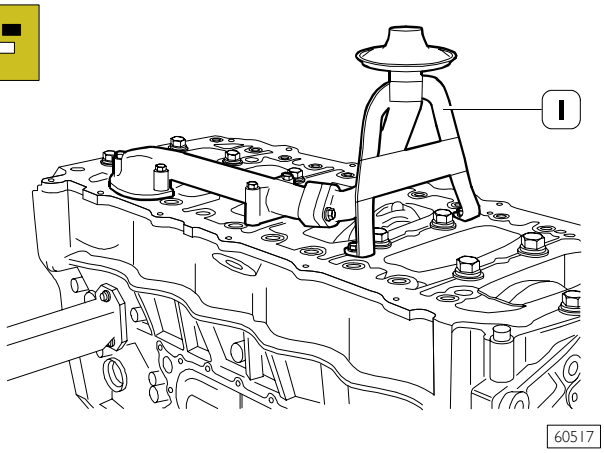
- ❑ By means of metal ropes, lift the cylinder head (1).
- ❑ Remove the seal (2)

Figure 55



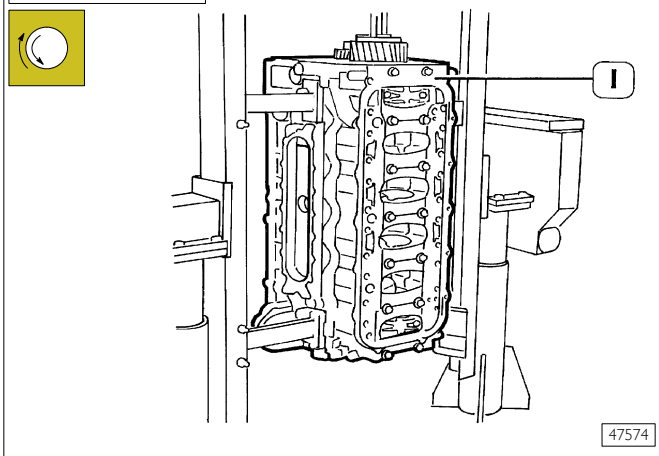
Unscrew the screws (2) and remove the engine oil sump (1) fitted with spacer (3) and seal.

Figure 56



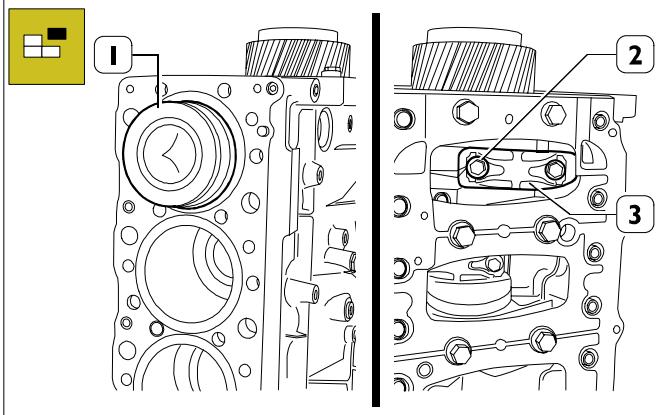
Unscrew the screws and remove suction rose (1).

Figure 57



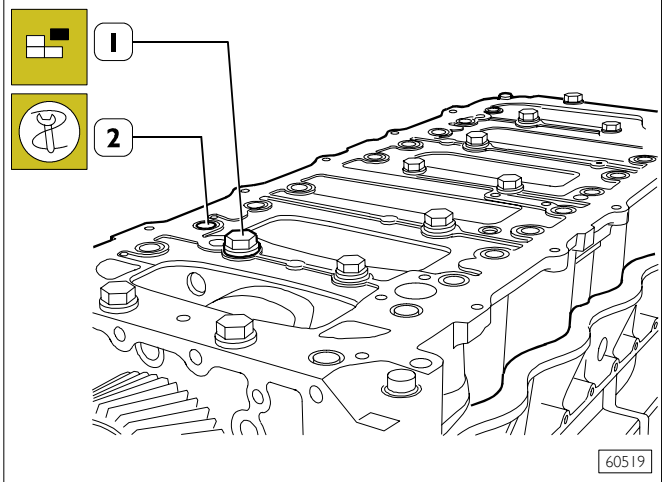
Rotate the block (1) to the vertical position.

Figure 58



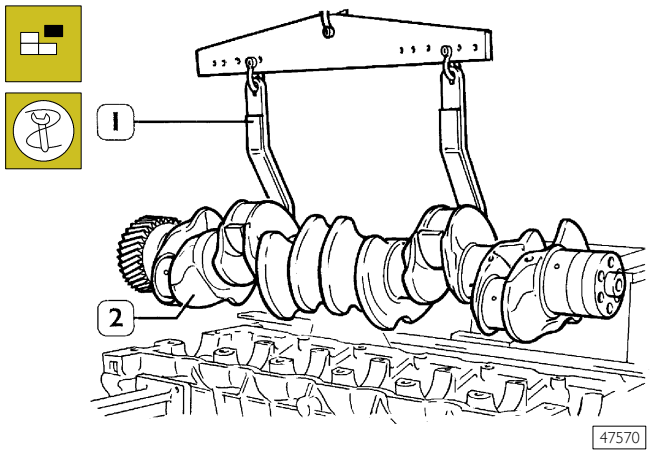
Untighten screws (2) fixing the connecting rod cap (3) and remove it. Remove the connecting rod-piston assembly from the upper side. Repeat these operations for the other pistons.

Figure 59



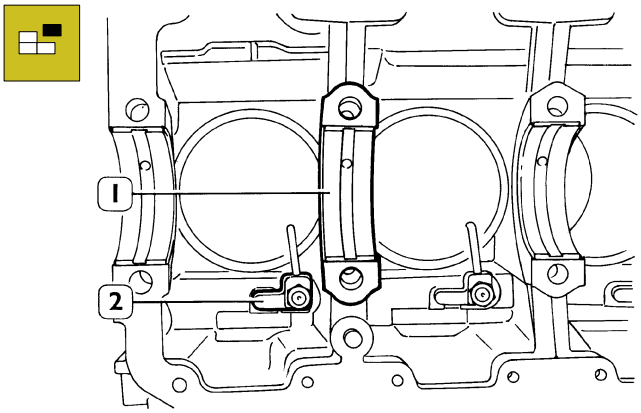
By means of proper and splined wrenches, untighten the screws (1) and (2) and remove the under-block.

Figure 60



Remove the crankshaft (2) by means of tool 99360500 (1).

Figure 61



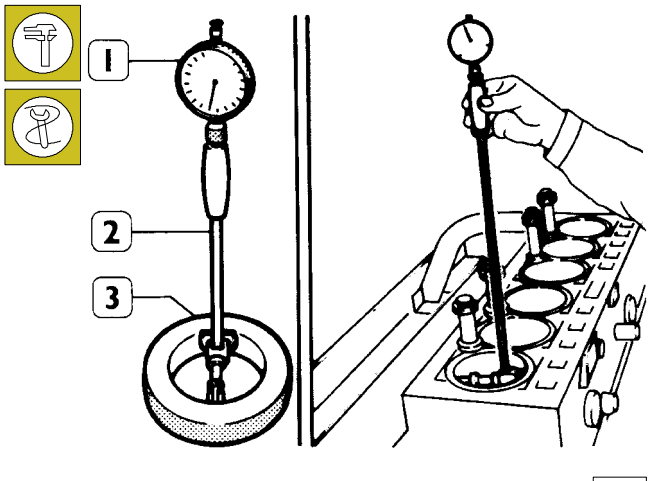
Remove the crankshaft half-bearings (1), untighten the screws and remove oil spray nozzles (2).
Take down cylinder liners as specified in the relative paragraph.

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

CYLINDER BLOCK
Checks and measurements

Figure 62 (Demonstration)

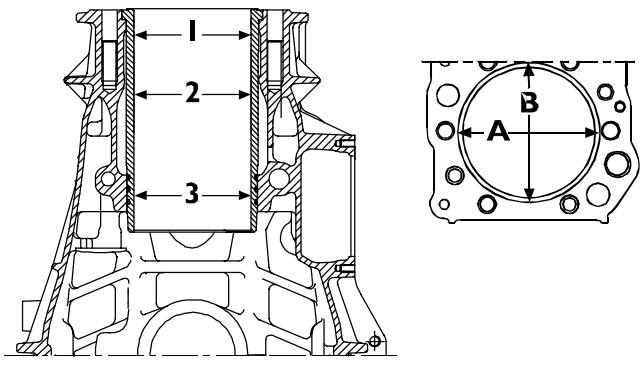


34994

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 135 mm.

If a 125 mm ring gauge is not available use a micrometer caliper.

Figure 63

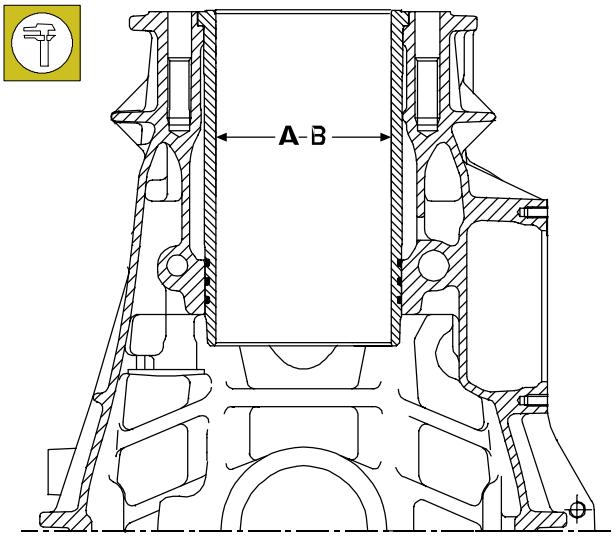


60596

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 NO TAG.

Figure 64



60595

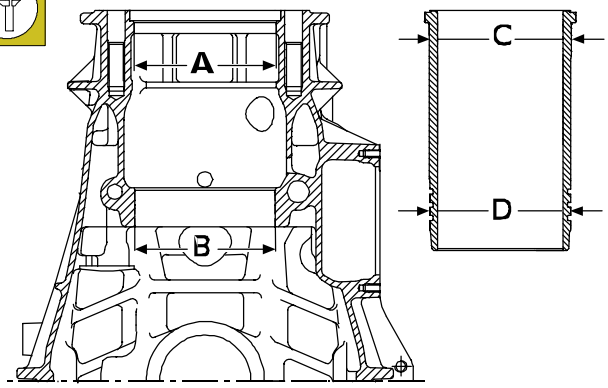
A = Selection class Ø 135.000 to 135.013 mm
B = Selection class Ø 135.011 to 135.024 mm

In case of maximum wear >0.150 mm or maximum ovalization >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.

ASTRA PARTS

Figure 65



60597

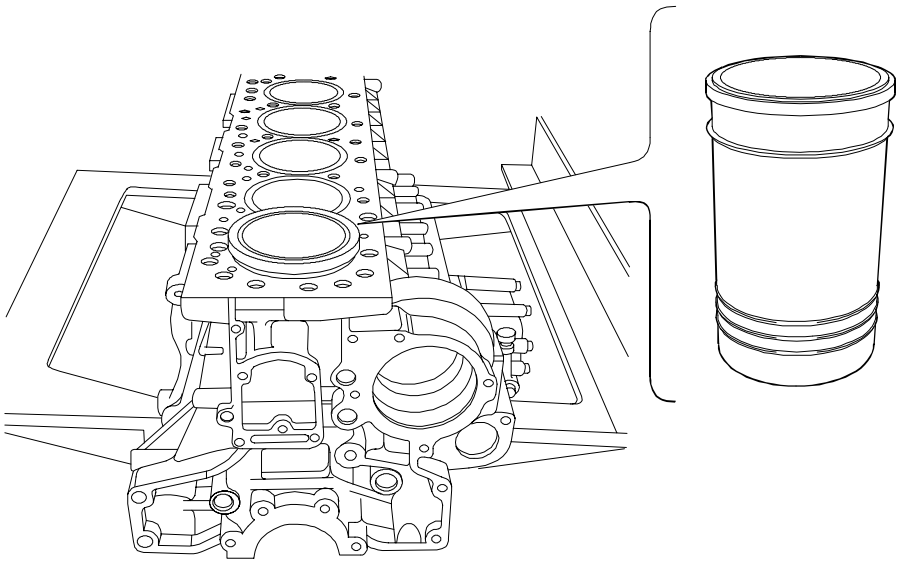
A = Ø 153.500 to 153.525 mm
B = Ø 152.000 to 152.025 mm
C = Ø 153.461 to 153.486 mm
D = Ø 151.890 to 151.915 mm

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

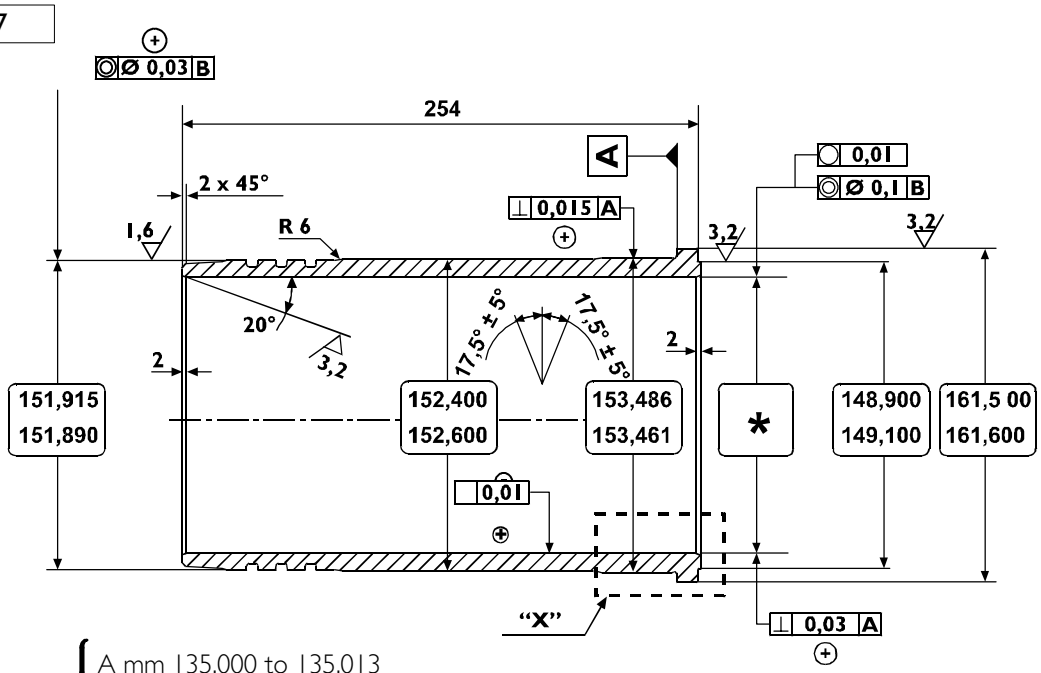
Figure 66



60598

BLOCK WITH CYLINDER LINERS

Figure 67

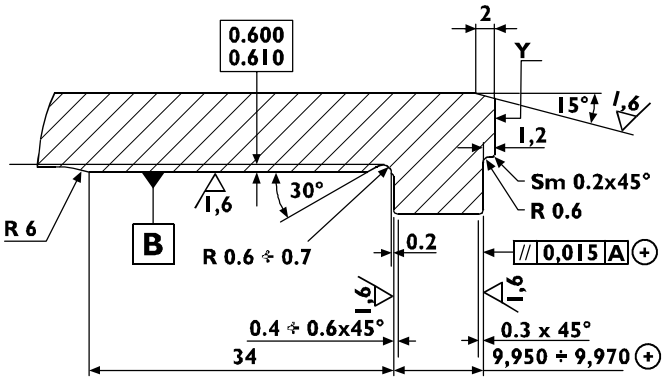


71710

Selection class { A mm 135.000 to 135.013
B mm 135.011 to 135.024

CYLINDER LINERS MAIN DATA

Figure 68

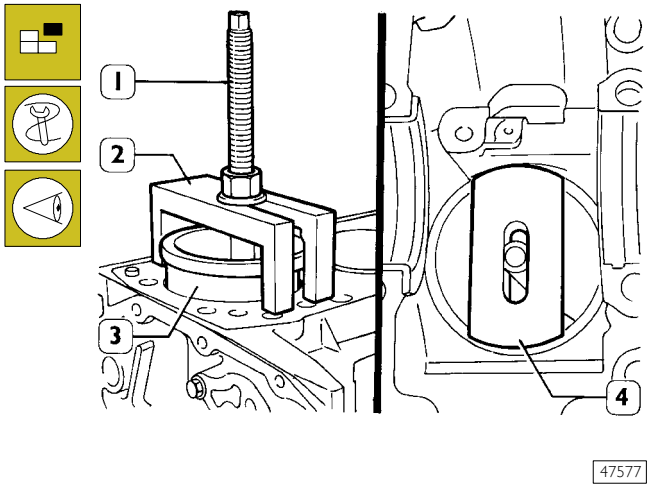


71711

DETAIL "X"
"Y" - Selection class marking area

Replacing cylinder liners
Removal

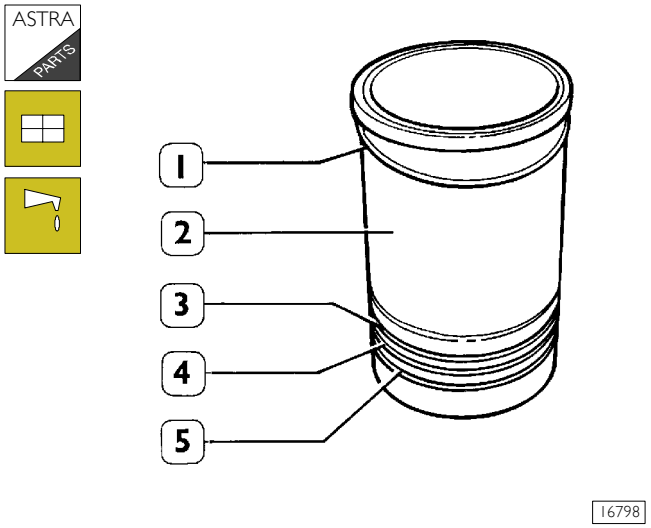
Figure 69



Place details 99360706 (2) and plate 99360728 (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

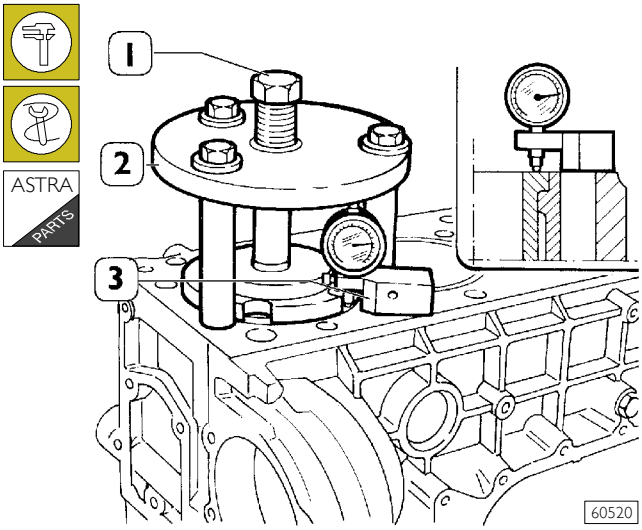
Figure 70



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.

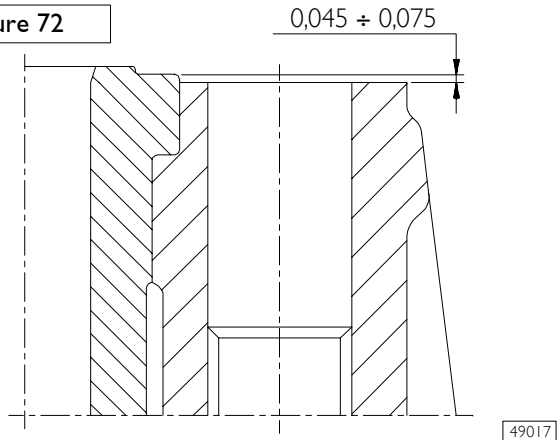
The adjustment ring (1) is supplied as spare parts in the following thicknesses: 0.08 mm - 0.10 mm - 0.12 - 0.14 mm.

Figure 71



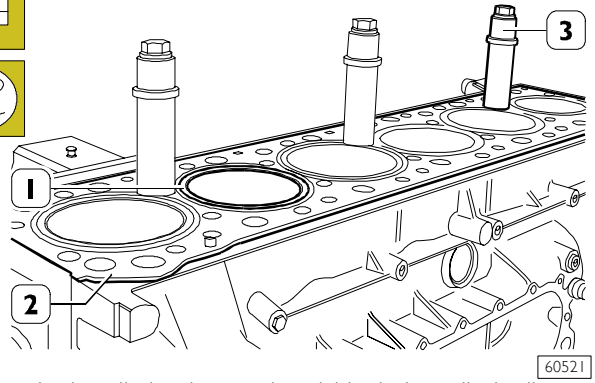
Check the protrusion of the cylinder liners, using tool 99260472 (2) and tightening screw (1) to 225 Nm torque. Using comparator 99395603 provided with comparator base 99370415 (3) that the cylinder lining protrusion from the cylinder head surface is 0.045 - 0.075 mm (Figure 71). If not, replace the adjuster shim (1) (Figure 70) supplied in various thickness.

Figure 72



CYLINDER LINER PROTRUSION

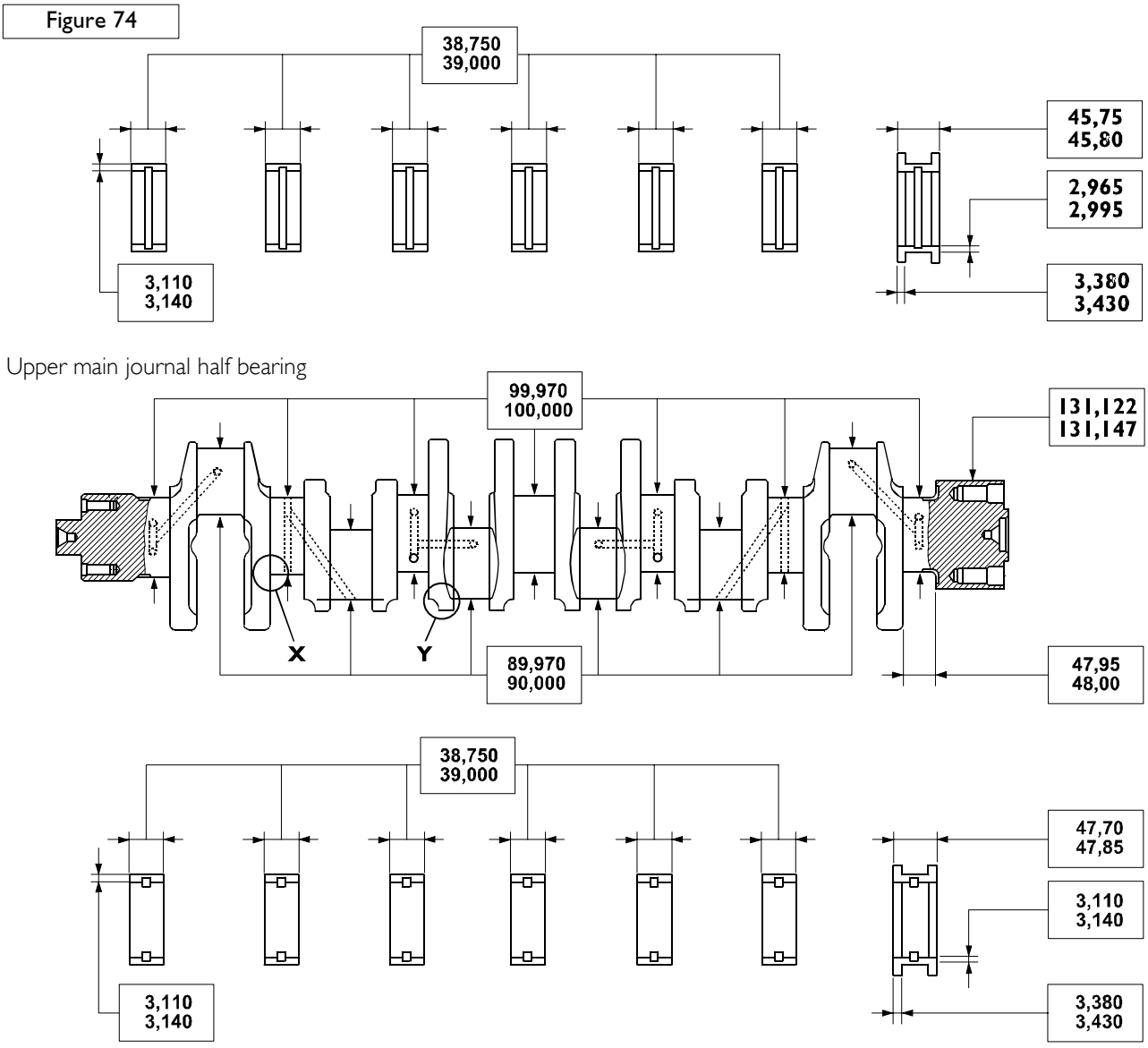
Figure 73



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

CRANKSHAFT

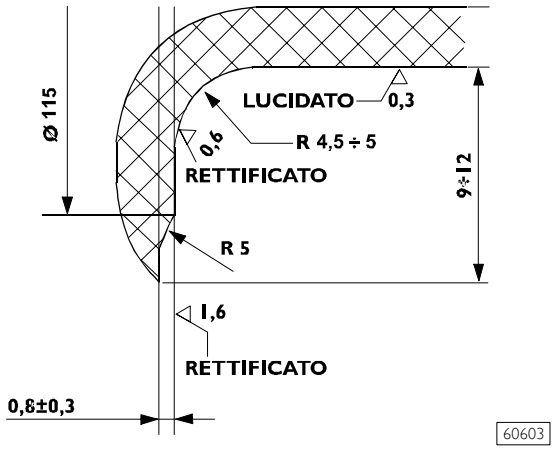
Figure 74



MAIN DATA FOR THE CRANK SHAFT PINS AND THE HALF BEARINGS

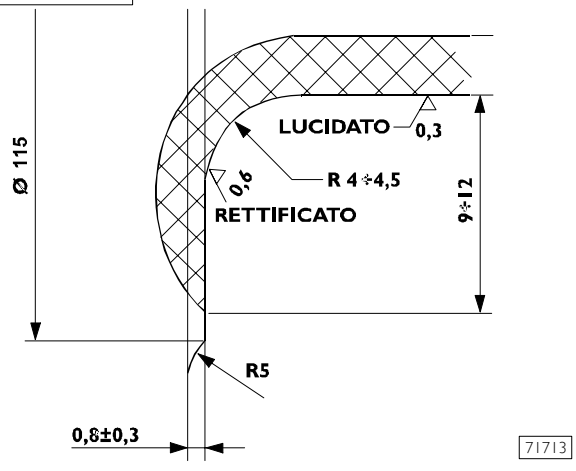
Check the condition of the journals and the big end pins; there must no be signs of scoring, ovalization or excessive wear.
The data given refer to the normal diameter of the pins.

Figure 75



X. Detail of main journals connections

Figure 76

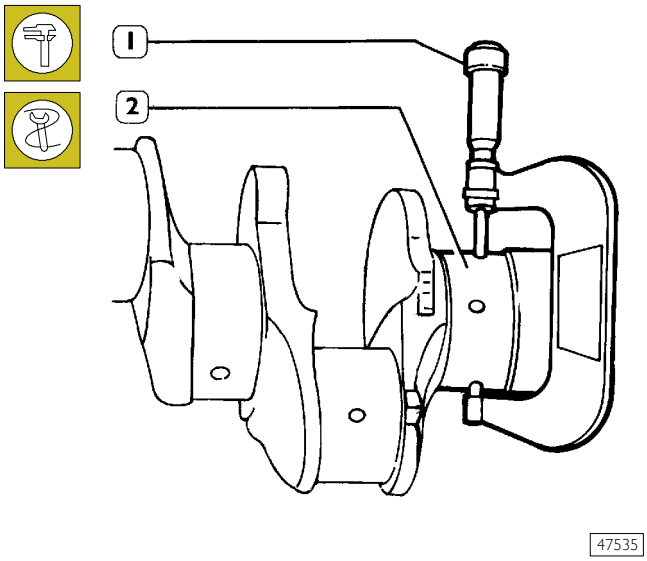


Y. Detail of crank pins connections

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.

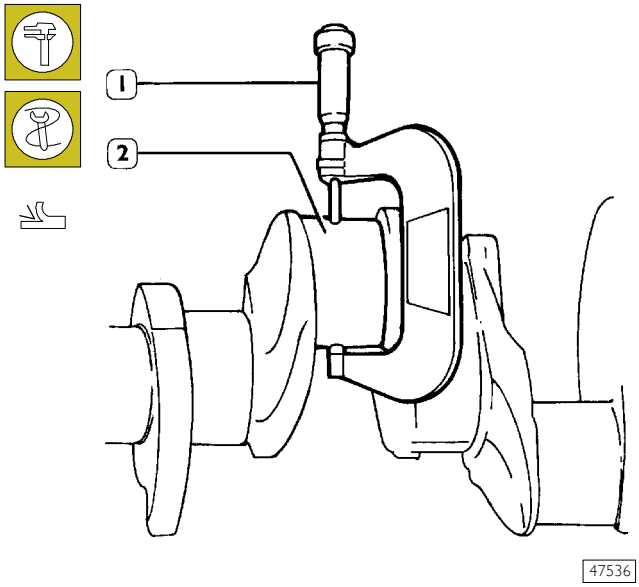
Figure 77



MEASURING THE MAIN JOURNALS

It is advisable to enter the values found in a table.

Figure 78



MEASURING CRANK PINS

During grinding, pay attention to journal and crank pins values specified.

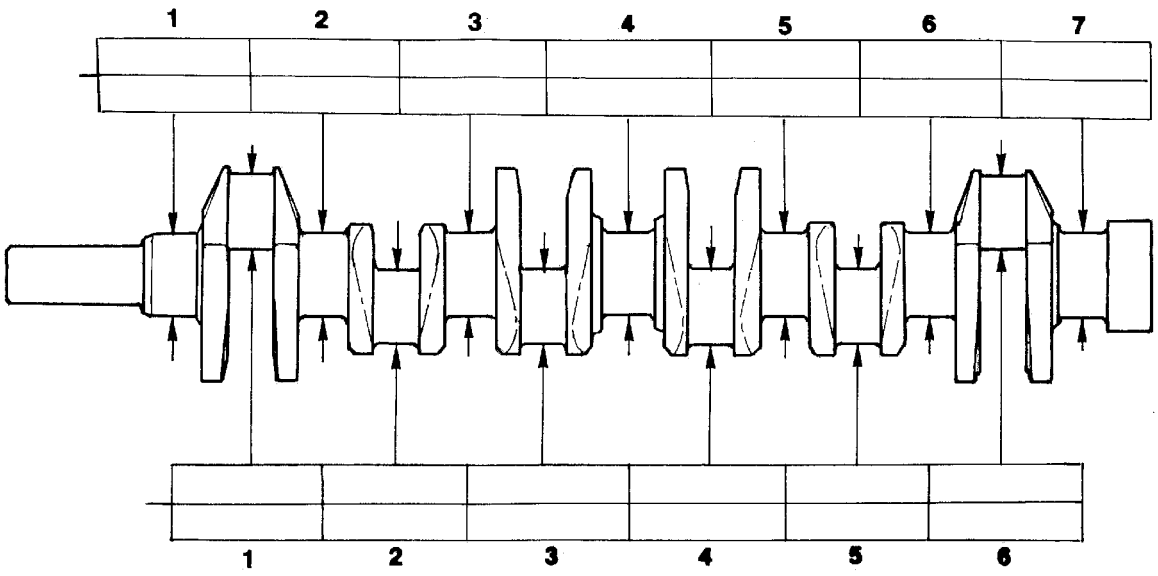
All journals and crank pins must also be ground to the same undersizing class, in order to avoid any alteration to shaft balance.

Figure 79

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

MAIN JOURNALS

	1	2	3	4	5	6	7
∅ MIN.							
∅ MAX.							



	1	2	3	4	5	6
∅ MIN.						
∅ MAX.						

CRANK PINS

36061

Choice of big end and main bearing half-shells

In order to obtain the clearance required, main half-bearings and big end half-bearings must be selected as specified below.

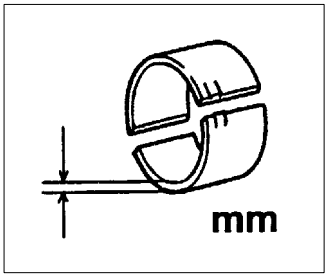
This operation makes it possible to identify the most suitable half-bearings for each journal (half-bearings can belong to different classes for the individual journals).

Depending on half-bearing thickness, tolerance classes are selected by colors (red-green-red/black-green/black).

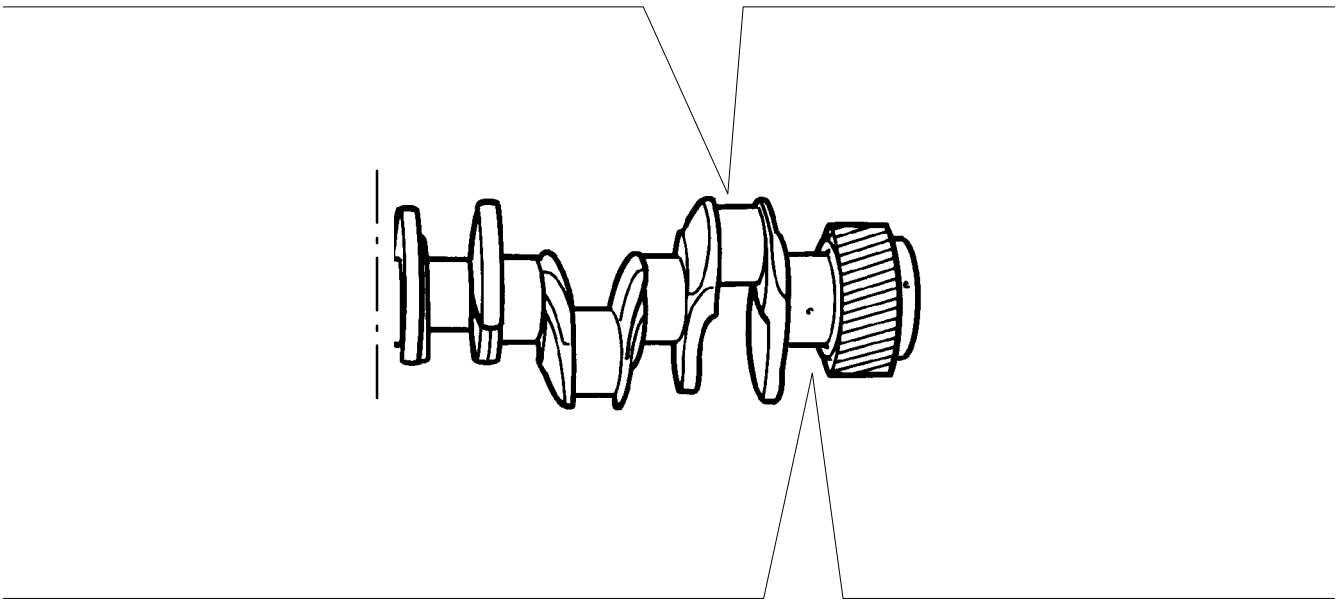
Figure 80 shows the characteristics of main half-bearings and big end half-bearings supplied as spare parts in standard measures (STD) and admissible oversizing (+0.127, +0.254, +0.508).

Figure 80

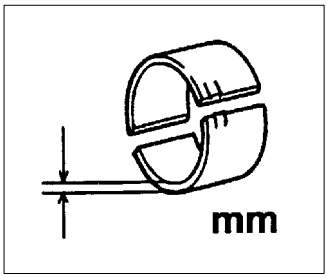
Big end half-bearings



	STD	+0.127	+0.254	+0.508
red	1.965 to 1.975		2.092 to 2.102	2.219 to 2.229
red/black		2.028 to 2.038		
green	1.976 to 1.985		2.103 to 2.112	2.230 to 2.239
green/black		2.039 to 2.048		



Main half-bearings



	STD	+0.127	+0.254	+0.508
red	3.110 to 3.120		3.237 to 3.247	3.364 to 3.374
red/black		3.173 to 3.183		
green	3.121 to 3.130			
green/black		3.184 to 3.193		

DETERMINATION OF PRELIMINARY DATA FOR SELECTION

For each journal and crankpin, the following operations must be carried out:

JOURNALS:

- ❑ determine the diameter class of the block housing;
- ❑ determine the diameter class of the main journal;
- ❑ select half-bearing class to be installed.

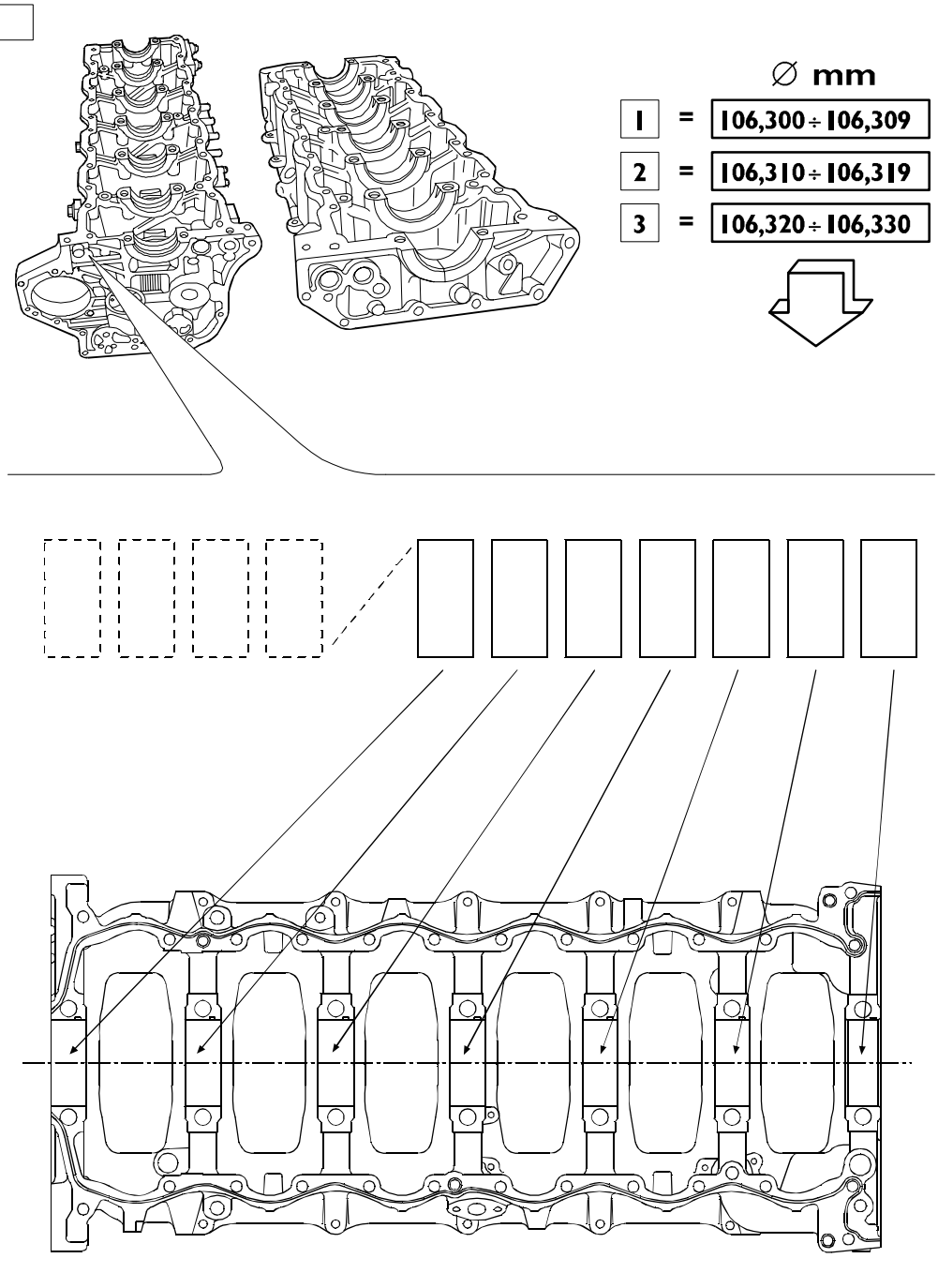
KRANKPINS:

- ❑ determine the diameter class of the connecting rod housing;
- ❑ determine the diameter class of the big end pin;
- ❑ select half-bearing class to be installed.

Two series of numbers are marked on the front side of the block, in the position specified (top).

- ❑ a four-digit number, representing the coupling number of block to the relevant underblock;
- ❑ each of the following seven digits represents the diameter class of the housing they refer to (bottom);
- ❑ each digit can be **1, 2** or **3**.

Figure 81

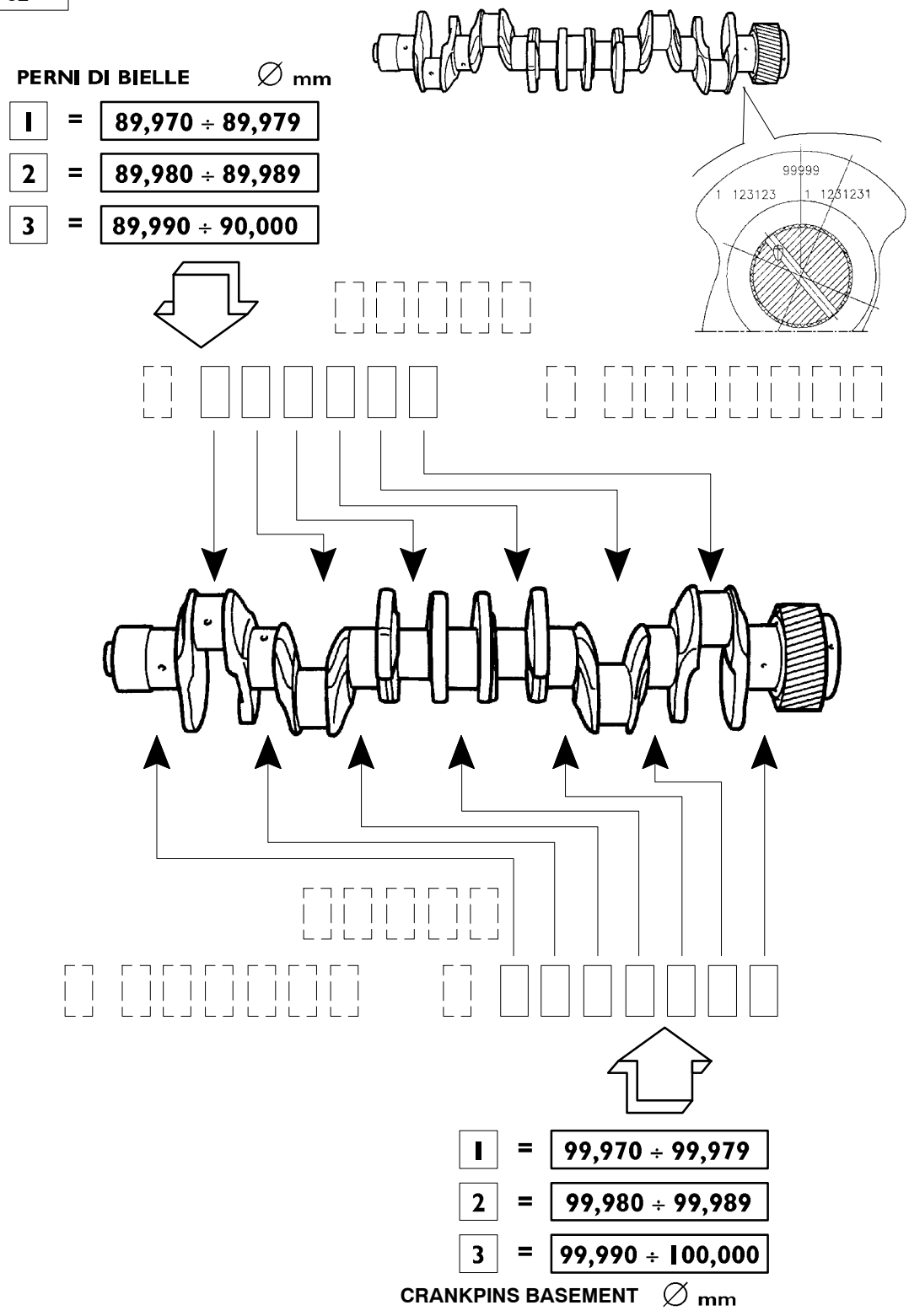


Definition of main journal and big end diameter class (journals with nominal diameter)

Three series of numbers are specified on the driving shaft, in the position specified.

- a five-digit number, representing the shaft serial number;
- under this number, on the left, a six-digit number refers to big end pins and is preceded by a single digit, which indicates pin status (1 = STD =-0.127); each of the following six digits represents the diameter class of each big end pin it refers to (bottom);
- the seven-digit series, on the right, refers to the journals and is preceded by a single digit, which indicates journal status (1 = STD =-0.127); each of the following seven digits represents the diameter class of the journal it refers to (bottom);

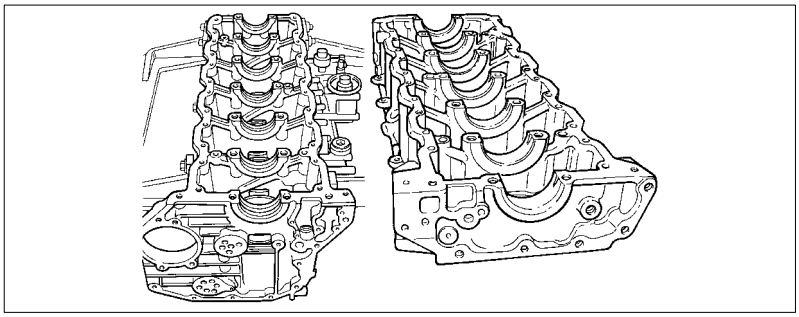
Figure 82



Selection of main half-bearings

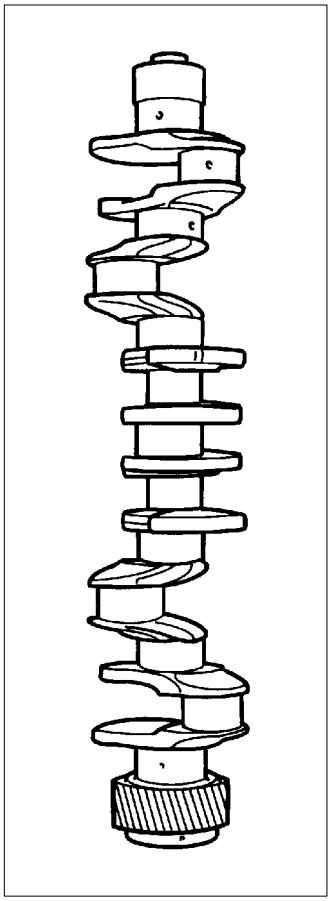
After detecting, for each journal, the necessary data on block and crankshaft, select the type of half-bearings to be used, in compliance with the following table:

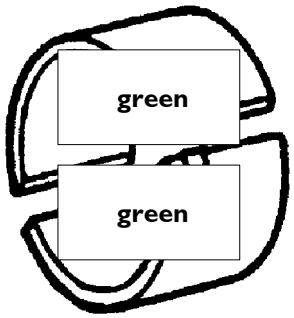
Figure 83



STD.

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

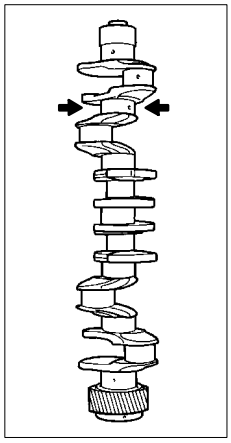


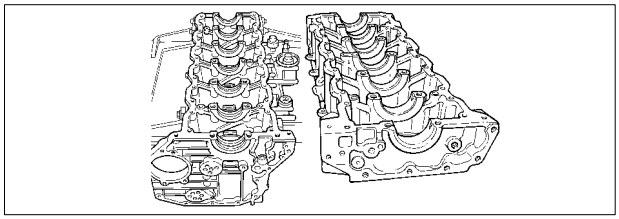


Selection of main half-bearings (rectified)

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 84



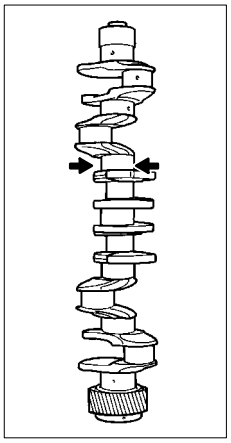


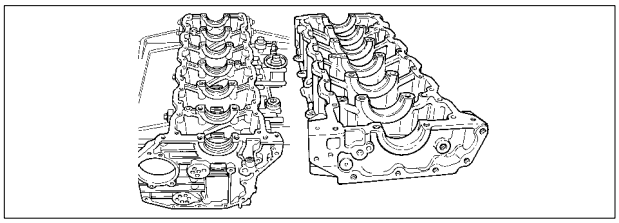
-0.127

red/black = mm 3.063 to 3.073

green/black = mm 3.074 to 3.083

		1	2	3
82.783 82.792	1	green/black green/black	green/black green/black	green/black green/black
82.793 82.802	2	red/black red/black	green/black green/black	green/black green/black
82.803 82.813	3	red/black red/black	red/black red/black	green/black green/black

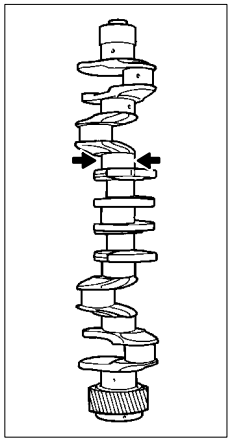


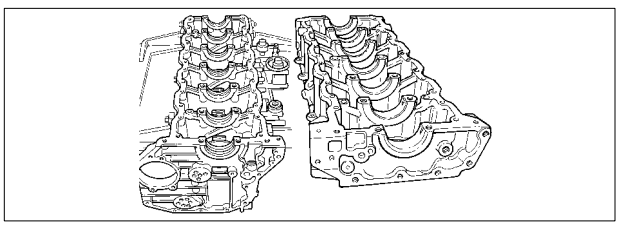


-0.254

red = mm 3.127 to 3.137

	1	2	3
82.666 82.686	red red	red red	red red





-0.508

red = mm 3.254 to 3.264

	1	2	3
82.412 82.432	red red	red red	red red

Choice of big-end half-shells (standard diameter)

Three indications are marked on the connecting rod, in position "A"

Figure 85

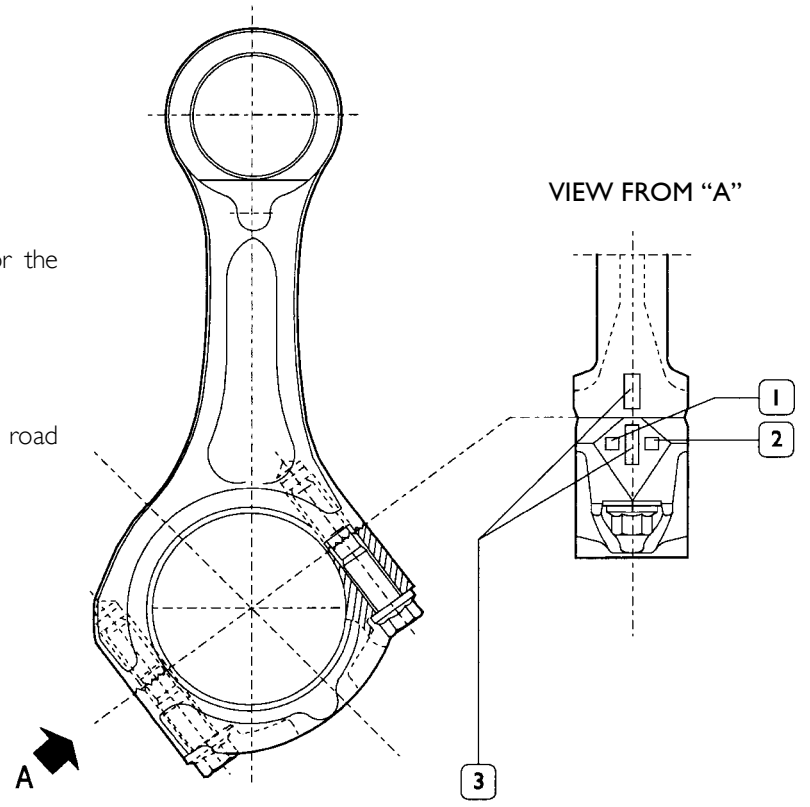
1 Letter indicating the weight class

A = 4661 to 4694 g.
B = 4695 to 4728 g.
C = 4729 to 4762 g.

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

1 = 94.000 to 94.010 mm
2 = 94.011 to 94.020 mm
3 = 94.021 to 94.030 mm

3 Numbers identifying the cap-connecting road coupling.

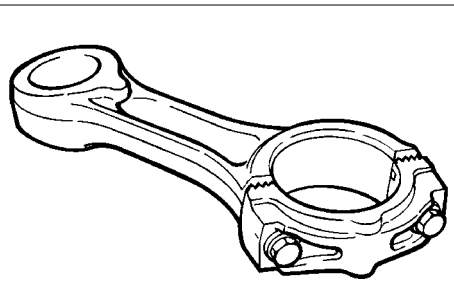


The number specifying the diameter class of the half-bearing housing can be **1, 2** or **3.**

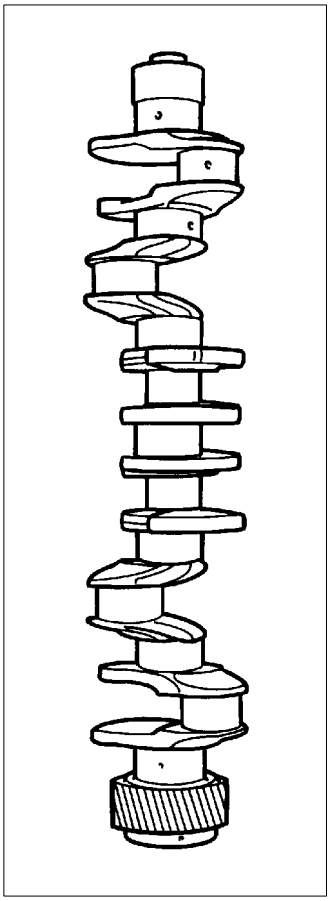
Determine the type of big end half-bearings to be installed on each pin by following the indications given in the table (Figure 86).

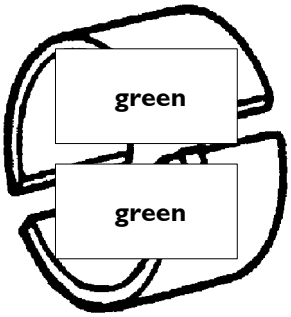
Figure 86

STD.



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

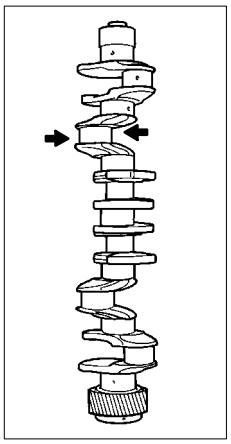


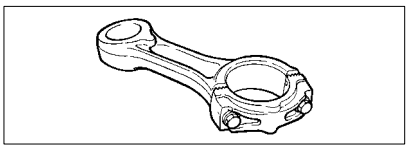


Choice of big-end half-shells (rectified)

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 87



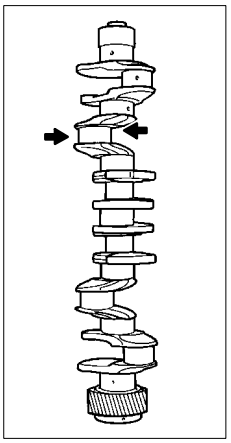


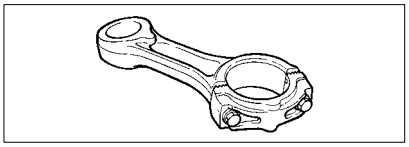
-0.127

red/black = mm 2.028 to 2.038

green/black = mm 2.039 to 2.048

		1	2	3
72.788 72.797	1	green/black	green/black	green/black
		green/black	green/black	green/black
72.798 72.807	2	red/black	green/black	green/black
		red/black	green/black	green/black
72.808 72.818	3	red/black	red/black	green/black
		red/black	red/black	green/black

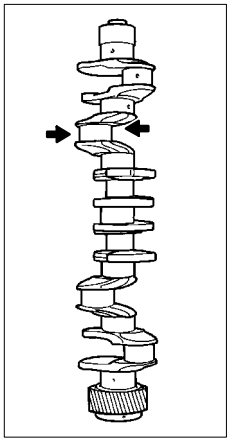


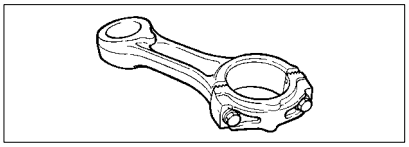


-0.254

red mm 2.092 to 2.102
green = mm 2.103 to 2.112

	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

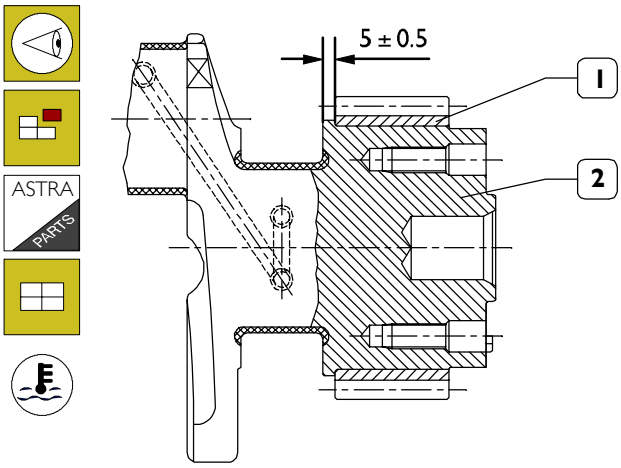
red = mm 2.219 to 2.229
green = mm 2.230 to 2.239

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

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 88

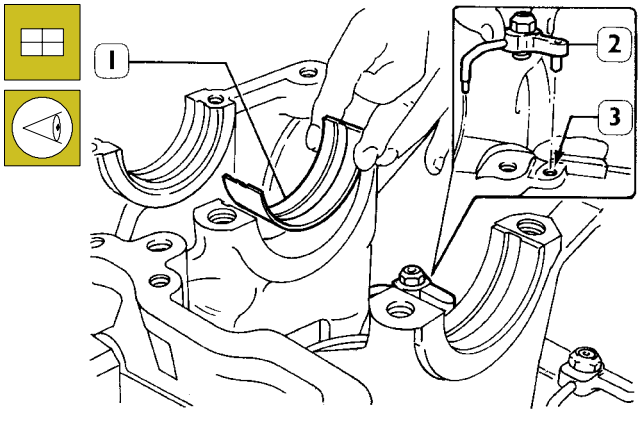


49020

When fitting the new gears (1) on the crankshaft (2), heat them for about 15 minutes in an oven at 180°C.
Let them cool down after the installation.

Checking main journal installation clearance

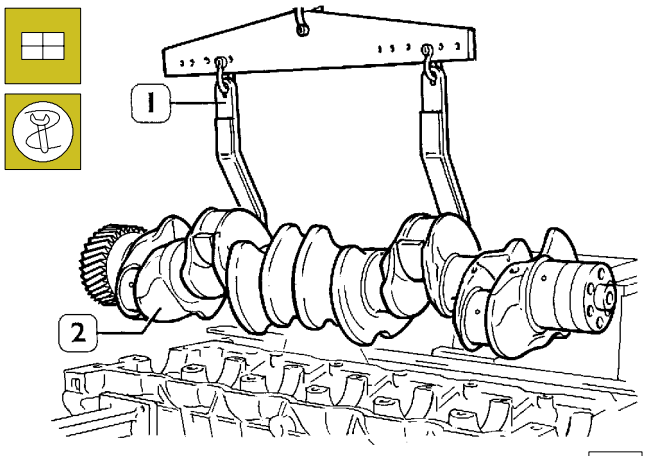
Figure 89



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.

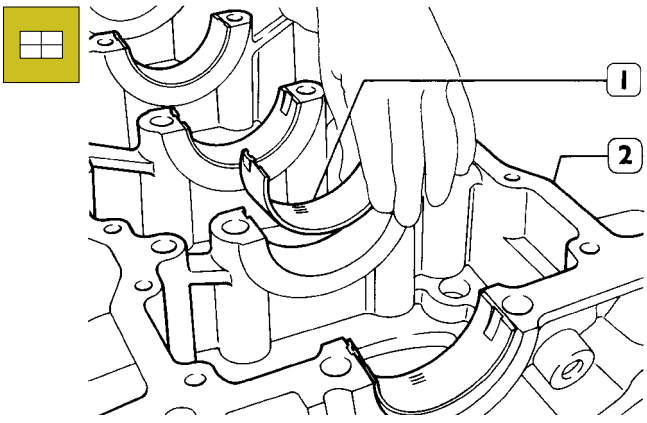
Figure 90



47578

Using pulley system and hook 99360500 (1), mount the crankshaft (2).

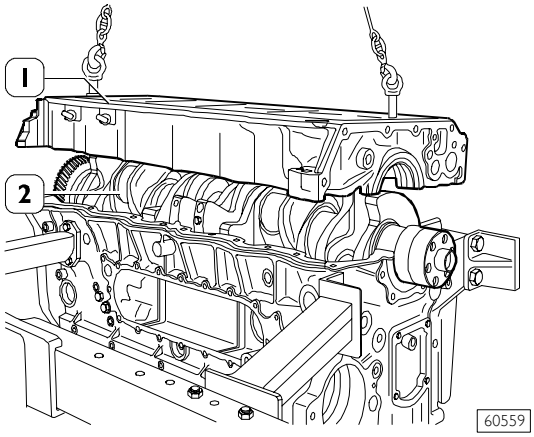
Figure 91



49021

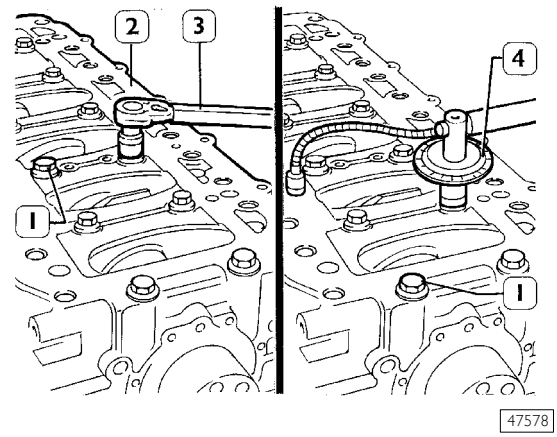
Install the half-bearings (1) on the main bearings in the underblock (2).
Check the installation clearance between the main journals and the relative bearings as follows:

Figure 92



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 95



❑ 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.

Figure 93

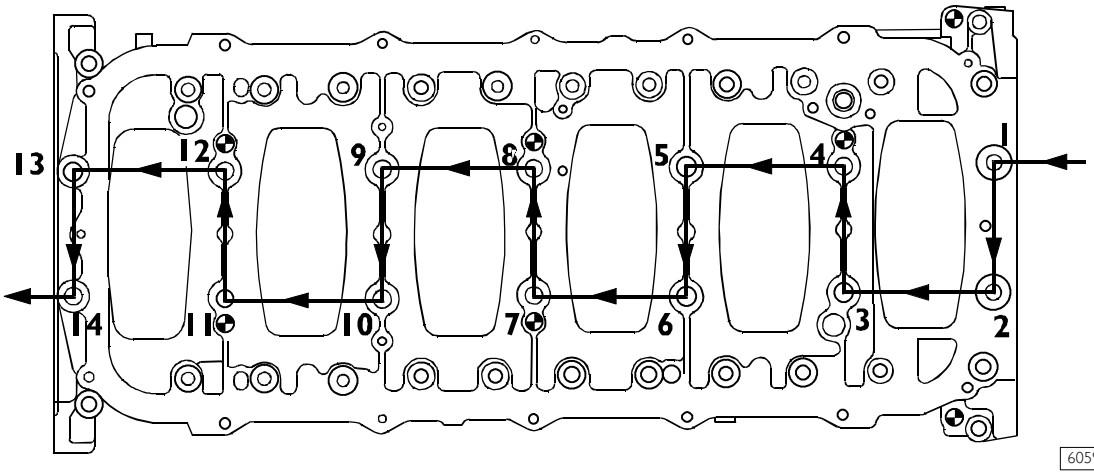
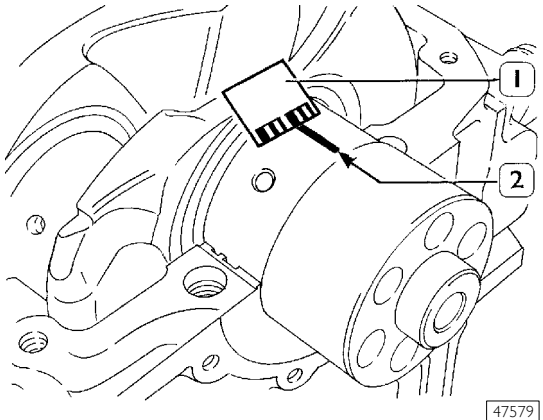


DIAGRAM SHOWING THE TIGHTENING ORDER OF THE SCREWS FIXING THE LOWER UNDER-BLOCK TO THE BLOCK

Figure 94

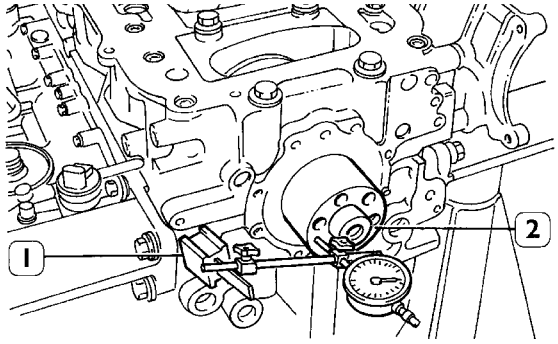


❑ Remove the under-block

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

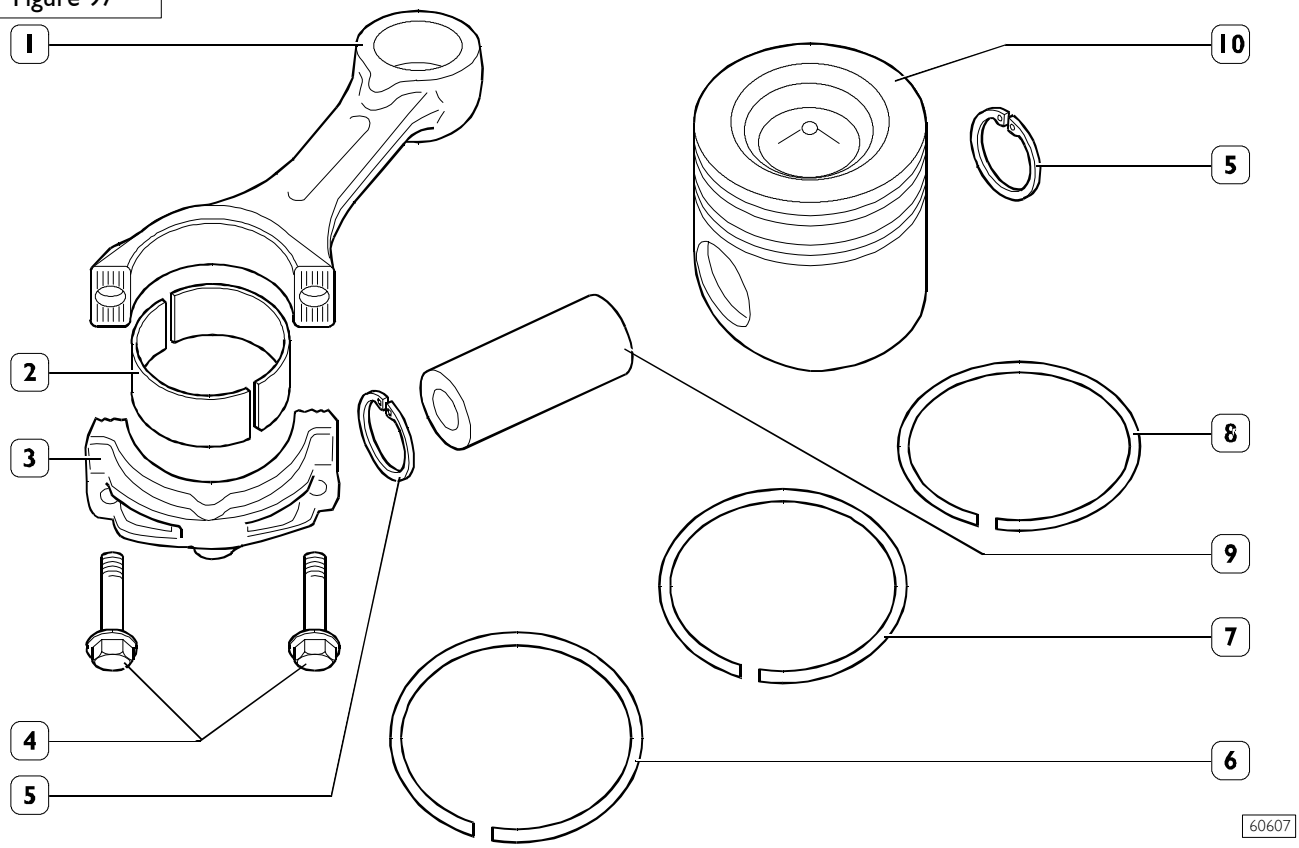
Figure 96



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.

Piston-connecting rod assembly

Figure 97



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

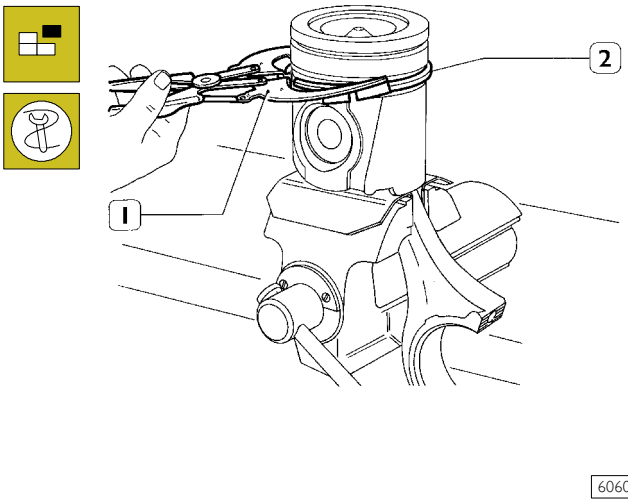
Make sure the piston does show any trace of seizing, scoring, cracking; replace as necessary.

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.

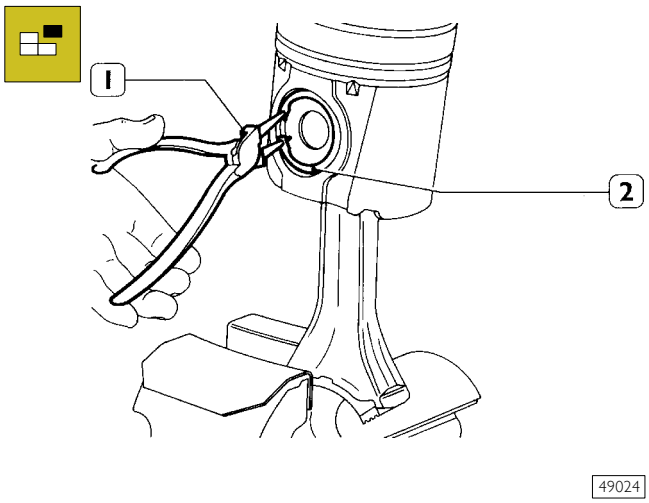
Removal

Figure 98



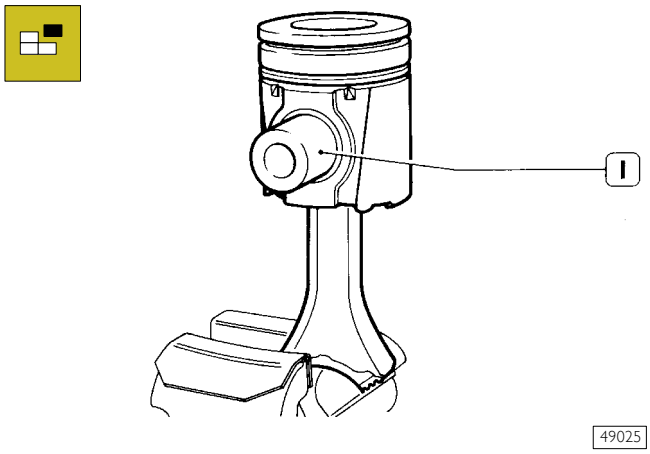
Removal of the piston split rings (2) using the pliers 99360184 (1).

Figure 99



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

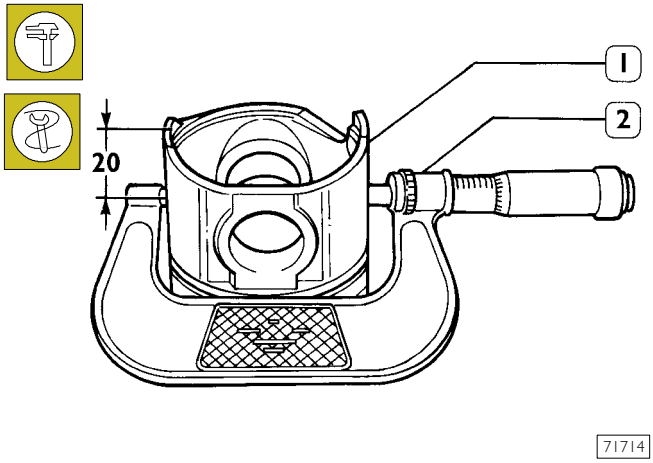
Figure 100



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

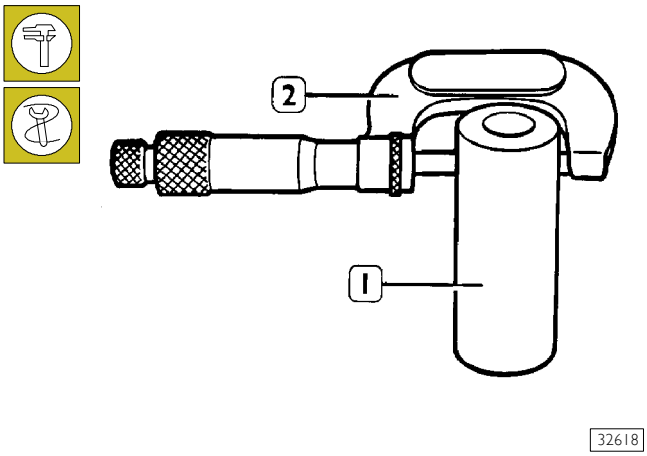
Measuring the diameter of the pistons

Figure 101



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.

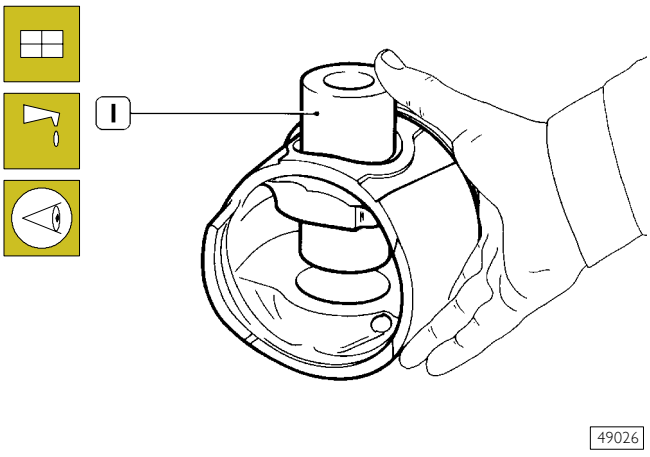
Figure 102



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

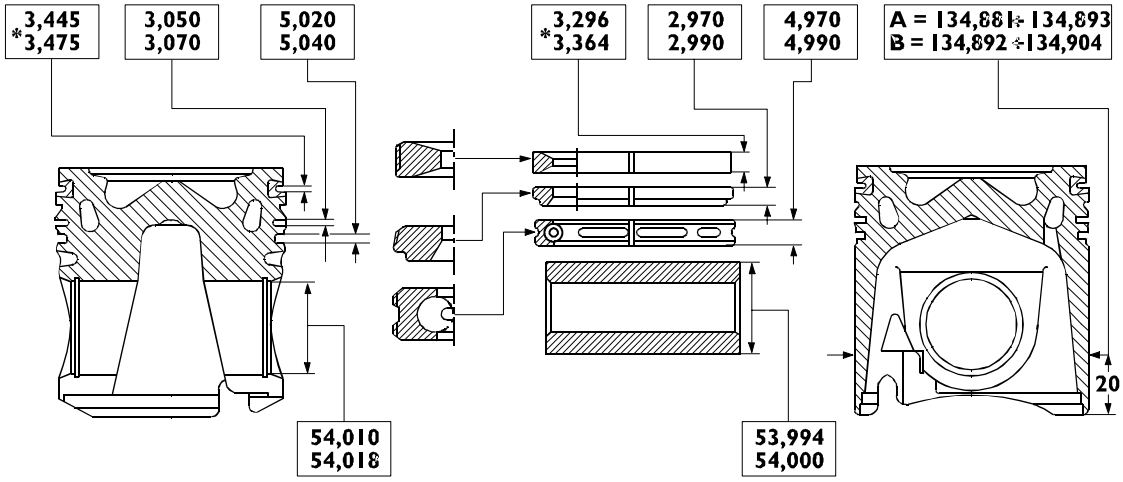
Conditions for correct gudgeon pin-piston coupling

Figure 103



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 104



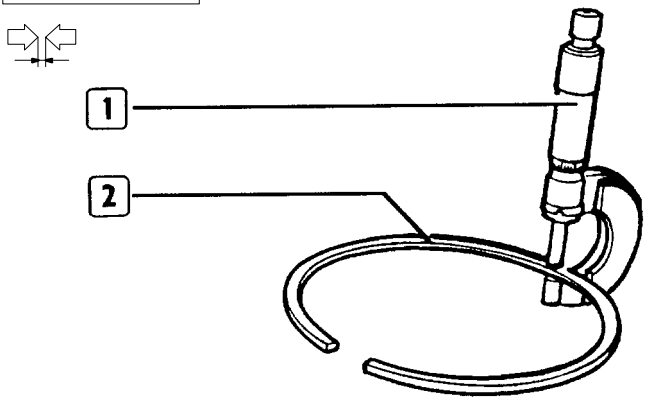
71715

MAIN DATA ON PISTONS, AND PISTONS RINGS

* Values are determined on ∅ of 130 mm.

Piston rings

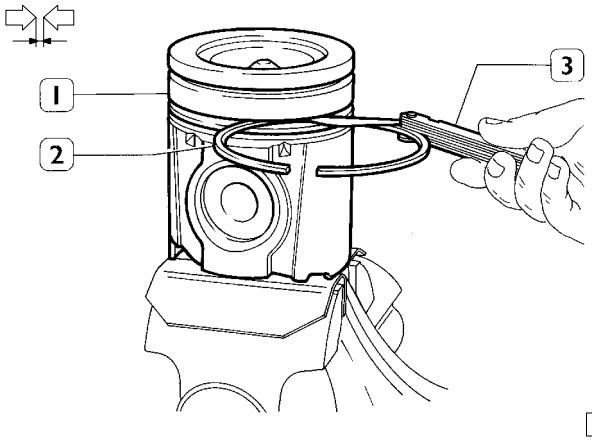
Figure 105



16552

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

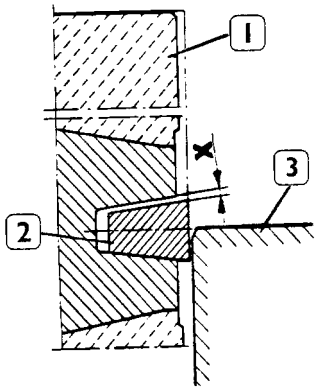
Figure 107



60610

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

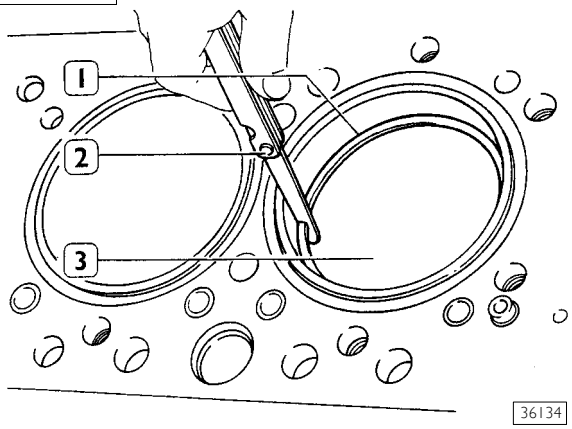
Figure 106



3513

The sealing ring (2) of the 1st 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 108



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.

Connecting rod

Figure 109

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 OF THE CONNECTING ROD MARKS

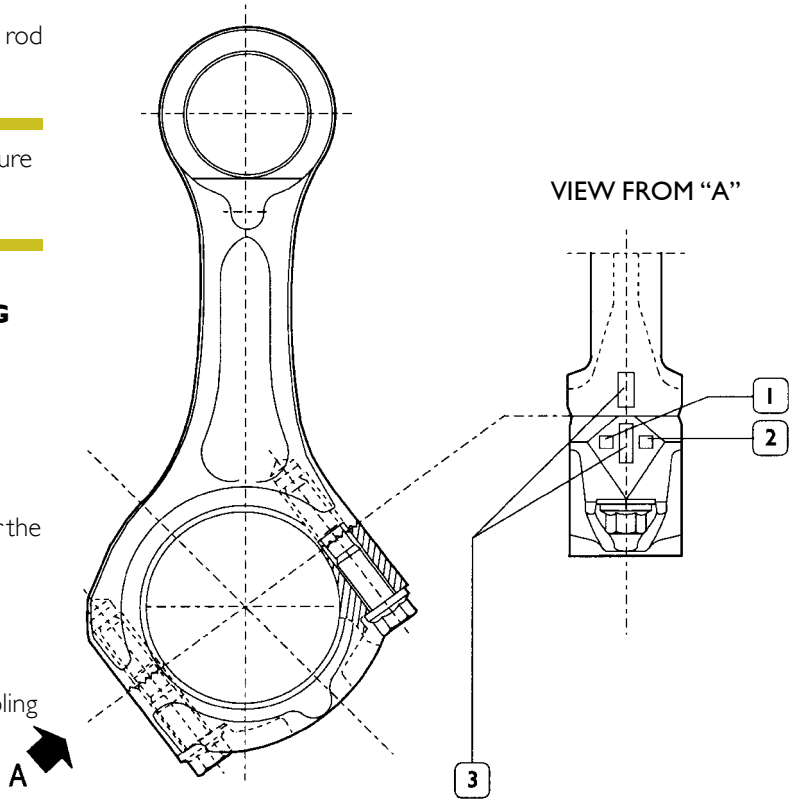
1 Letter indicating the weight class:

A = 4661 to 4694 g.
B = 4695 to 4728 g.
C = 4729 to 4762 g.

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

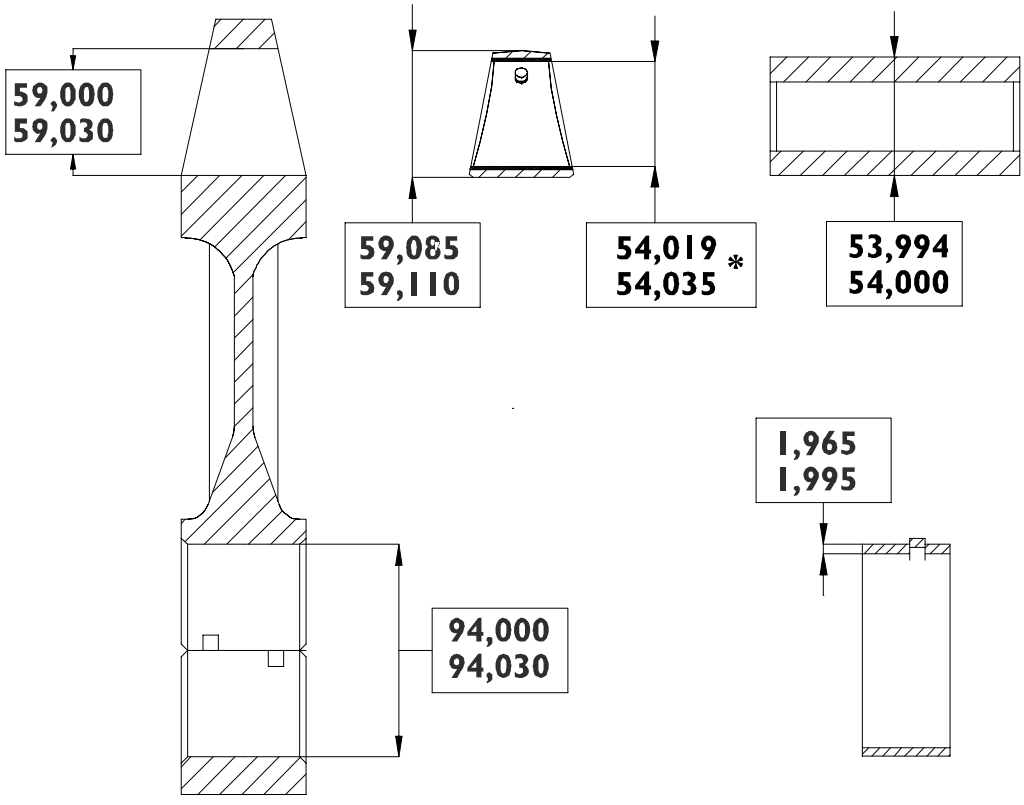
1 = 94.000 to 94.010 mm
2 = 94.011 to 94.020 mm
3 = 94.021 to 94.030 mm

3 Numbers identifying cap-connecting rod coupling



47957

Figure 110

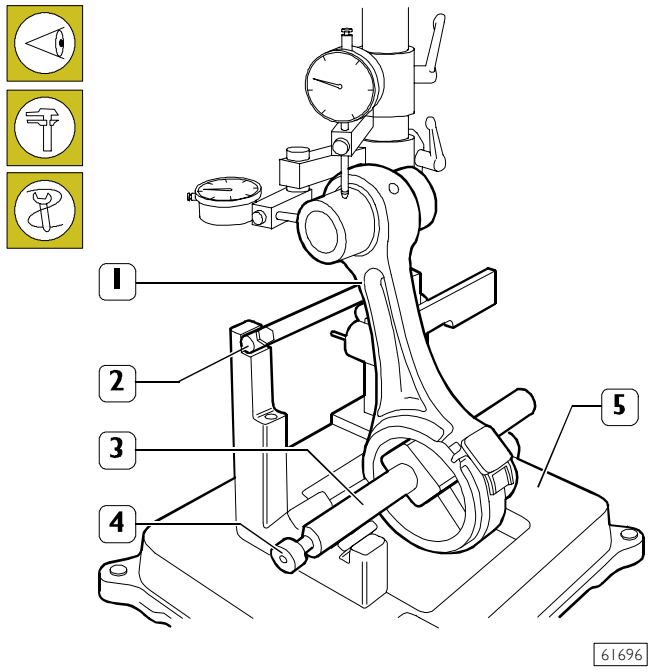


71716

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

Checking con-rods

Figure 111



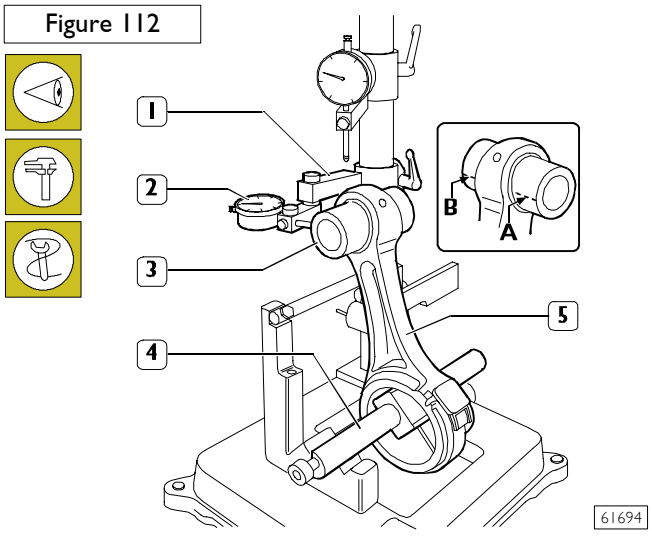
Check axis parallel

Proceed as follows to check con-rod parallel (1) using tool 99395363 (5)

- ❑ Fit the con-rod (1) to the chuck of tool 99395363 (5) and lock it with the screw (4).
- ❑ Set the chuck (3) on the V-shaped mountings and rest the con-rod (1) on the stopper bar (2).

Check con rod

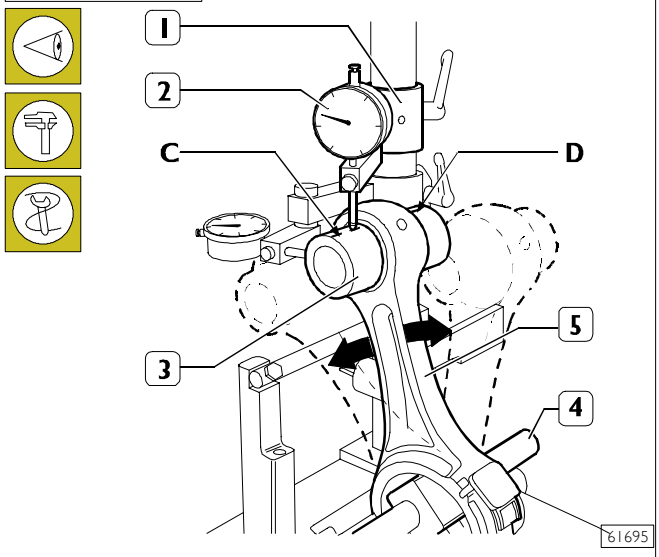
Figure 112



Check con-rod (5) twist by comparing two points of the gudgeon pin (3) (A and B), horizontal to the con-rod axis. Position the comparator support such that it applies a preload of ~ 0.5 mm on the pin (3) at point A and zero the comparator (2). Shift the chuck (4) with the con-rod (5) and check any shift of the pin (3) on the opposite side (B). The difference between A and B must not exceed 0.08 mm.

Con-rod bend

Figure 113

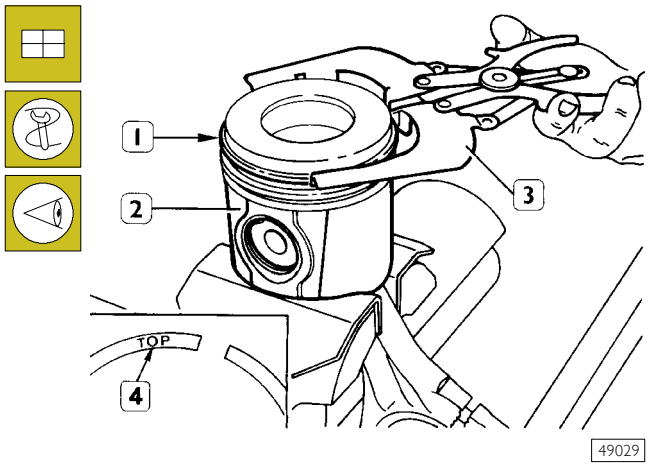


Check con-rod bend by comparing two points (C and D) of the gudgeon pin (3) on the vertical plane of the con-rod axis. Position the vertical support (1) of the comparator (2) such that the comparator rests on the gudgeon pin (3) at point C. Move the con-rod backward and forward to find the highest point of the gudgeon pin and zero the comparator at that point.
Move the chuck and con-rod (5) and repeat the operation on the opposite side of the pin at point D, and check the highest point. The difference between points C and D must not exceed 0.08 mm.
Assemble the con-rod and piston assembly.
Follow removal instructions in reverse order to replace the assembly.

Con-rod bolts can be re-used until the diameter of the thread is less than 13.4 mm.

Fitting piston rings

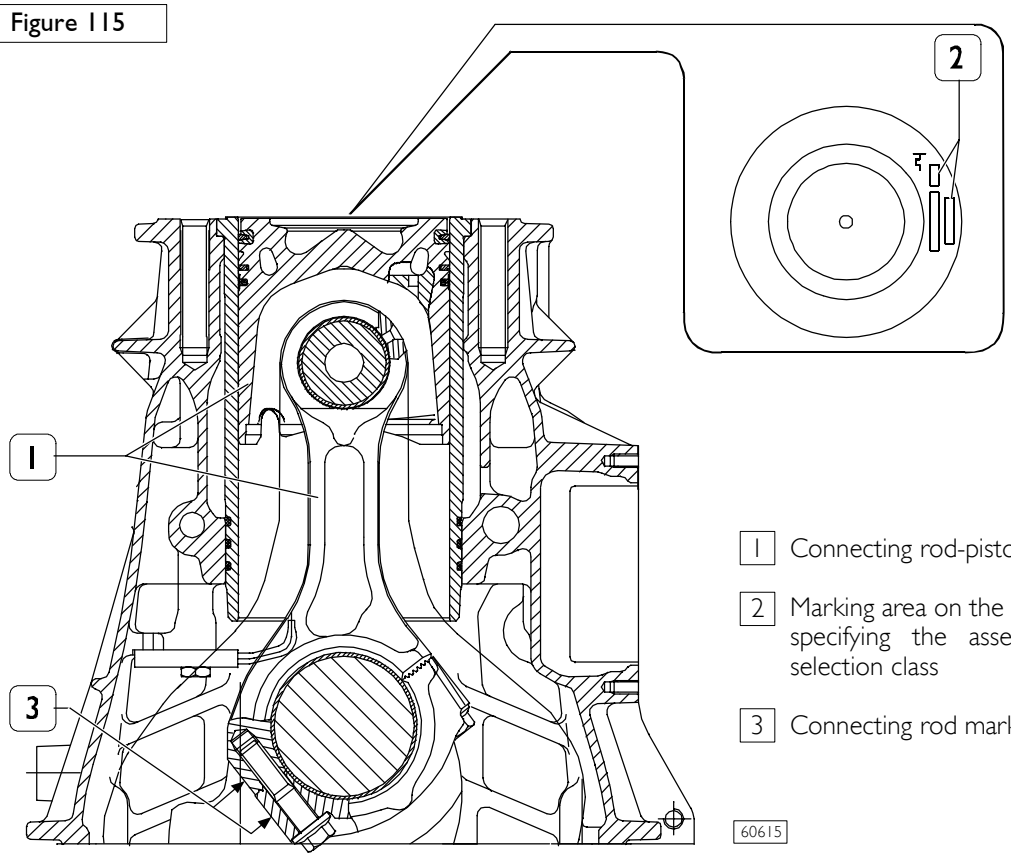
Figure 114



Use clamp 9936014 (3) to fit the rings (1) to the piston (2). The rings must be fitted with the marking "Top" (4) facing upwards. Orient the openings in the rings with an offset of 120° to each other.

Fitting connecting rod-piston assies in cylinder liners for checking fitting play

Figure 115

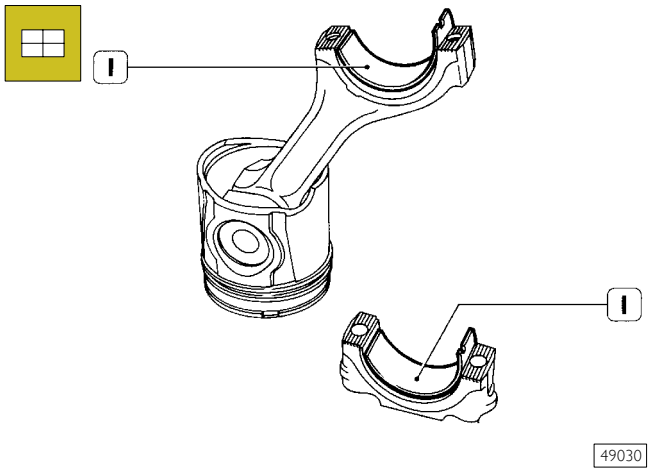


1 Connecting rod-piston assembly

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

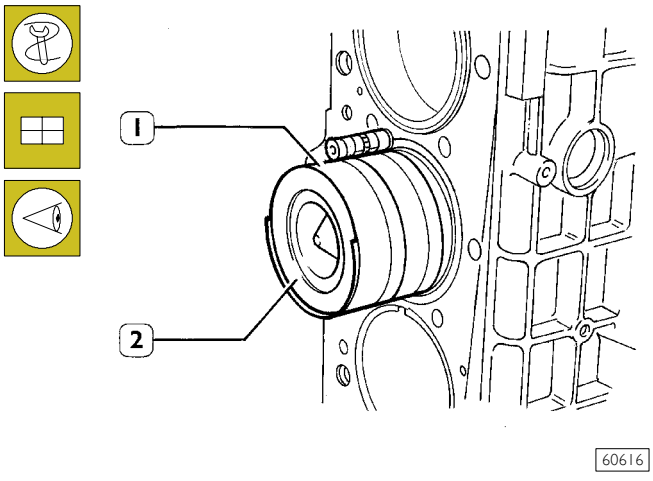
3 Connecting rod marking area (see Figure 109).

Figure 116



Install half-bearings (1).

Figure 117



Fit the connecting rod-piston assemblies (1) into the piston liners (2) using band 99360605 (1, Figure 117). Check the following:

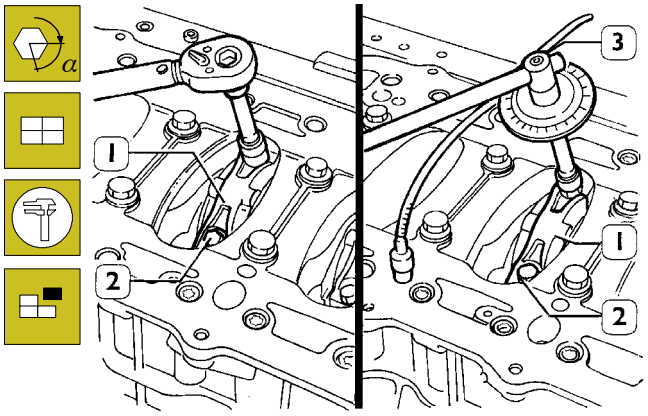
- ❑ the openings of the split rings are offset by 120°;
- ❑ all pistons belong to the same class, A or B;
- ❑ ideogram stamped on the piston crown is placed toward the engine flywheel, or the cavity, on the piston cover, corresponds to the position of the oil spray nozzles.

Measuring big-end bearing play

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 118



47594

Install the connecting rod caps (1) with half-bearings; tighten the connecting rod cap fixing screws (2) to 60 Nm (6 kgm) torque. By tool 99395216 (3), tighten the screws further at 60° angle.

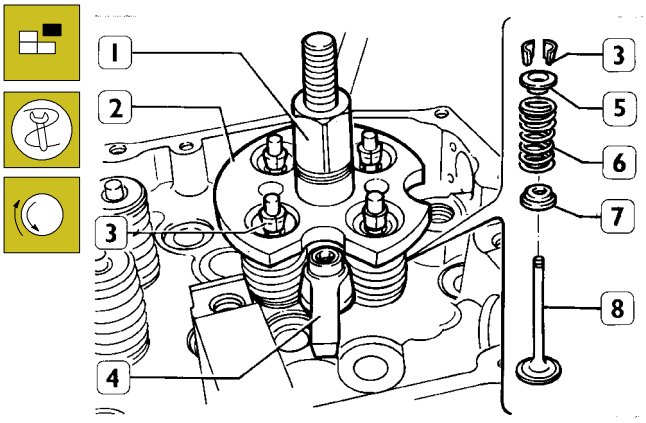
Remove the caps and check the clearance by comparing the width of the calibrated wire with the scale calibration on the envelope containing the wire.

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 119

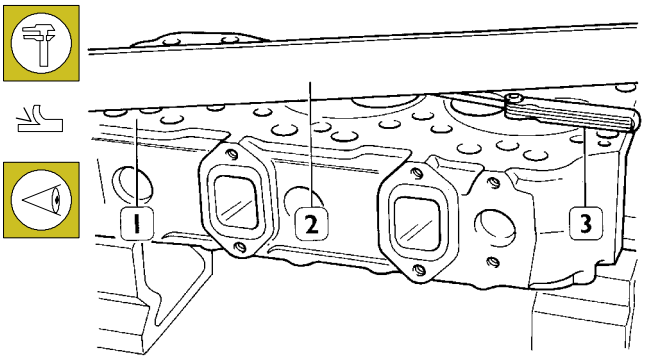


47583

Install and fix tool 99360263 (2) with bracket (4); tighten by lever (1) until cotters are removed (3); remove the tool (2) and the upper plate (3), 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 120 (Demonstration)



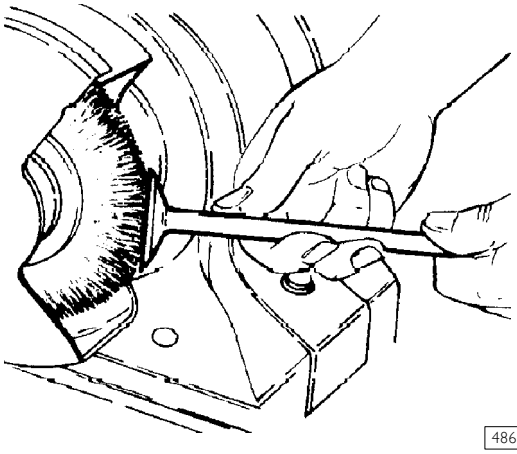
36159

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.

Removing deposits and checking the valves

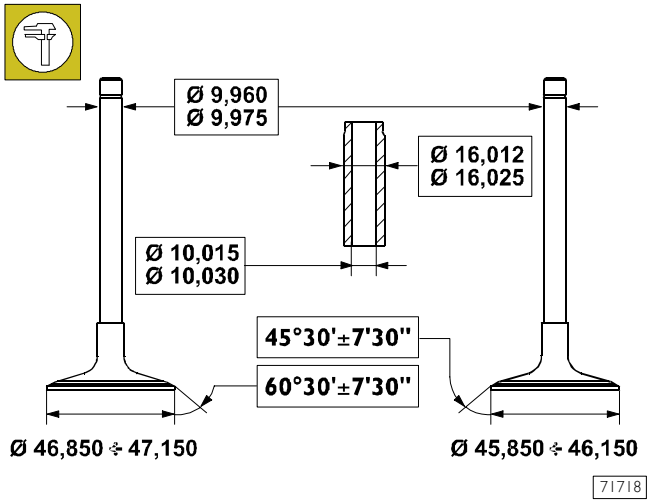
Figure 121



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 and replace if necessary.

Figure 122

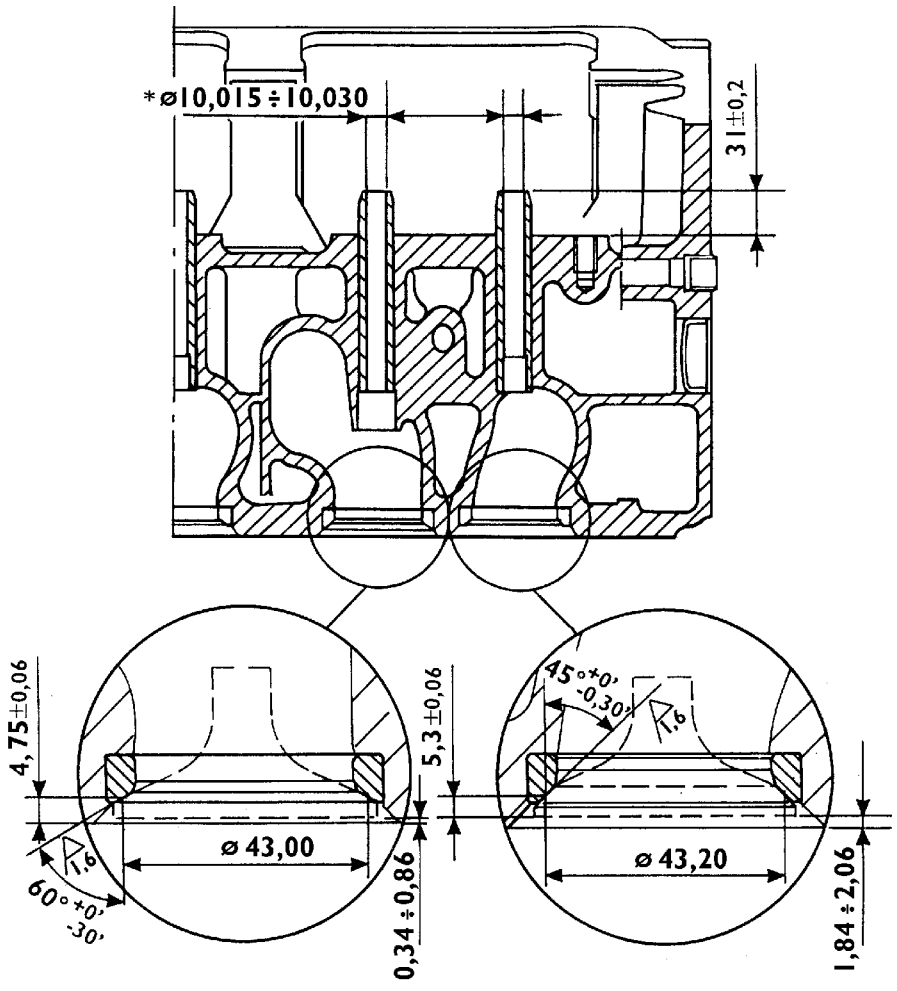


MAIN DATA - VALVES AND VALVE GUIDES

* 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.

Figure 123



INSTALLATION DIAGRAM FOR VALVE GUIDES AND VALVES

* Values to be obtained after installing the guide valves

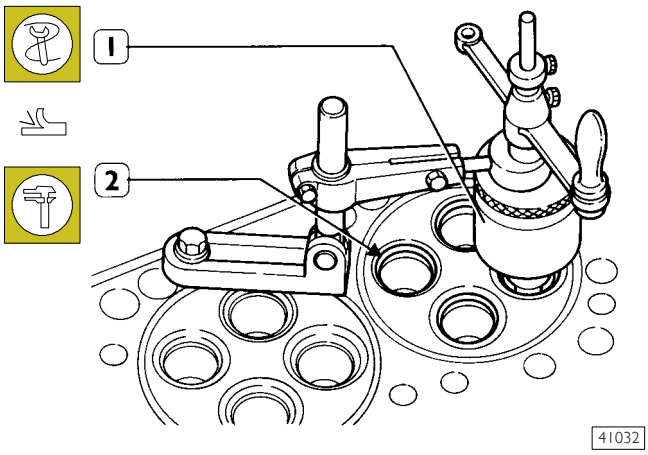
Replacing of valve guides

Remove valve guides by means of tool 99360143.
Install by means of tool 99360143 equipped with part 99360296, 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 30.8 to 31.2.
After installing the valve guides, smooth their holes with sleeker 99390330.

Replacing - Reaming the valve seats

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

Figure 124



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.

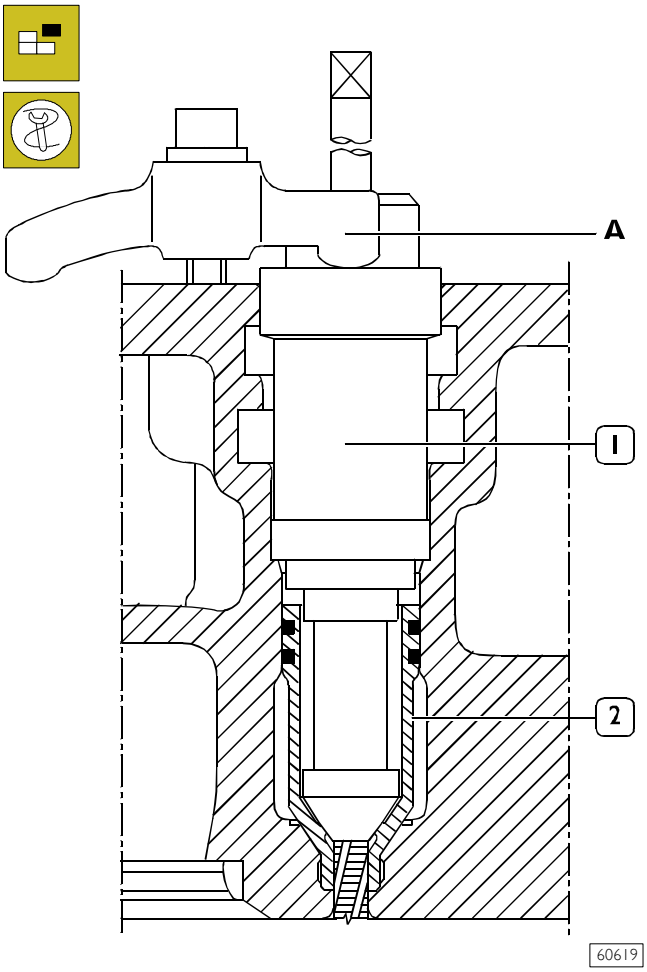
After reaming the valve seats, use tool 99370415, to make sure that the valve position, with respect to the cylinder head surface, is the following:

- ❑ -0.54 to -0.85 mm (recessing) of exhaust valves;
- ❑ -1.75 to -2.05 mm (recessing) of discharge valves.

REPLACING INJECTOR HOLDER CASES

Removal

Figure 125

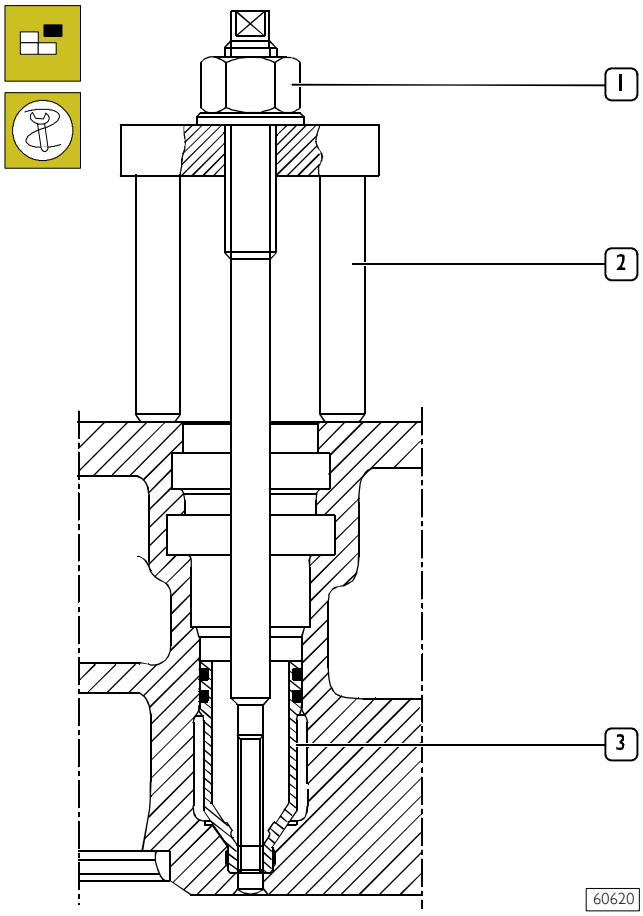


To replace the injector case (2), act as follows:

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

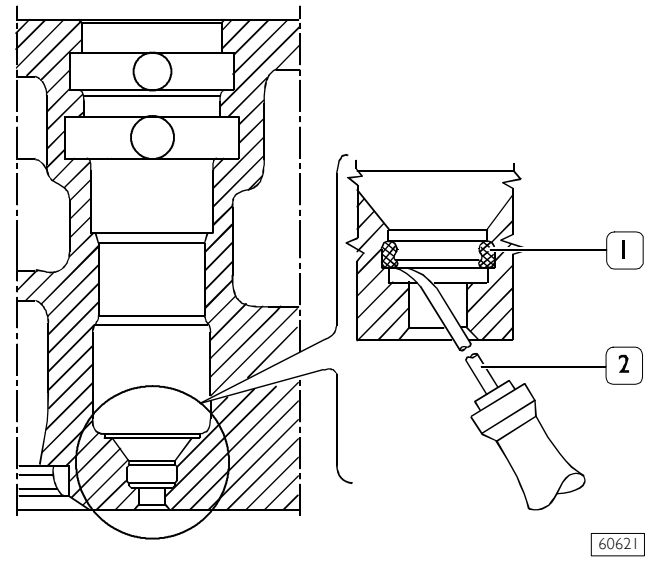
Carry out operations described in figs. 126-128-129-130 by fixing tools to the cylinder head by means of braket A.

Figure 126



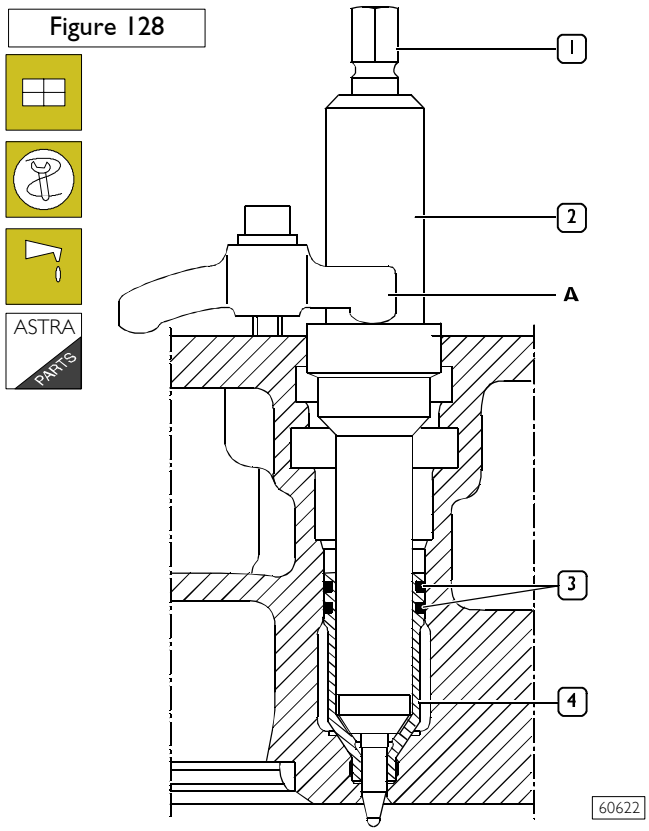
❑ Fasten extractor 99342149 (2) to case (3), by tightening the nut (1), and pull out the case from cylinder head.

Figure 127



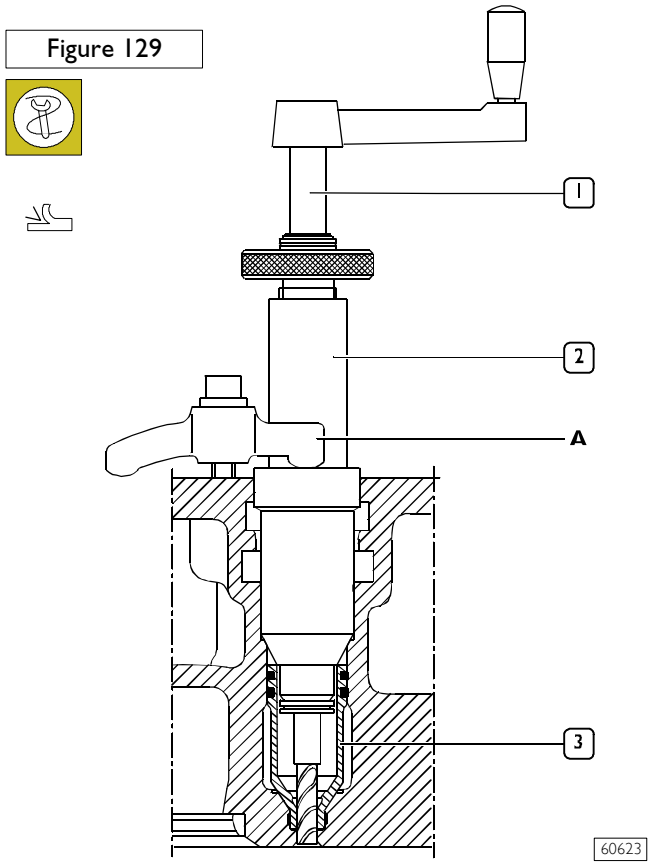
❑ Remove any residue (1), with tool 99390772 (2), from the cylinder head groove.

Figure 128



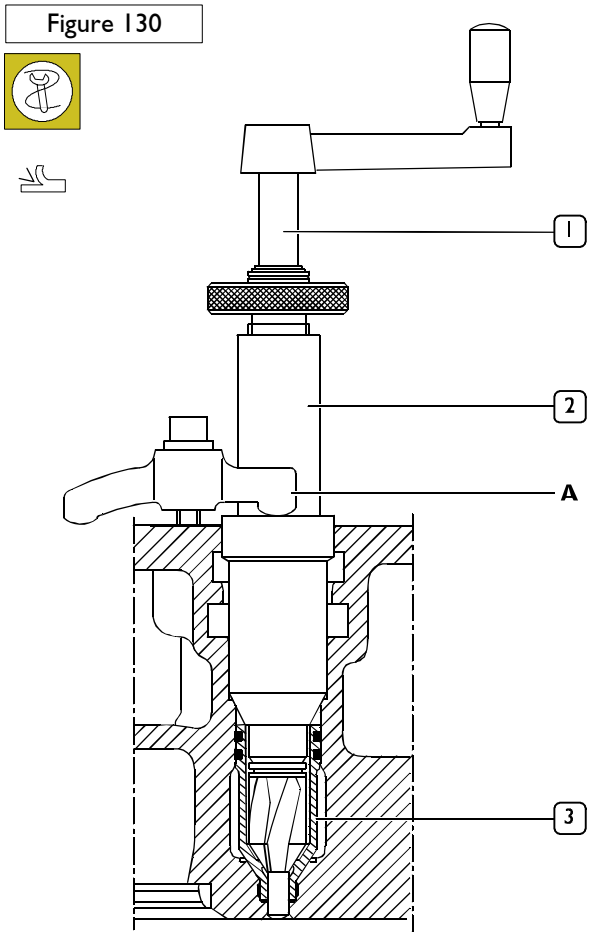
❑ Lubricate sealing rings (3) and fit them to the case (4); fix tool 99365056 (2) to the cylinder head by means of bracket **A**, install the new case, tighten the screw (1), upsetting the case lower part.

Figure 129



❑ Ream the case hole (3) with reamer 99394041 (1).

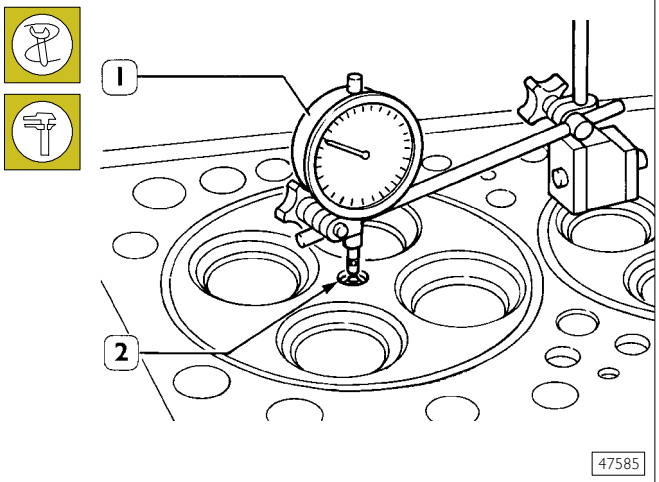
Figure 130



❑ Using grinder 99394043 (1-2), ream the injector seat in the case (3).

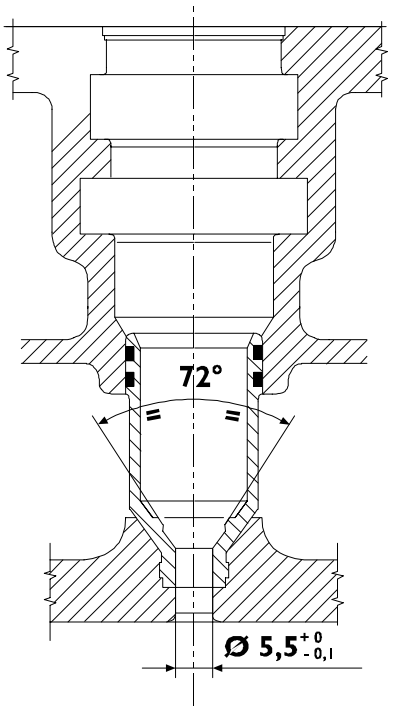
Checking protrusion of injectors

Figure 131



Using dial gauge (1), check the protrusion of the injector (2) which must be 0.52 to 1.34 mm.

Figure 132

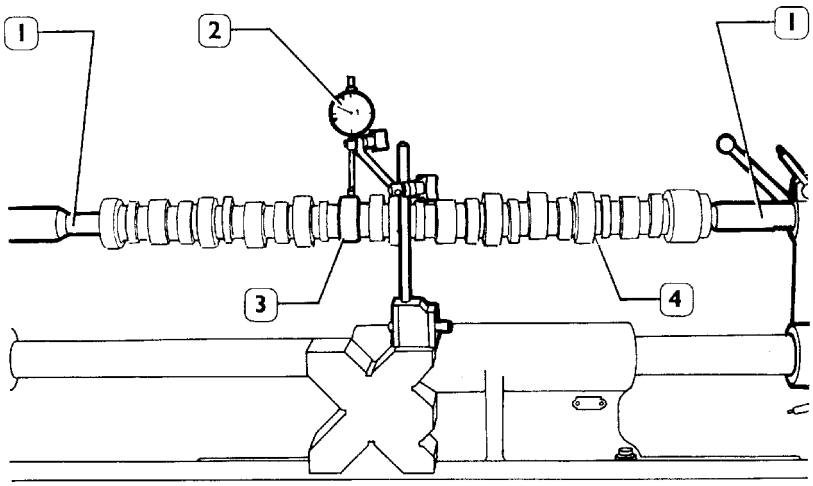


INSTALLATION DIAGRAM FOR INJECTOR CASE

Timing gear

Checking cam lift and pin alignment

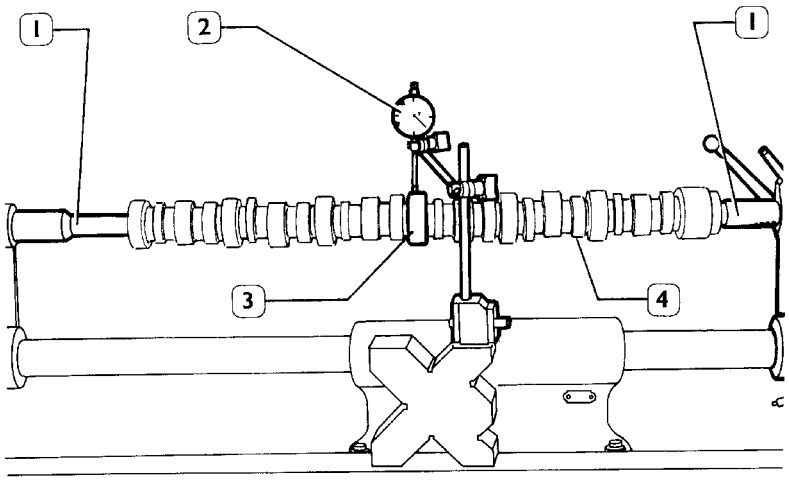
Figure 133



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 17.

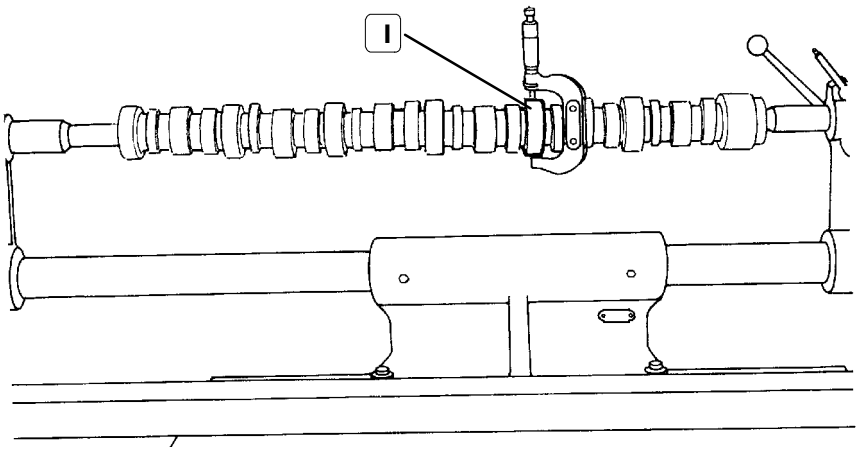
Figure 134



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.

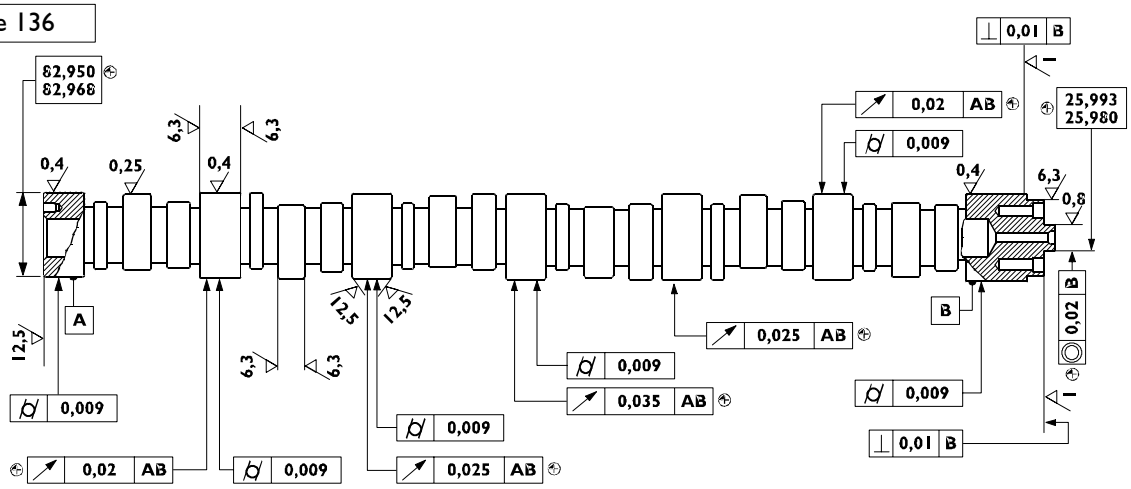
Figure 135



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 0.135 mm, replace bushes and, if necessary, the camshaft.

Figure 136



MAIN DATA - CAMSHAFT AND TOLERANCES

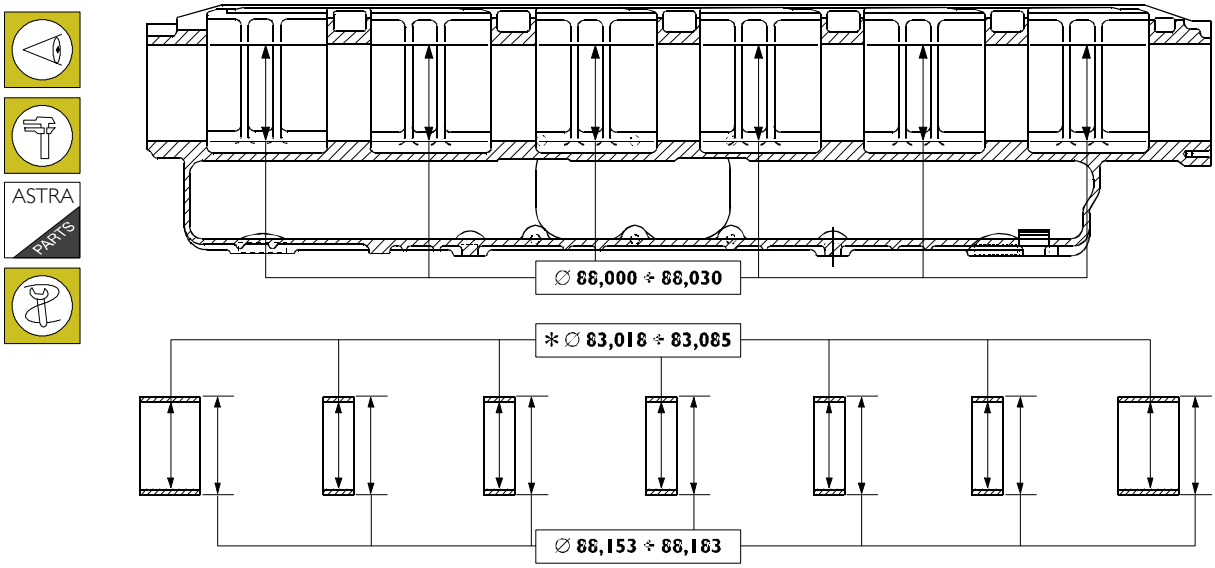
The surfaces of shaft supporting pin and cams must be extremely smooth; if you see any sign of seizing or scoring, replace the shaft and the relative bushes.

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

Fitting the connecting rod-piston assembly into the piston liners

Bushes

Figure 137

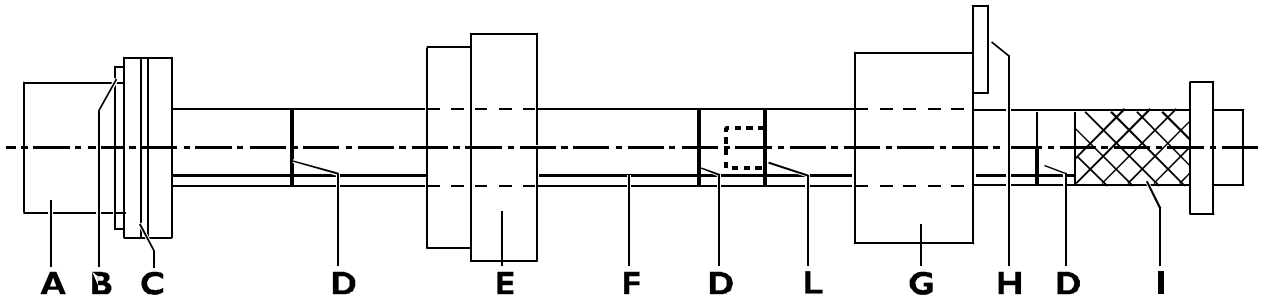


MAIN DATA OF CAMSHAFT BUSHES AND RELEVANT HOUSINGS ON CYLINDER HEAD.
* Bush inner diameter after installation

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 99360499.

Figure 138

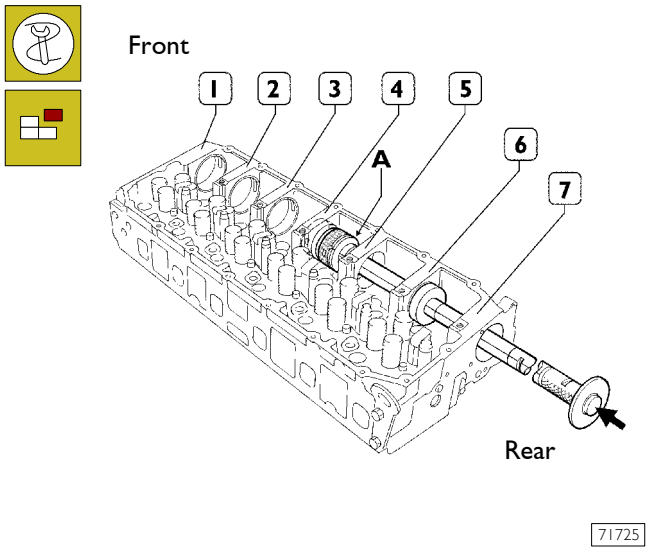


71721

A = Beater with seat for bushes for insertion/removal
B = Bush positioning pin
C = Mark for correct insertion of seventh bush
D = Mark for correct insertion of bushes 1, 2, 3, 4, 5 and 6 (yellow notches)
E = Guide bush
F = Guide line
G = Guide bush to fasten to seventh bush support
H = Cylinder head yellow bush fastening plate
I = Grip
L = Extension joint

Removal

Figure 139

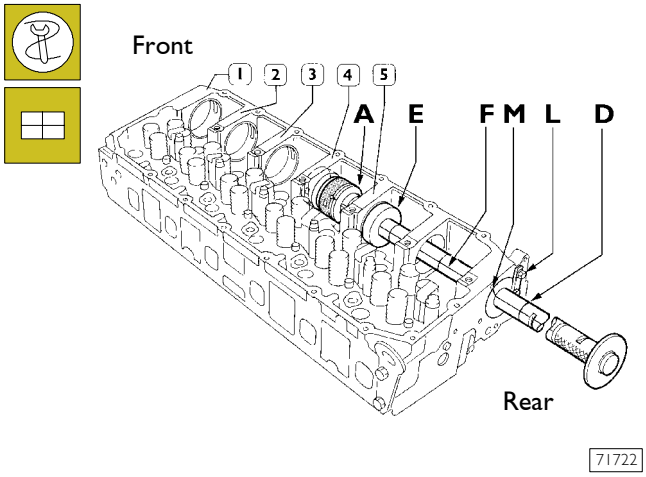


71725

The bush removal order is 7, 6, 5, 4, 3, 2, 1. The bushes are slipped out from the front side of their individual seats. Removal does not require the beater extension for bushes 5, 6 and 7 and use of the guide bush is not necessary.
The extension is instead required for bushes 1, 2, 3 and 4, as well as the guide bush
Position the beater precisely during the removal operation.

Replacement

Figure 140



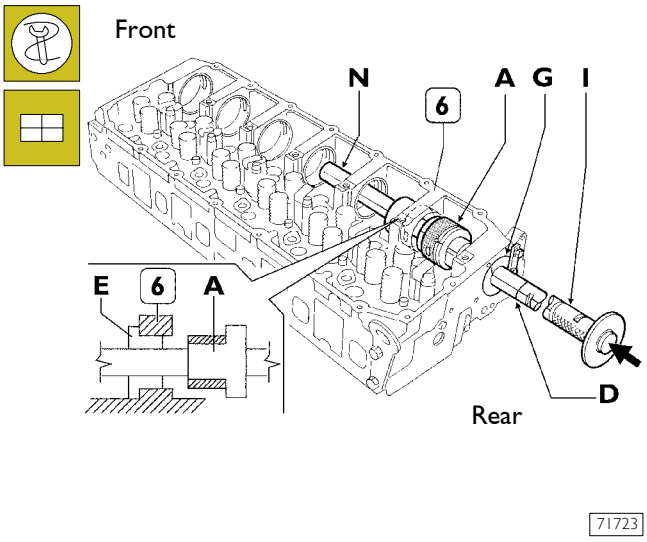
71722

Fit the beater complete with extension.
To insert bushes 1, 2, 3, 4 and 5, proceed as follows:

1. Place the bush for insertion on the beater (A) lining up the pin (B) (Figure 138) with the seat on the bush.
2. Position the guide bush (E) and fasten the guide bush (G) (Figure 138) in the seat of the 7th bush by means of plate H).
3. When inserting the bush, line up notches F and M. Doing so, when the bush is pushed in the lubrication hole on it is aligned with the oil hole in the seat.

The bush is fully inserted when the 1st yellow reference notch (D) is flush with the guide bush (G).

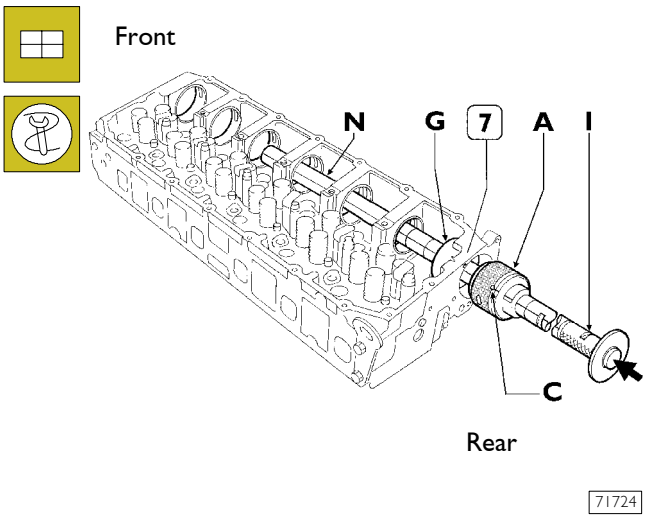
Figure 141



To insert bush 6, proceed as follows:

- ❑ remove the grip (I) and the extension (N);
- ❑ position the extension (N) and the guide bush (E) as shown in the figure;
- ❑ repeat operations 1, 2 and 3.

Figure 142

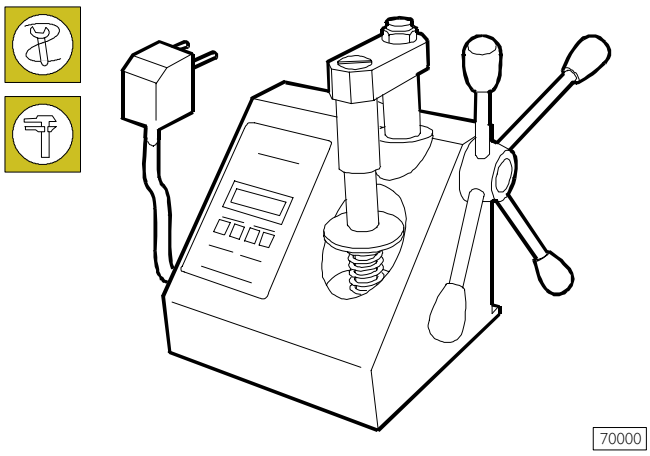


To insert bush 7, proceed as follows:

- ❑ remove the grip (I) and the guide bush (G) fastened to the head (Figure 142);
- ❑ replace the guide G from the inner side as shown in the figure.
- ❑ Position the bush on the beater (A) and bring it toward its seat making sure the hole in the bush aligns with the lubrication hole in the head. Proceed to fit.
  The 7th bush is fully inserted when the reference mark (C) is flush with the bush seat.

Valve springs

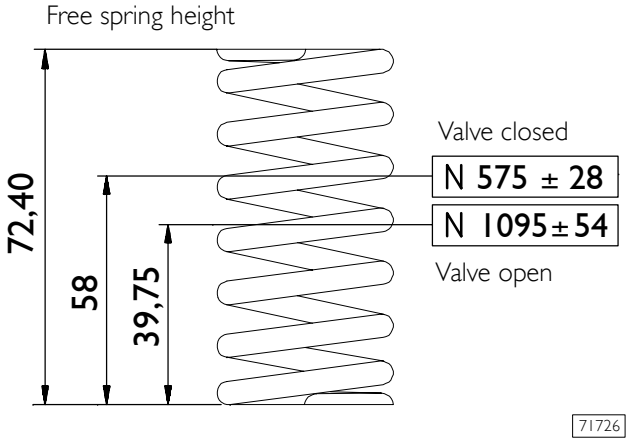
Figure 143



70000

Before installation, check valve spring flexibility using tool 99305047 and compare the loading and elastic deformation data with data referred to the new valves, shown in the following figure.

Figure 144

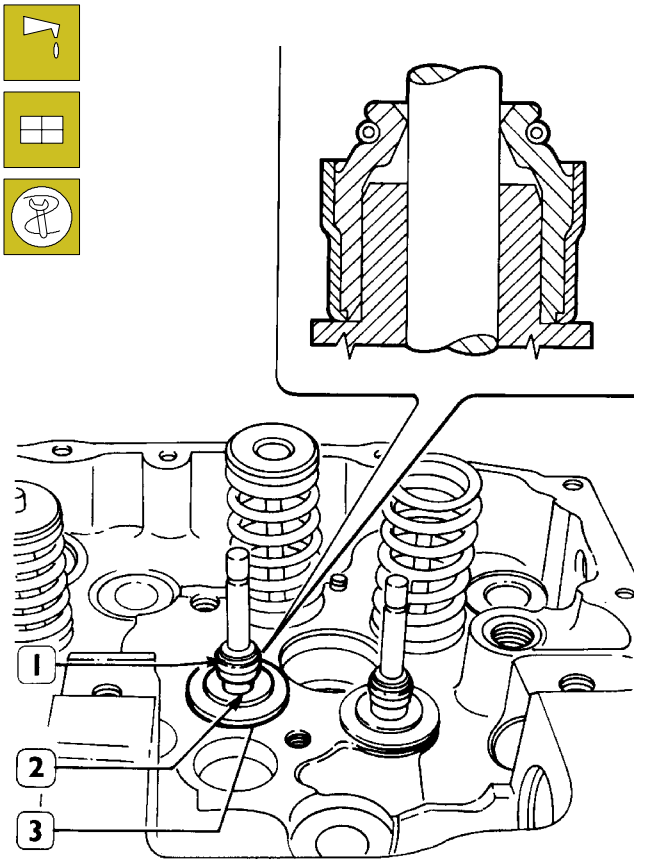


71726

MAIN DATA TO CONTROL EXHAUST AND DISCHARGE VALVE SPRING

Fitting the valves and oil seal ring

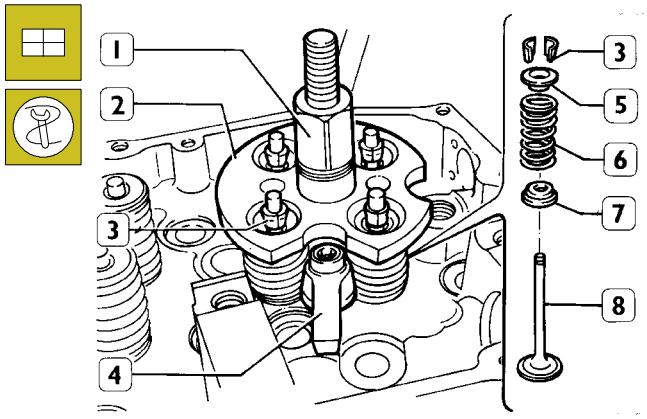
Figure 145



49033

Lubricate the valve stem and place the valves in the relevant valve guides; install the lower plates (3) using tool 99360329, fit the oil seal ring (1) on valve guides (2), then install the valves as shown:

Figure 146

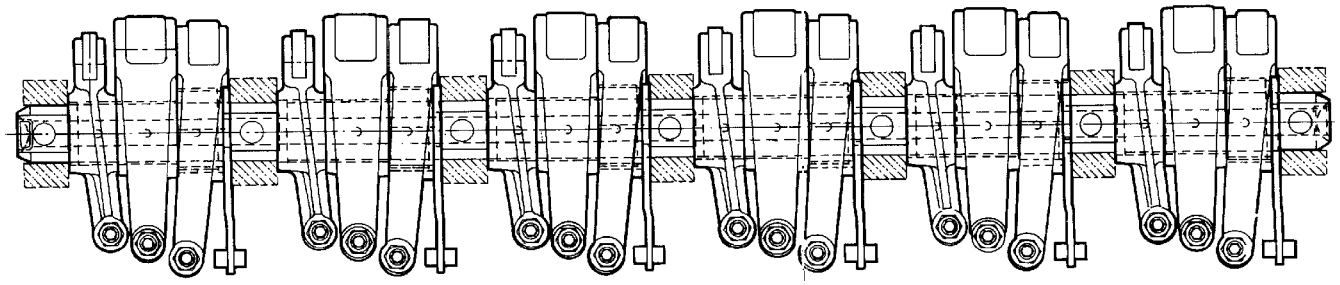


47583

- ❑ Fit springs (6) and the upper plate (5);
- ❑ apply tool 99360263 (2) and block it with bracket (4); tighten the lever (1) until cotters are installed (3), remove tool (2).

Rocker shaft

Figure 147

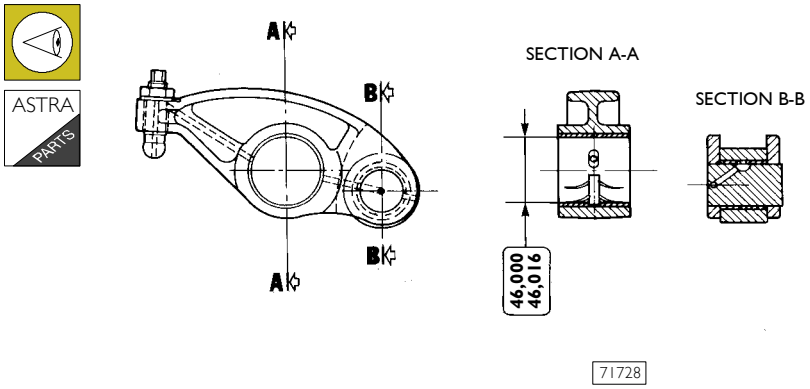


44925

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.
The length of the rocker shaft is practically the same as that of the cylinder head. It must be removed in order to remove all the components located beneath it.

ROCKERS

Figure 148

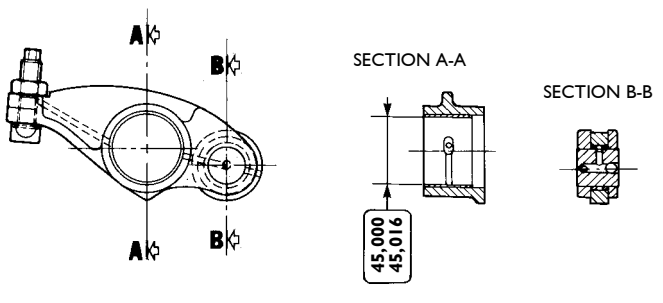


71728

PUMP INJECTOR ROCKER

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

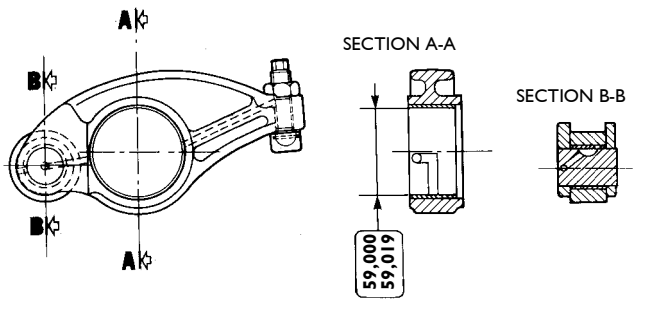
Figure 149



71729

EXHAUST VALVES ROCKER

Figure 150



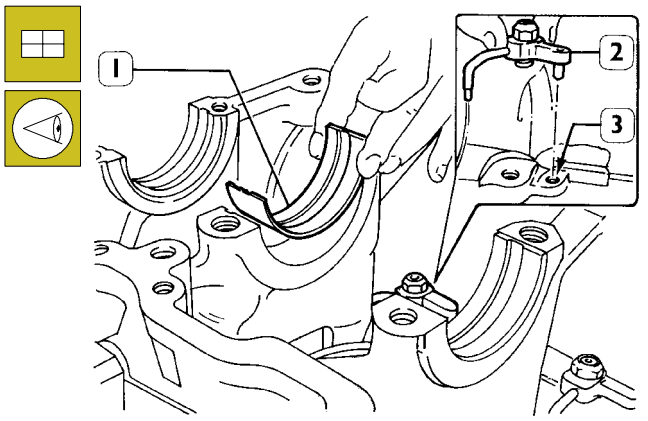
71730

DISCHARGE VALVE ROCKER

ASSEMBLING THE ENGINE ON THE BENCH

Fix the engine block to the stand 99361036 by means of brackets 99322230.
Install the cylinder liners as described in the relevant paragraph.

Figure 151

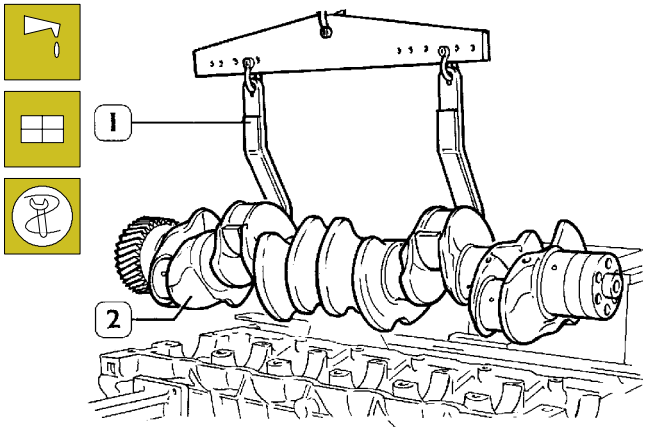


47586

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.

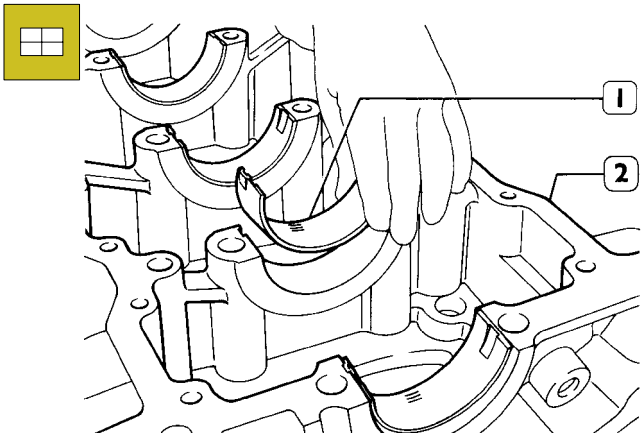
Figure 152



47570

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

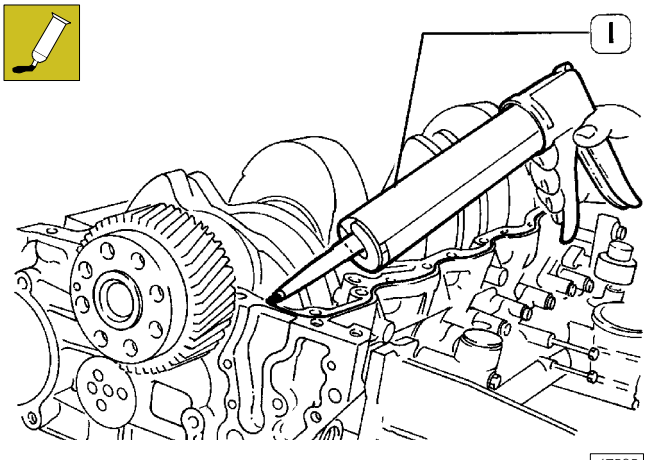
Figure 153



49021

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

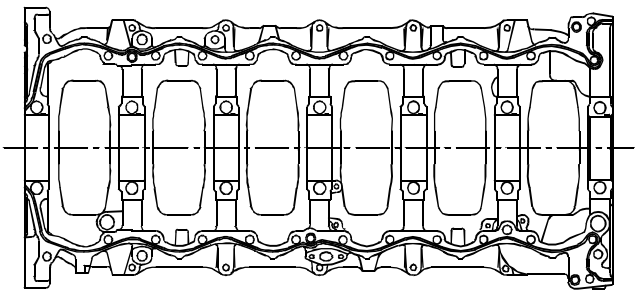
Figure 154



47595

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

Figure 155

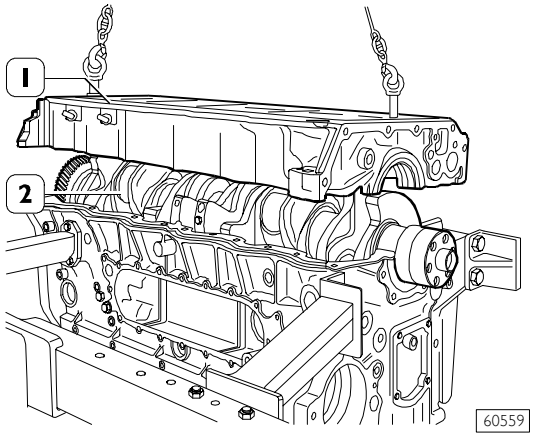


60632

Sealant application diagram

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

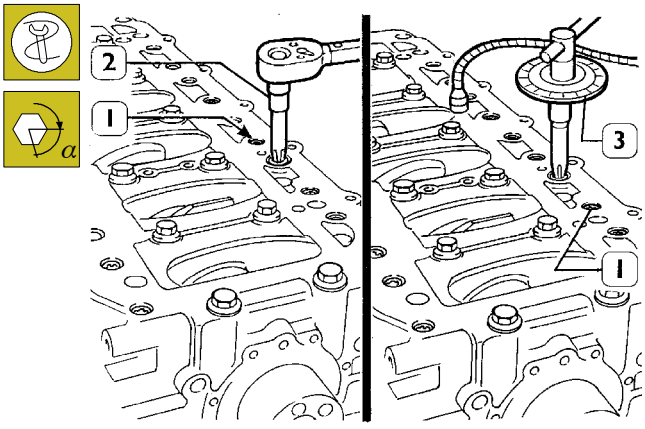
Figure 156



60559

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

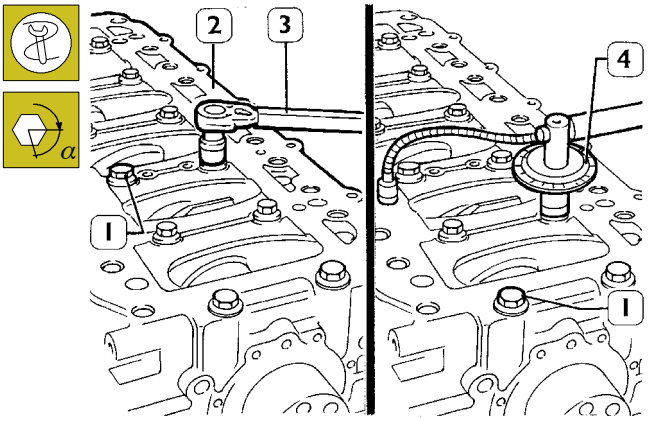
Figure 157



47581

Fit the underblock and, using a dynamometric wrench (2), close the splined outer screws (1) to 30 Nm torque, according to the diagram shown on page 83.

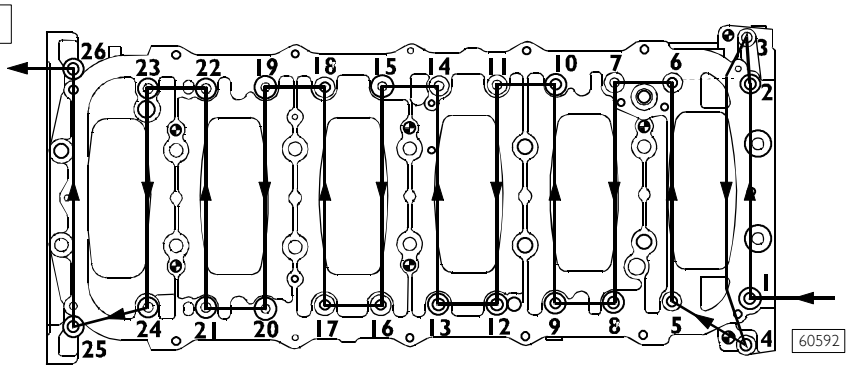
Figure 158



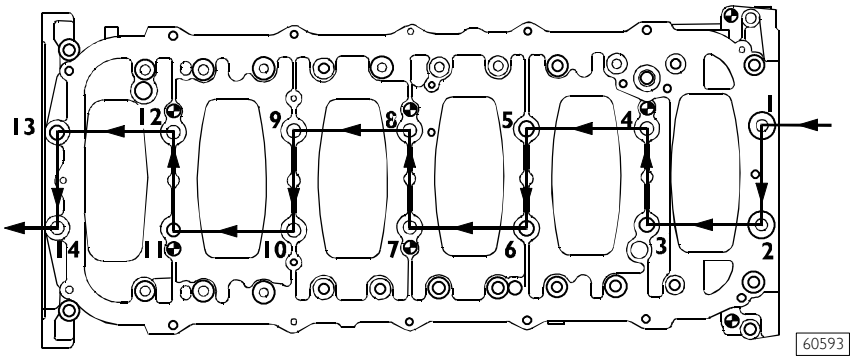
47579

Close the inner screws (1) to 120 Nm torque by means of a dynamometric wrench (3, Figure 158), then with two further angular phases 90° + 45°, using tool 99395216 (4). Tighten again the outer screws (1, Figure 157) with 60° angular closing, using tool 99395216 (3, Figure 157).

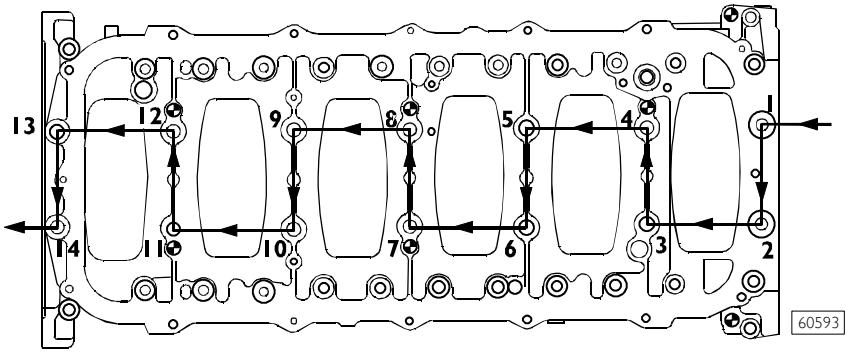
Figure 159



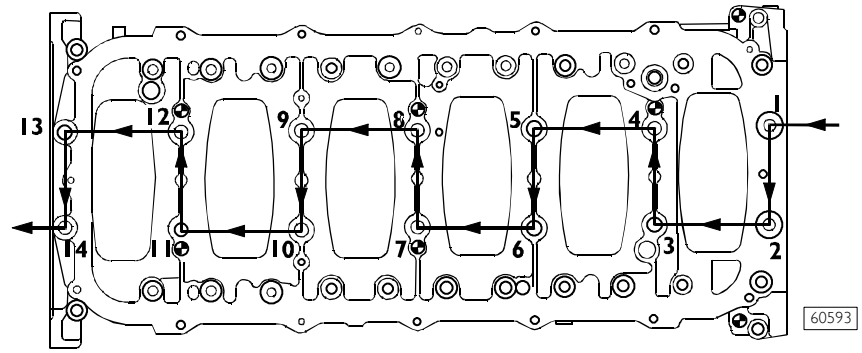
stage 1: pretightening outer screws 30 Nm)



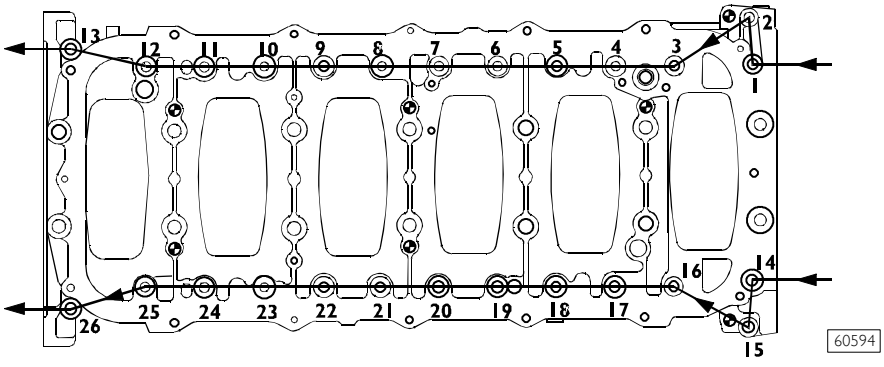
stage 2: pre-tightenig inner screws 120 Nm



stage 3: angle inner screws 60°



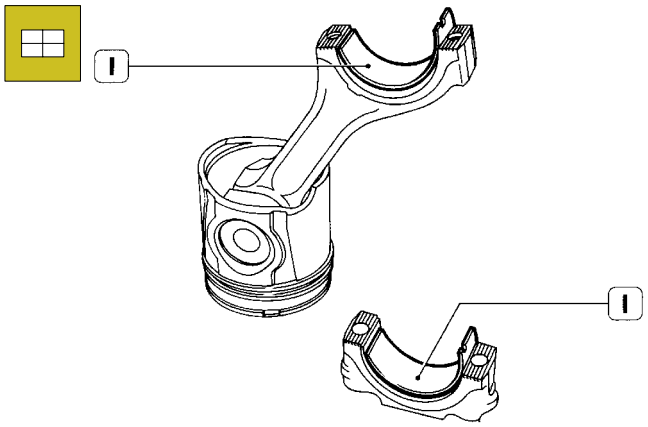
stage 4: angle inner screws 55°



stage 5: angle outer screws 60°

DIAGRAM SHOWING TIGHTENING ORDER OF UNDER-CRANKCASE SECURING SCREWS

Figure 160

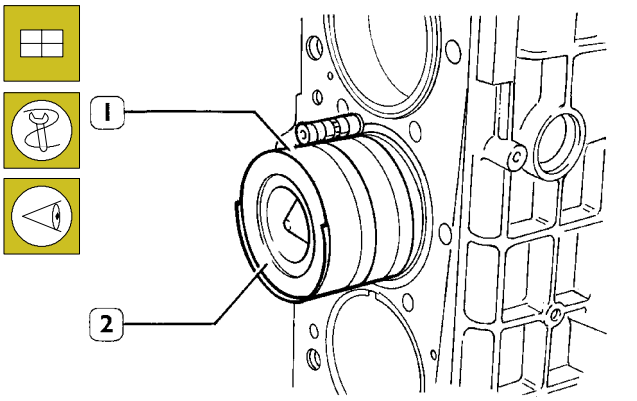


49030

Rotate the cylinder assembly placing it vertically.
Fit the half-bearings (1) on both the connecting rod and the cap.

Fitting the connecting rod-piston assembly into the cylinder liners

Figure 162

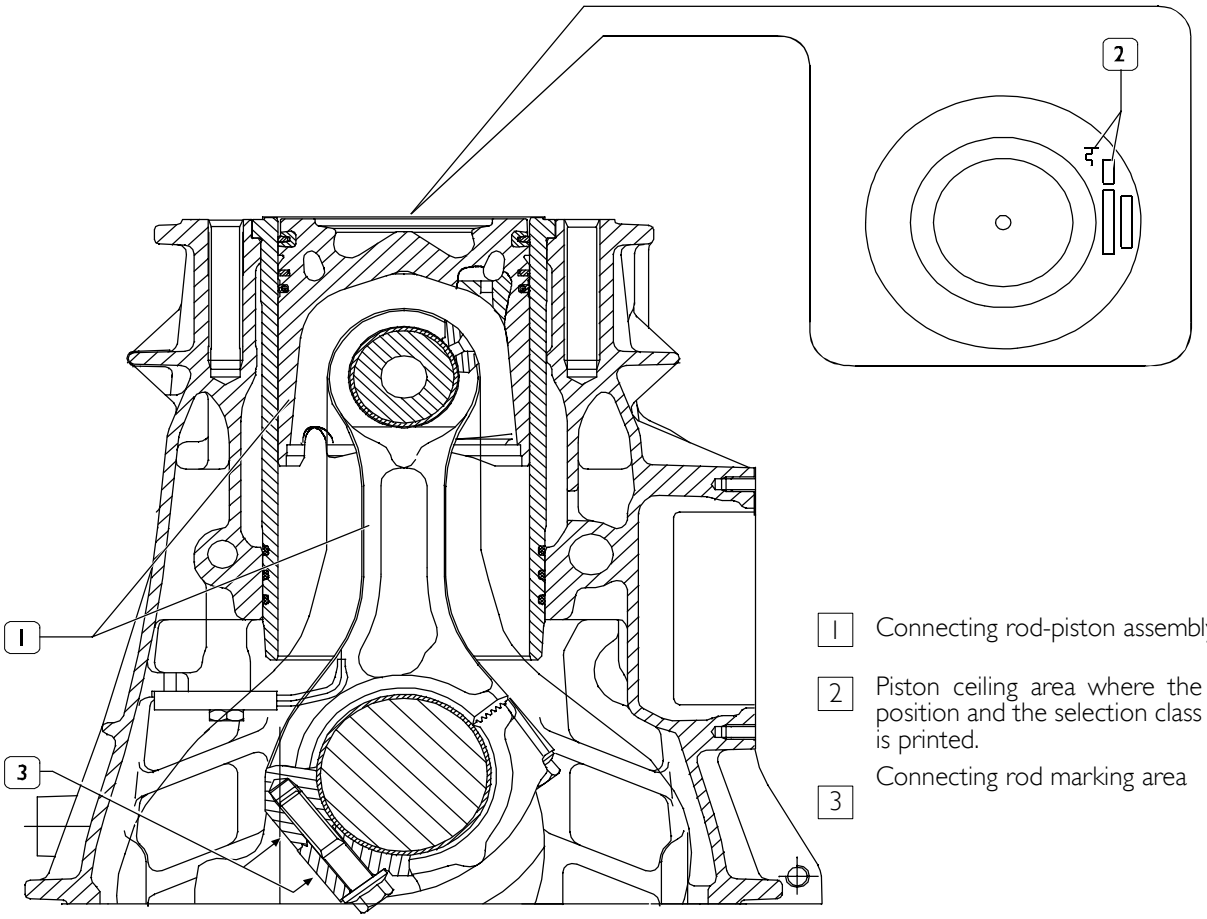


60616

Fit the connecting rod-piston assemblies (2) into the piston liners, using the band 99360605 (1). 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), 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

Figure 161



1 Connecting rod-piston assembly

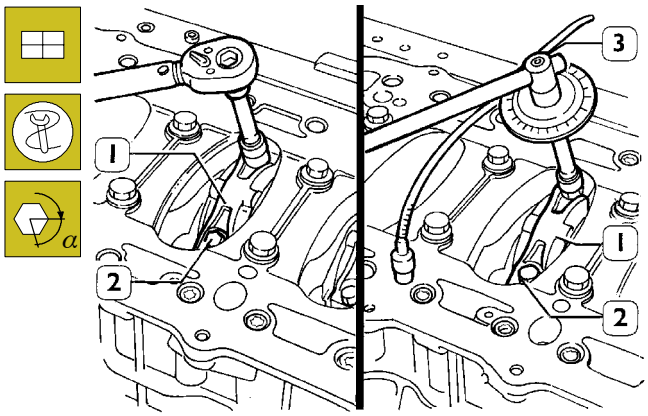
2 Piston ceiling area where the assembly position and the selection class ideogram is printed.

3 Connecting rod marking area

60615

Fitting the cylinder head

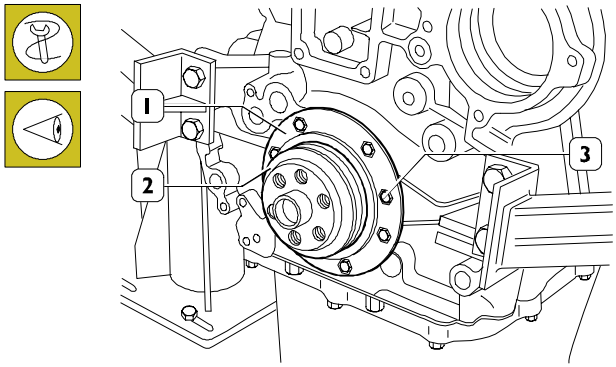
Figure 163



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 60 Nm torque (6 kgm). Using tool 99395216 (3), further tighten screws with 60° angle.

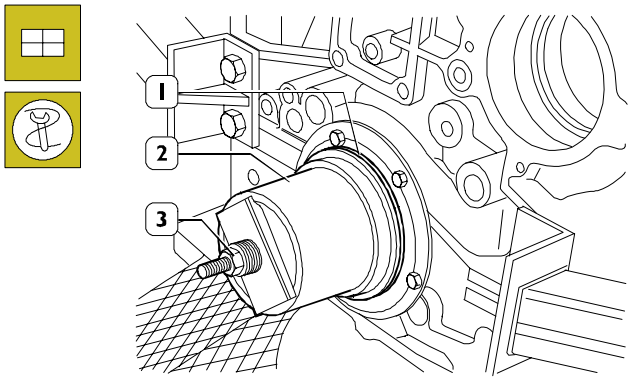
Figure 164



60563

By means of centering ring 99396035 (2), check the exact cover position (1), otherwise act as necessary and tighten the screws (3).

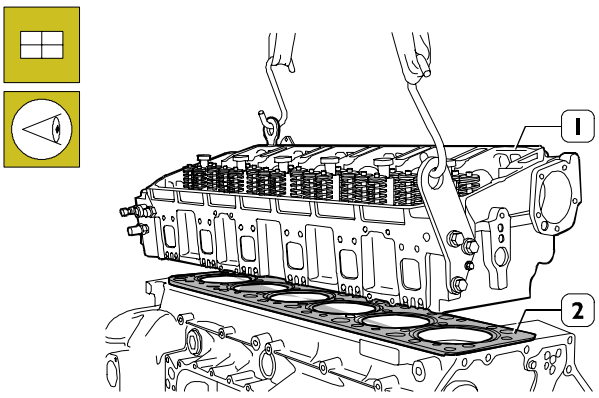
Figure 165



60564

Fit the sealing gasket (1), install the fitting tool 99346250 (2) and drive the sealing gasket (1) by screwing nut (3).

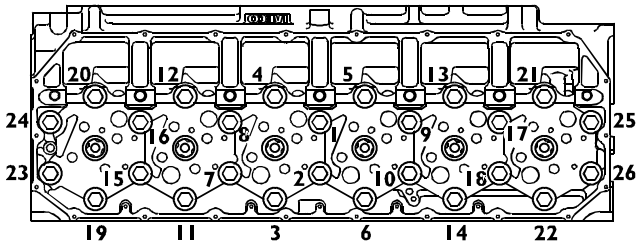
Figure 166



60515

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. 91, 92 and 93.

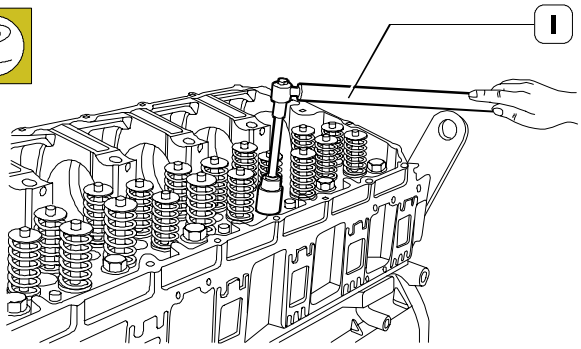
Figure 167



61270

Diagram showing the cylinder head fixing screws tightening order

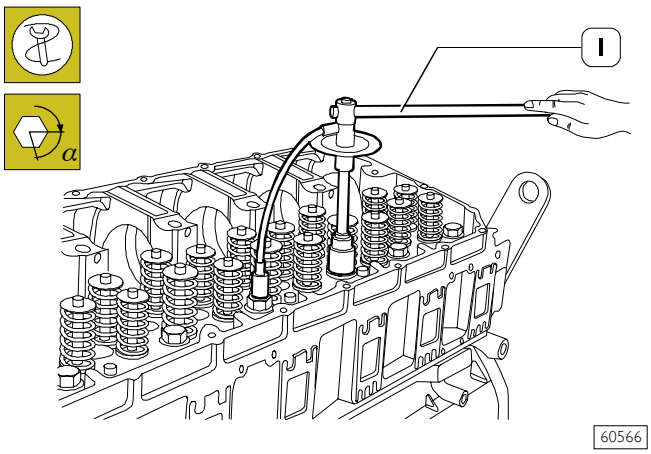
Figure 168



60565

❑ Preliminary tightening by means of a dynamometric wrench (1):
1st phase: 60 Nm (6 kgm)
2nd phase: 120 Nm (12 kgm);

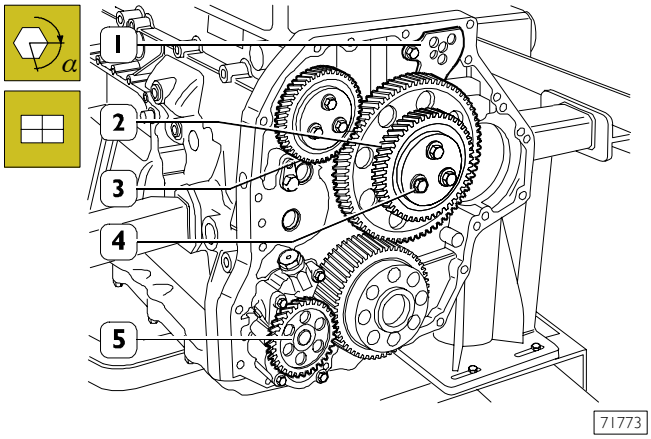
Figure 169



60566

❑ Angular tightening using tool 99395216 (1);
3rd phase: 90° angle
4th phase: 45° angle for screws 4, 5, 12, 13, 20, 21
5th phase: 65° angle for screws 1, 2, 3, 6, 7, 8, 9, 10, 11.

Figure 170

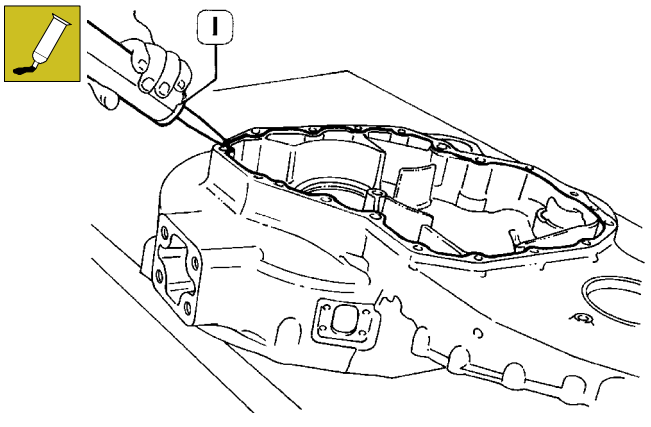


71773

Fit the oil pump (5), intermediate cogs (2) complete with P.T.O tie-rod (1) and drive cog (3)
Tighten the screws (4) to the specified torque.

Replacing flywheel casing

Figure 171

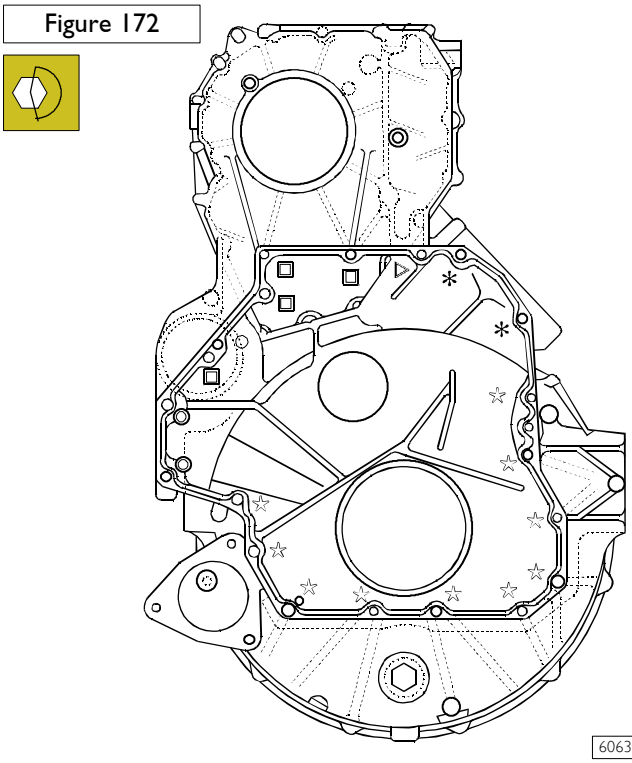


47592

Apply (as shown in the figure) sealant LOCTITE 5699 to the gear box using the proper equipment (1).

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

Figure 172

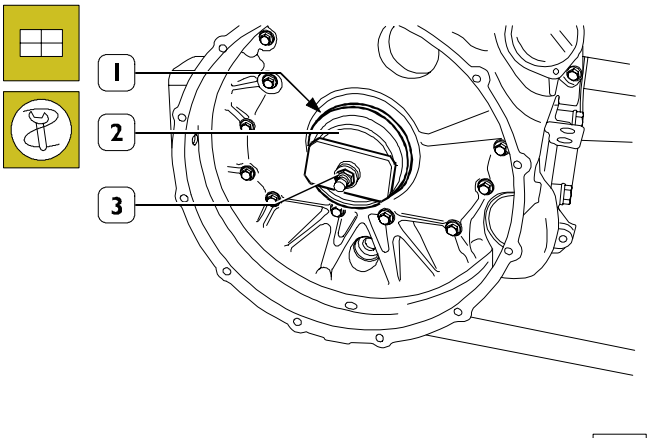


60633

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

✡	no. 10 M12 x 1.75 x 100	56 to 70 Nm
◎	no. 2 M12 x 1.75 x 70	56 to 70 Nm
□	no. 4 M12 x 1.75 x 35	56 to 70 Nm
△	no. 1 M12 x 1.75 x 120	56 to 70 Nm
✳	no. 2 M12 x 1.75 x 193	56 to 70 Nm

Figure 173

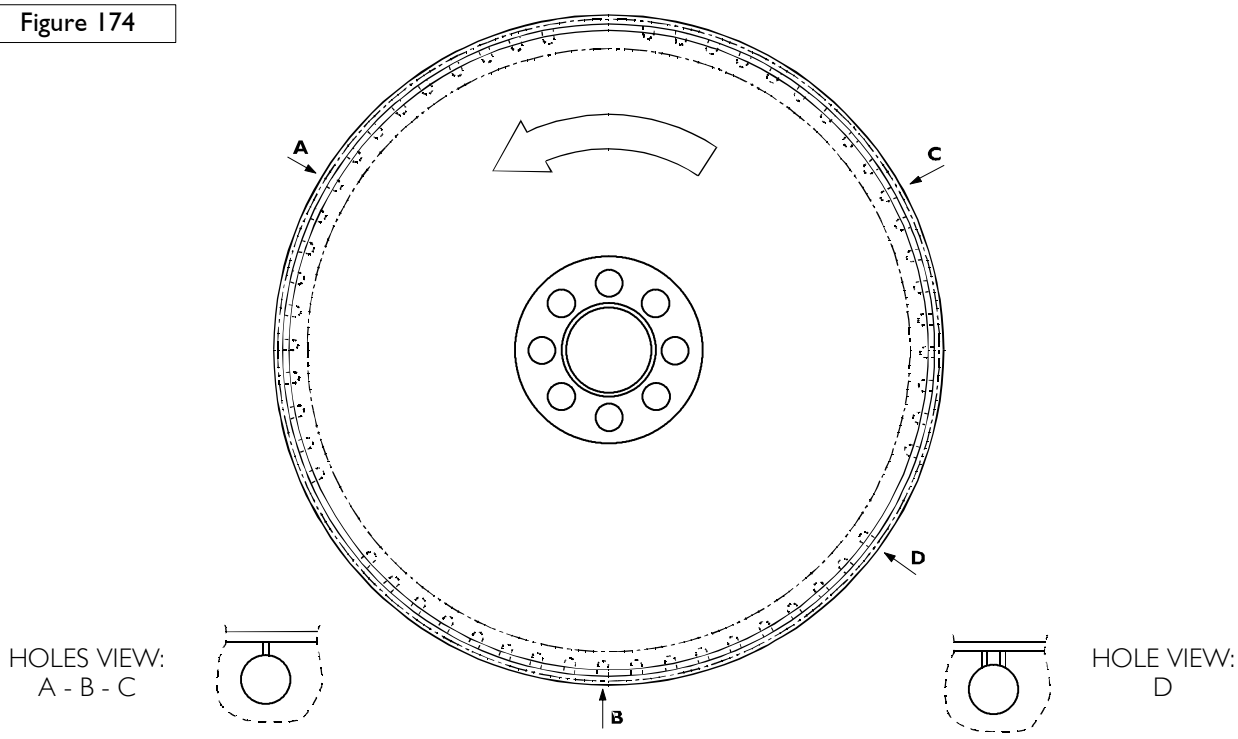


60568

Fit the sealing gasket (1), install the fitting tool 99346251 (2) and drive the sealing gasket by screwing the nut (3).

Replacing engine flywheel

Figure 174



DETAIL OF PISTON POSITION MARKS ON ENGINE FLYWHEEL

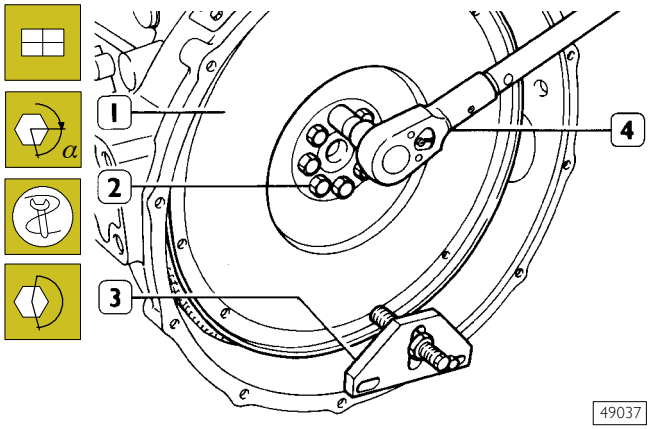
A = Hole on the flywheel with 1 notch, corresponding to TDC of pistons 3-4.

B = Hole on the flywheel with 1 notch, corresponding to TDC of pistons 1-6.

C = Hole on the flywheel with 1 notch, corresponding to TDC of pistons 2-5

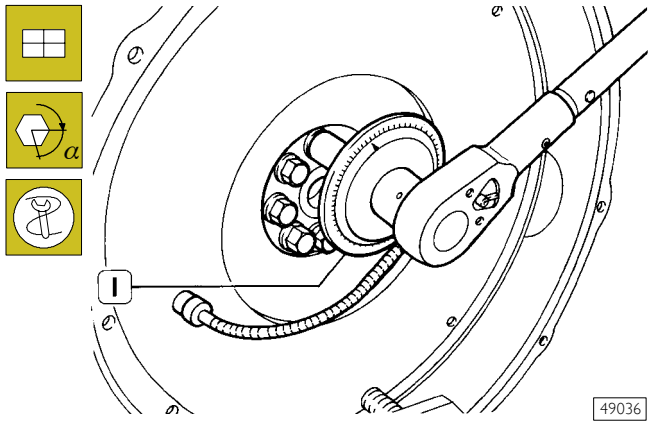
D = Hole on the flywheel with 2 notches, corresponding to 54°.

Figure 175



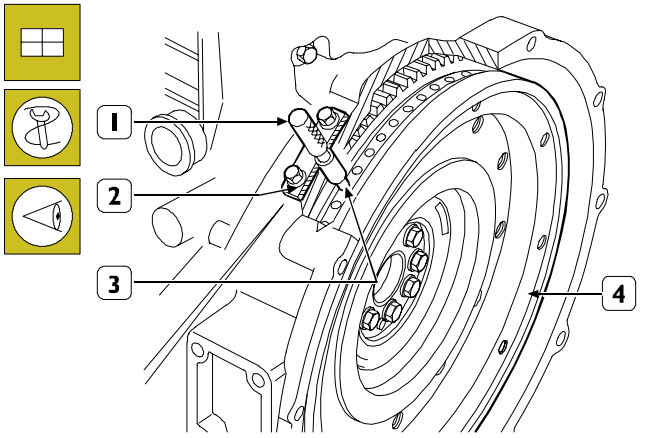
Stop rotation using the tool 99360351 (3); tighten the screws (2) in three phases.
First phase: pre-torque at a 120 Nm (12 kgm) torque using a torque wrench (4).

Figure 176



Second and third phase: tighten at a 60° + 30° angle using the tool 99395216 (1).

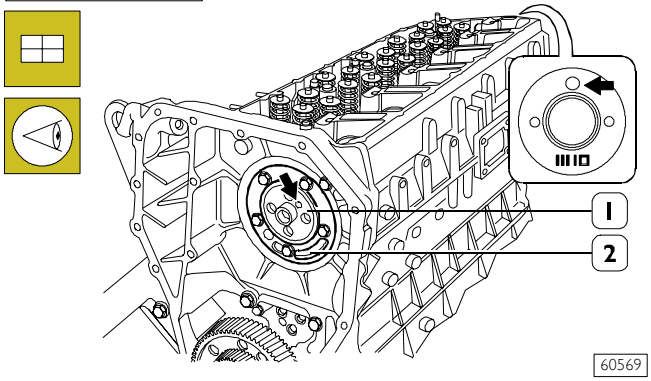
Figure 177



Position the crankshaft with pistons 1 and 6 at top dead centre (TDC).
At this position check when it is possible to see a notch and hole through the inspection hole located on the lower part of the flywheel casing, and fit pin 99360612 (1) into it (Figure 177).
If this situation does not occur, turn the engine slightly until it does.

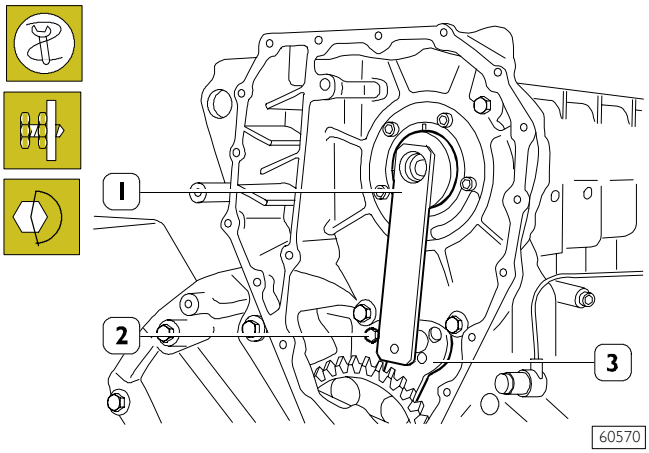
Replacing camshaft, valves and injectors

Figure 178



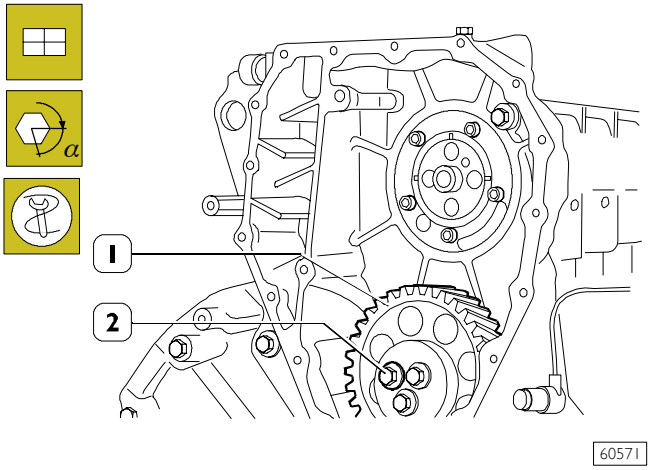
❑ Replace:
- the camshaft (1) positioning it according to the references ( ) as shown in Figure 178.
  This operation simplifies subsequent camshaft timing
- The shoulder plate (2) with metal gasket.

Figure 179



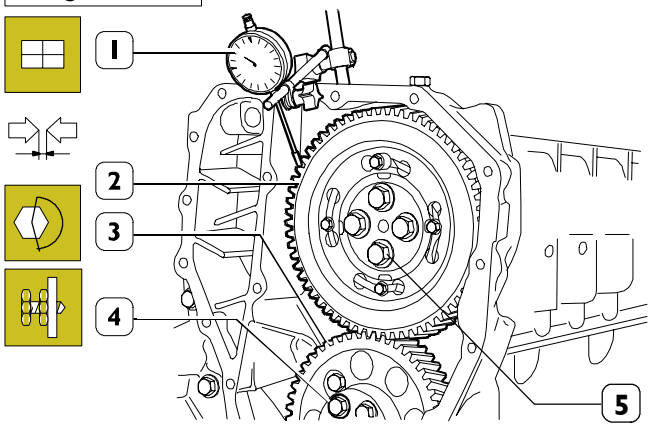
❑ Fit the gauge 99395219 (1) and check and adjust the transmission gear connecting rod (3), tighten the screw (2) at the prescribed torque.

Figure 180



❑ Refit the motion transmission gear (1) and secure the screws (2) to tightening torque 30 ± 3 Nm and then close at an angle of 90° with tool 99395216.

Figure 181

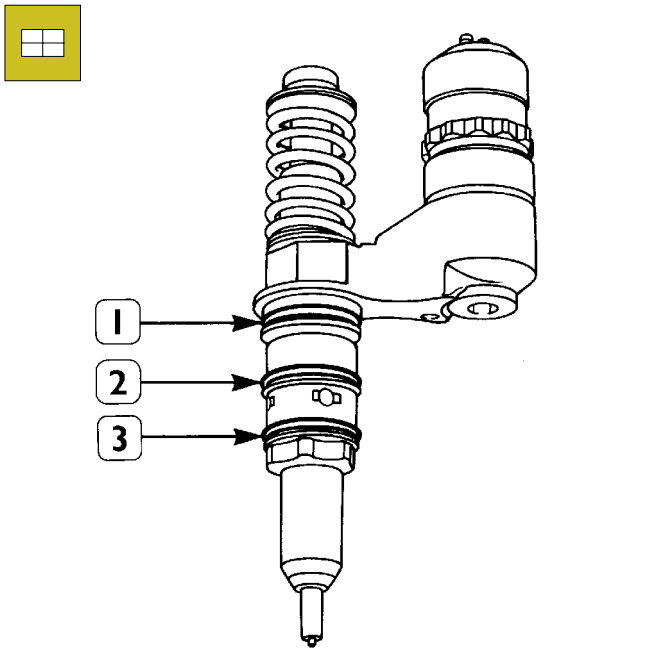


60572

Fit back the gear (2), without fully tightening screws (5) on the camshaft and place it so that the 4 oval holes are centered with respect to the camshaft fixing holes. Using a magnetic gauge (1), make sure that the gear (2 and 3) clearance is 0.073 to 0.195 mm, otherwise adjust the clearance as follows:

untighten screws (4) fixing transmission gear (3);
untighten screws (2, Figure 183) fixing the rod, move the rod (3, Figure 183) to obtain the required clearance;
Tighten the rod fixing screw (2, Figure 183) as well as the screws (4, NO TAG) fixing the gear to the prescribed torque.

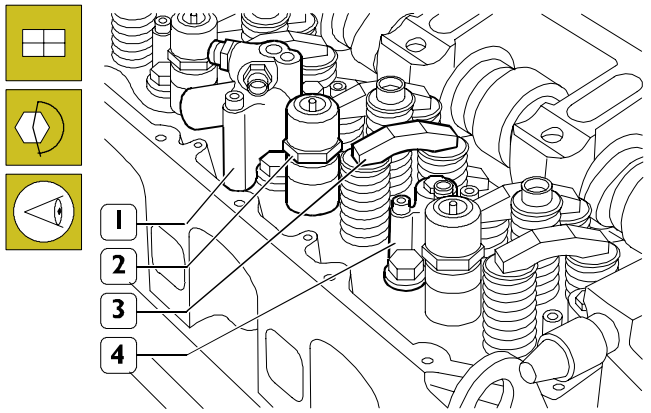
Figure 182



44908

Fit the sealing rings (1) (2) (3) on injectors.

Figure 183



71775

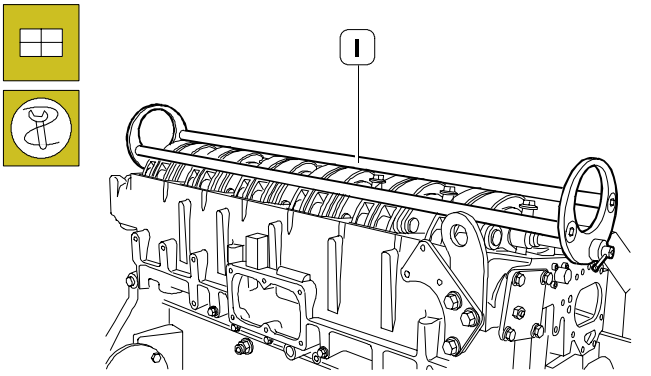
Fit:

- ❑ the injectors (2) and tighten the bracket screws to 26 Nm using a torque wrench.
- ❑ The engine brake cylinders (1) and (4), tightening to toque of 19 Nm using a torque wrench.
- ❑ The valve bridge bars (4) with the larger hole on the same side

Replacing rocker shaft assembly

Figure 184

Before fitting back the rocker shaft assembly, make sure that all the adjusting screws have been completely unscrewed.

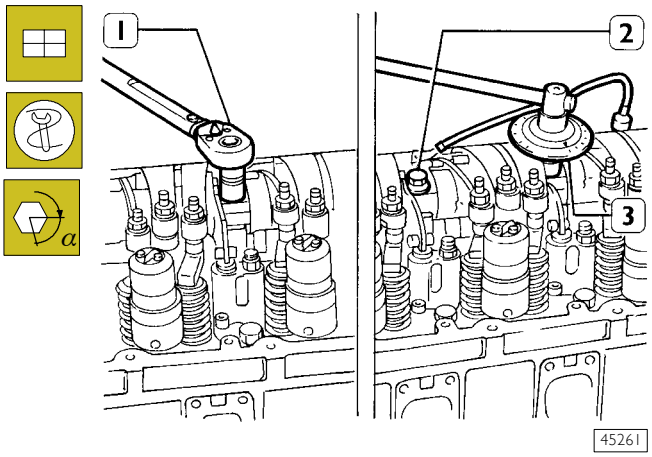


60512

Apply tool 99360553 (1) and remove the rocker shaft assembly.

Timing the camshaft

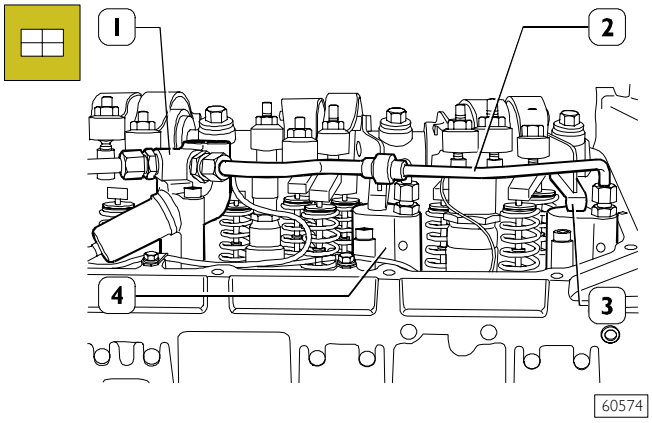
Figure 185



Tighten the screws (2) fixing the rocker shaft as follows:

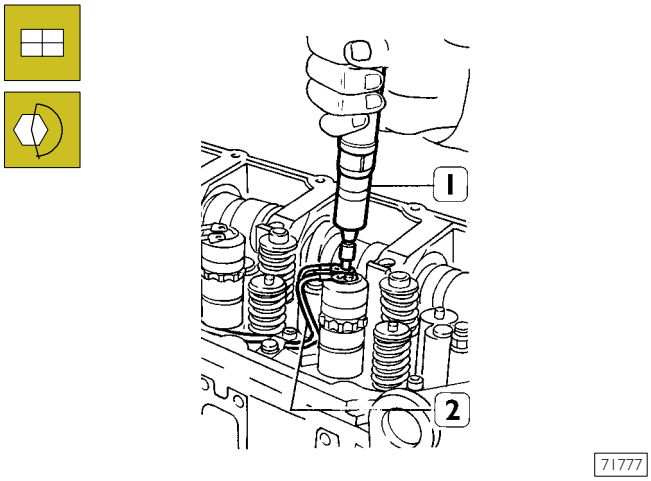
- ❑ 1st phase: tightening with a dynamometric wrench (1) to 100 Nm torque (10 kgm)
- ❑ 2nd phase: closing by means of tool 99395216 (3), with 60° angle.

Figure 186



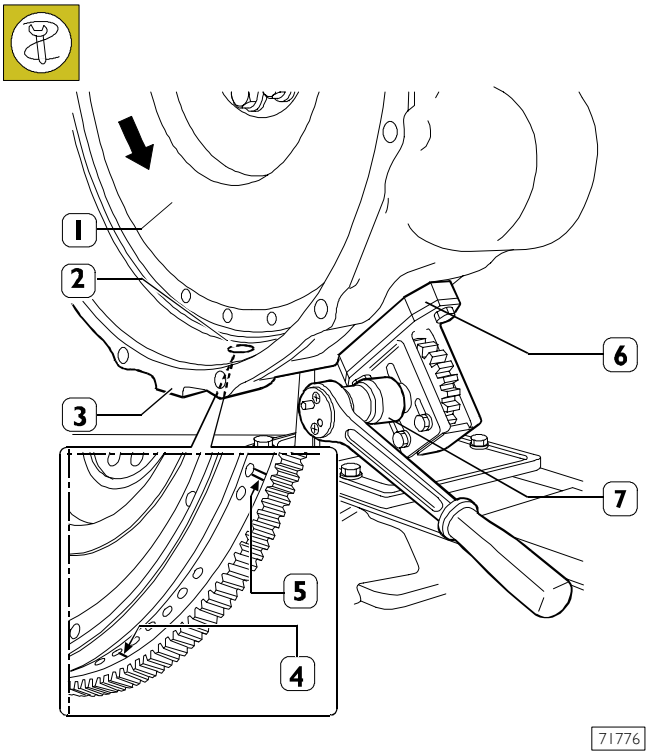
- ❑ Assemble exhaust brake lever check springs (3)
- ❑ Connect piping (2) to the exhaust brake pins (4) and to the slave cylinder (1)

Figure 187



Fit the wires fastening them to the injectors using a torque screwdriver (1) to a torque of 1.36 - 1.92 Nm.

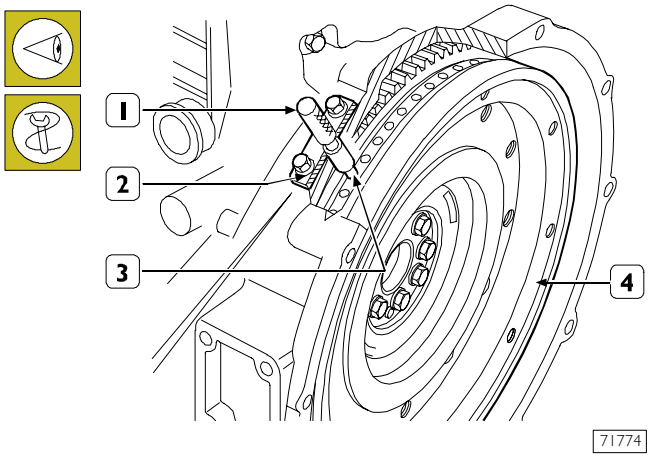
Figure 188



Apply tool 99360321 (7) and shim 99360325 (6) to the gearbox.

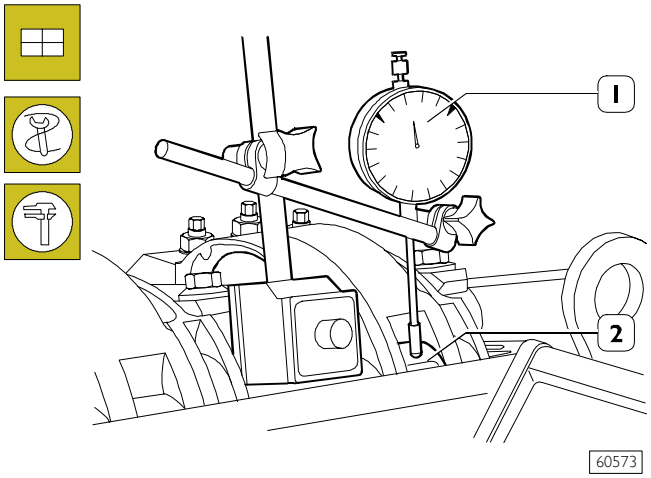
The arrow indicates engine rotation direction.
With the above tool, turn the flywheel (1) in the engine direction such that it brings piston 1 approximately to TDC on the firing stroke.
This condition is realised when the hole with a notch (4) following the hole with two notches (5) present on the flywheel (1), appears in the inspection hole (2).

Figure 189



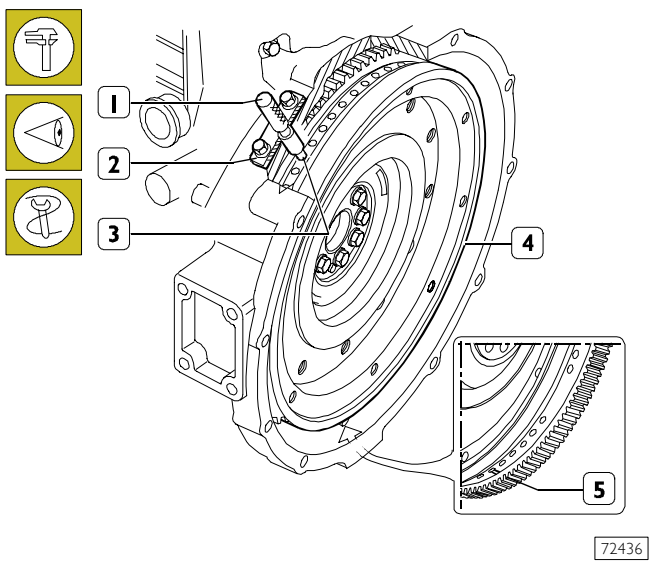
The exact position of piston 1 at TDC is achieved in the previously described position, when tool 99360612 (1) fits into the hole (3) on the flywheel (4) through the engine revs sensor seat (2).

Figure 190



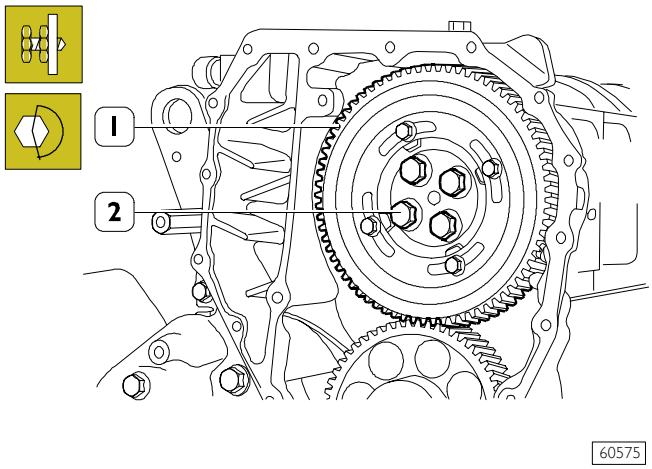
Position the magnetic dial gauge (1) with the stem on the roller (2) of the rocker controlling the injector of cylinder 1, and pre-load it 6 mm.
Using tool 99350321 (7) Figure 188, turn the crankshaft clockwise until the pointer on the gauge reaches the minimum value beyond which it cannot go.
Reset the dial gauge.
Turn the flywheel anti-clockwise until the gauge reads a lift value of 5.31 ±0.05 mm for the camshaft cam .

Figure 191



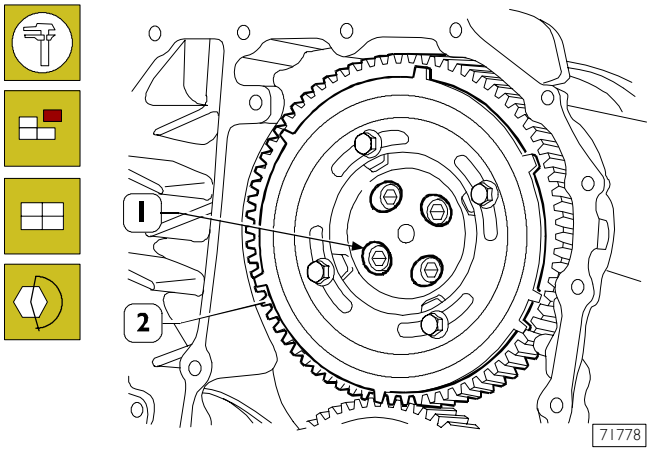
The camshaft is timed if the following conditions are present when the cam lift values are 5.31 ± 0.05 mm:
1) the hole marked with double notch (5) can be seen through the inspection window;
2) tool 99360612 (1) can be inserted into hole (3) on the engine flywheel (4) through the seat (2) of the engine rpm sensor.

Figure 192



If the conditions illustrated in Figure 191 and specified in points 1 and 2 above do not exist, proceed as follows:
Loosen the screws (2) securing gear (1) to the camshaft and use the slots (1) on the gear.
Move the engine flywheel to obtain the conditions described in points 1 and 2, Figure 191, while keeping the cam lift value the same.
Lock the screws (2) and repeat the check already described.
Tighten the screws (2) to the specified torque.

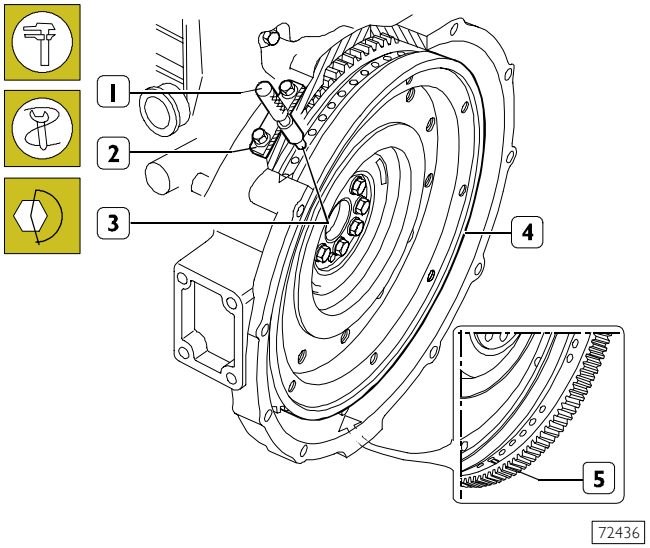
Figure 193



When adjustment in the slots (1) is not sufficient to recover timing offset and the camshaft rotates tight with the gear (2), to consequently vary the cam lift reference value, proceed as follows:

- ❑ Check that the screws (2, Figure 192) are tight.
- ❑ Rotate the flywheel by ca. ½ a turn clockwise.
- ❑ Rotate the flywheel anticlockwise until a cam lift value of 5.31 ± 0.05 mm can be read on the comparator.
- ❑ Remove the screws (2, Figure 192) and remove the gear (2) from the camshaft.

Figure 194



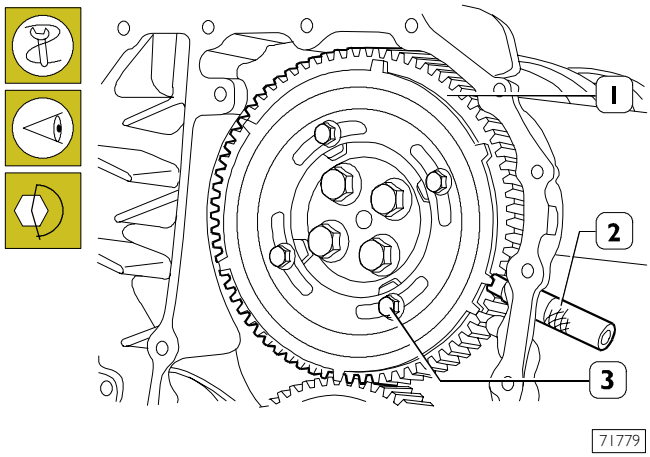
Rotate the flywheel again to bring it into the following conditions:

- ❑ Double notch (5) visible through lower inspection hole.
- ❑ Tool 99360612 (1) fitted flush into the engine revs sensor seat (2) and (3).

Fit the gear (2) Figure 193, with the 4 slotted holes centred with respect to the threaded holes in the camshaft tightening the screws to the specified torque.
Check the timing of the camshaft by first rotating the flywheel clockwise to fully drop the cam and then turning it anticlockwise until the comparator read 5.31 ± 0.05.
Check the timing conditions described in Figure 191.

Timing the phonic wheel

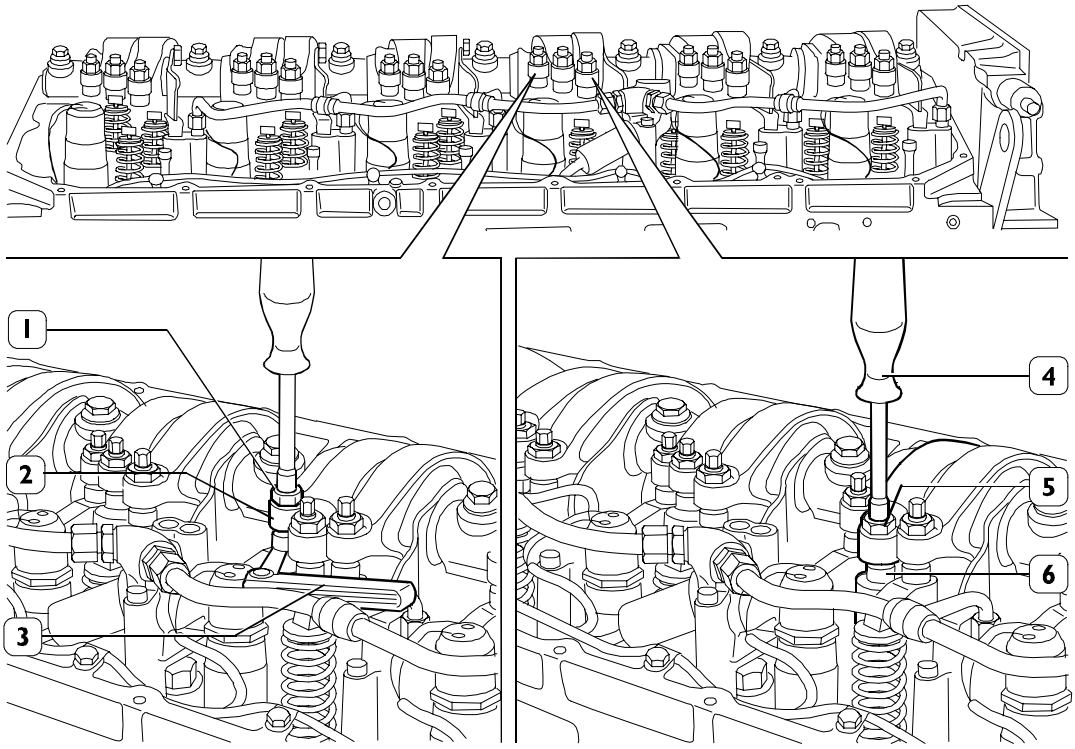
Figure 195



With the engine in timed conditions, check that pin 99360613 (2) positions itself on the marked tooth on the phonic wheel (1). If not, loosen the screws (3) and suitably orient the phonic wheel (1).
Tighten the screws (3) to the specified torque.

Adjusting the unload/intake rockers play and pump injector control rockers preload

Figure 196



ADJUSTMENT OF INTAKE, EXHAUST AND INJECTION ROCKERS

The adjustment of clearance between the rockers and rods controlling the intake and exhaust valves, as well as the adjustment of pre-loading of the rockers controlling pump injectors, must be carried out carefully.

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.

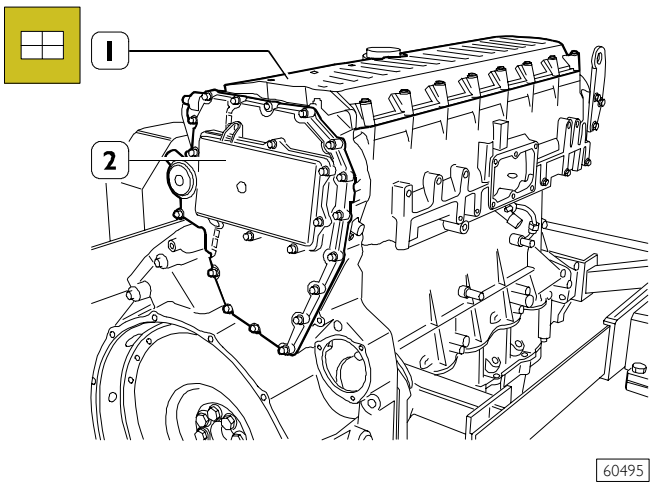
FIRING ORDER **1-4-2-6-3-5**

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 TDC	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.

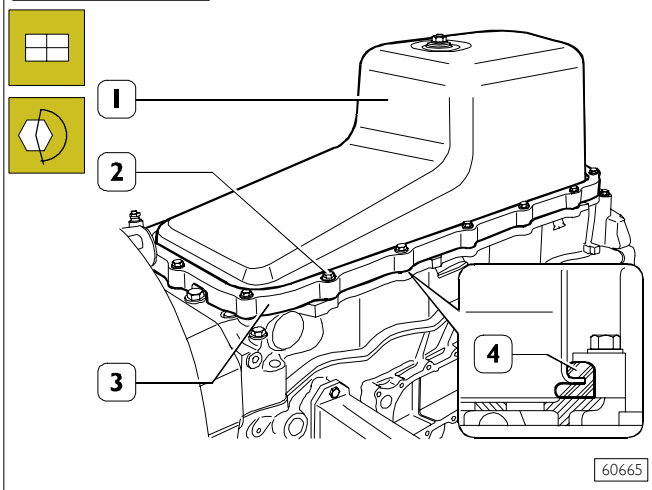
COMPLETING ENGINE ASSEMBLY

Figure 197



❑ Assemble the rocker cover (1) and the timing gear cover (2)

Figure 198



❑ Fit the gasket (4) on the oil sump, position the spacer (3) and assemble the oil sump on the engine block tightening the screws (2) at the prescribed torque.

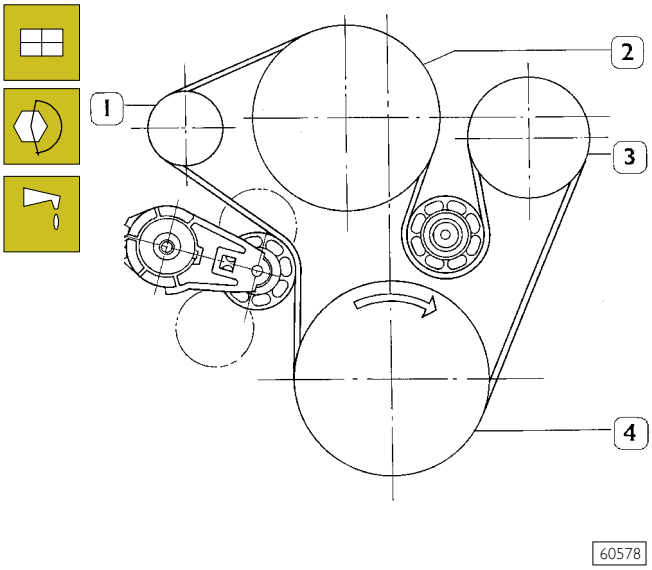
Complete the engine assembly by assembling or connecting the following components:

❑ thermostat unit

❑ automatic belt tightener, water pump, alternator;

❑ control belt.

Figure 199



FAN - WATER PUMP - ALTERNATOR CONTROL BELT ASSEMBLY DIAGRAM
1. Alternator - 2. Fan - 3. Water pump - 4. Crankshaft

❑ damping flywheel;

❑ fan;

❑ starter;

❑ fuel pump;

❑ power steering system tank;

❑ fuel filter and line;

❑ pre-heating resistance;

❑ suction manifold;

❑ heat exchanger

❑ oil filter, lubricating gaskets;

❑ exhaust manifold;

❑ turbocharger and relevant water and oil lines;

❑ Power take off (P.T.O) and respective piping.

Turbocharger cooling water and lube oil piping unions must be tighten at a torque of:

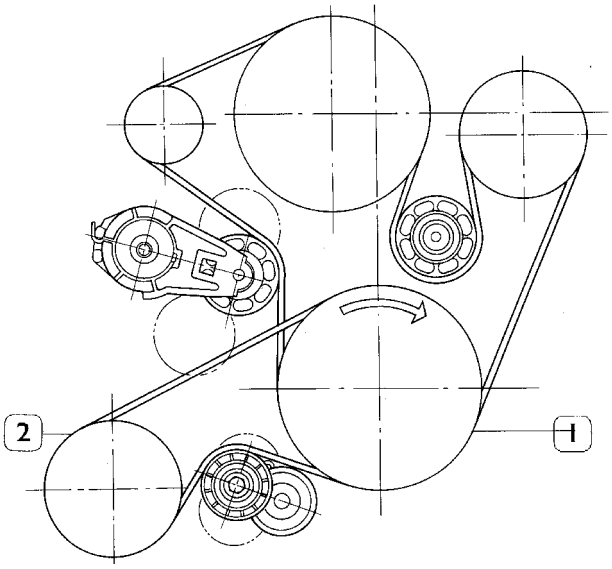
- ❑ 35 ± 5 Nm, water pipe unions;
- ❑ 55 ± 5 Nm, oil pipe female union;
- ❑ 20-25 Nm, oil pipe male union.

- ❑ Oil dipstick
- ❑ Electrical connections and dipstick
- ❑ Fill engine with specified quantity of oil
- ❑ Remove engine from rotary bench and remove engine mounting brackets (99361036)

Fit:

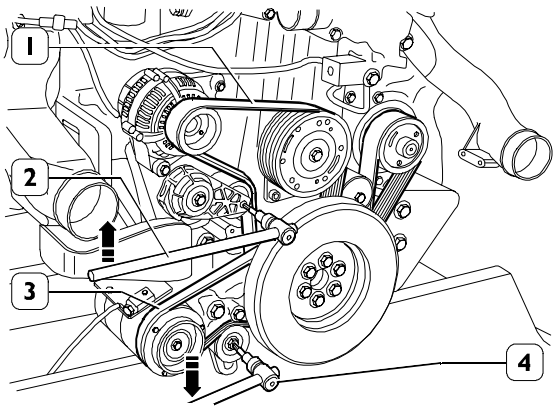
- ❑ Air conditioner automatic belt tensioner
- ❑ Drive belt

Figure 200



COMPRESSOR CONTROL BELT ASSEMBLY DIAGRAM
1. Crankshaft - 2. Air conditioner compressor

Figure 201

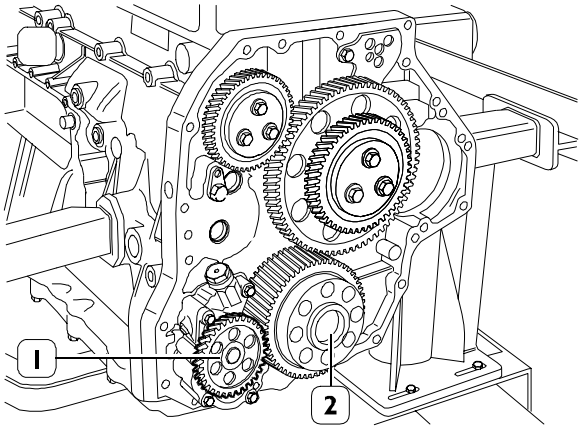


When assembling the belts (1-3) operate on the belt tighteners using fit tools (2-4), acting in the direction shown by the arrows.

Belt tighteners are automatic and do not need further adjustment after assembly.

LUBRICATION

Figure 202



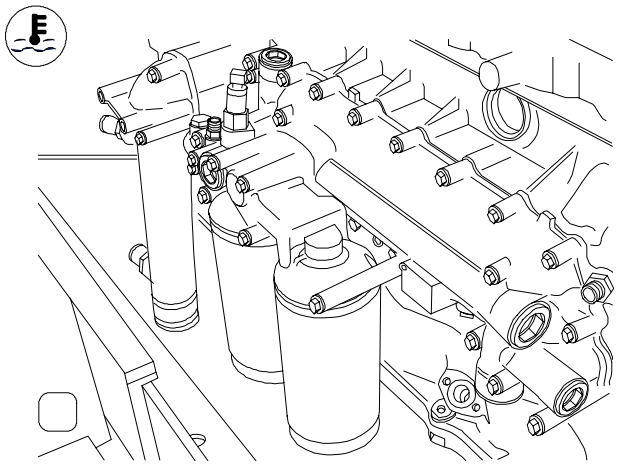
71578

The forced-circulation lubrication is obtained by means of gear pump (1).

The pump is driven via the cog (1) by the crankshaft (2).

A heat exchanger and the oil filter are installed on the lubrication system.

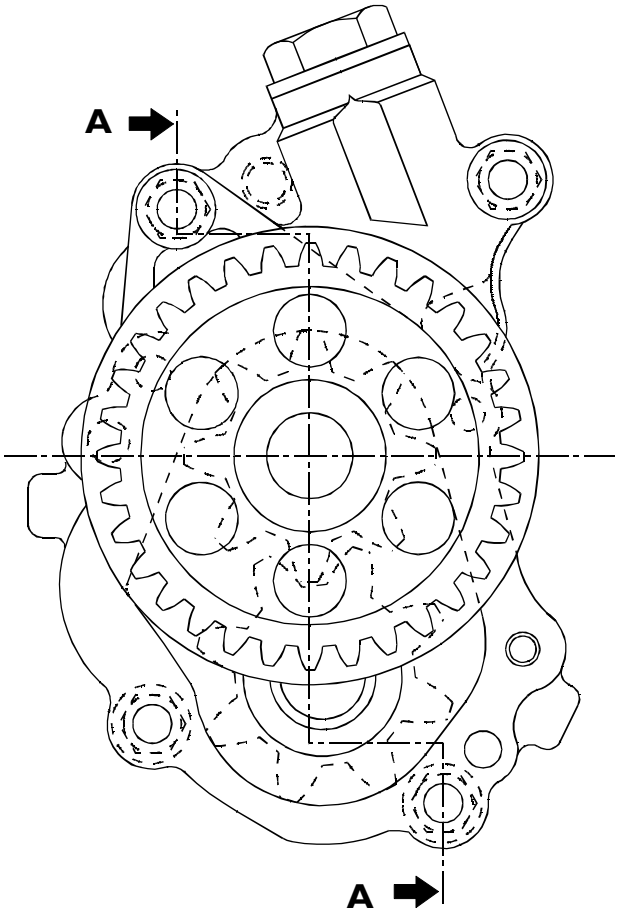
Figure 203



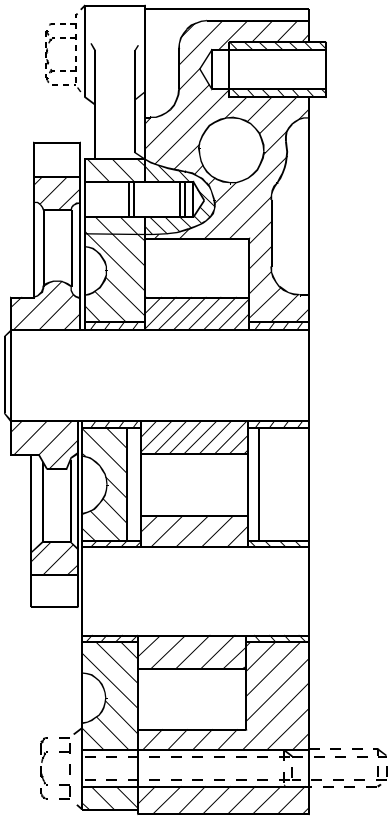
60651

The heat exchanger houses the by-pass valve with opening pressure at 3 bar and the thermostatic valve that cuts-in when temperature exceeds 82.5°C.

Figure 204



SECTION B-B

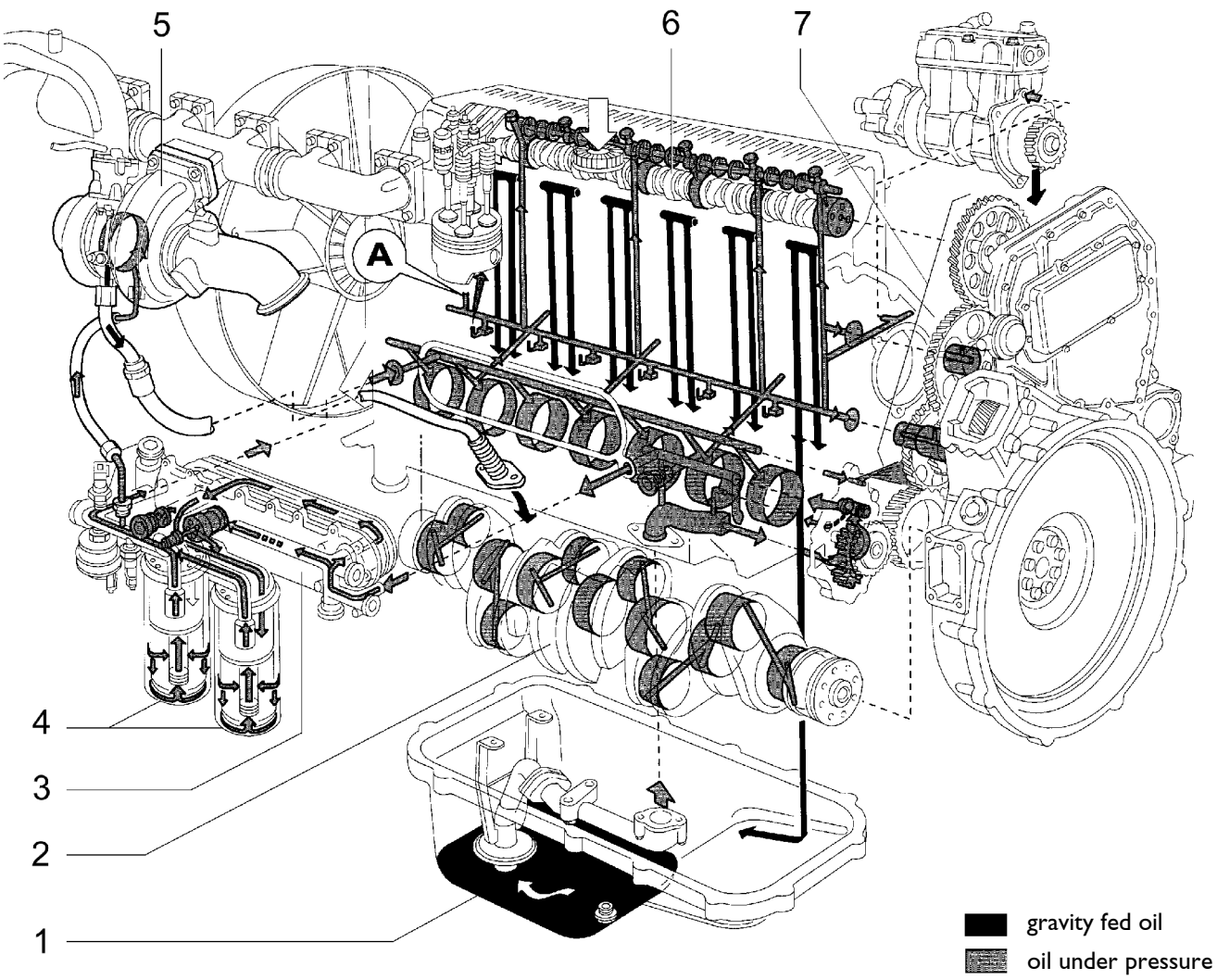


OIL PUMP SECTION

60628

Lubrication system outline

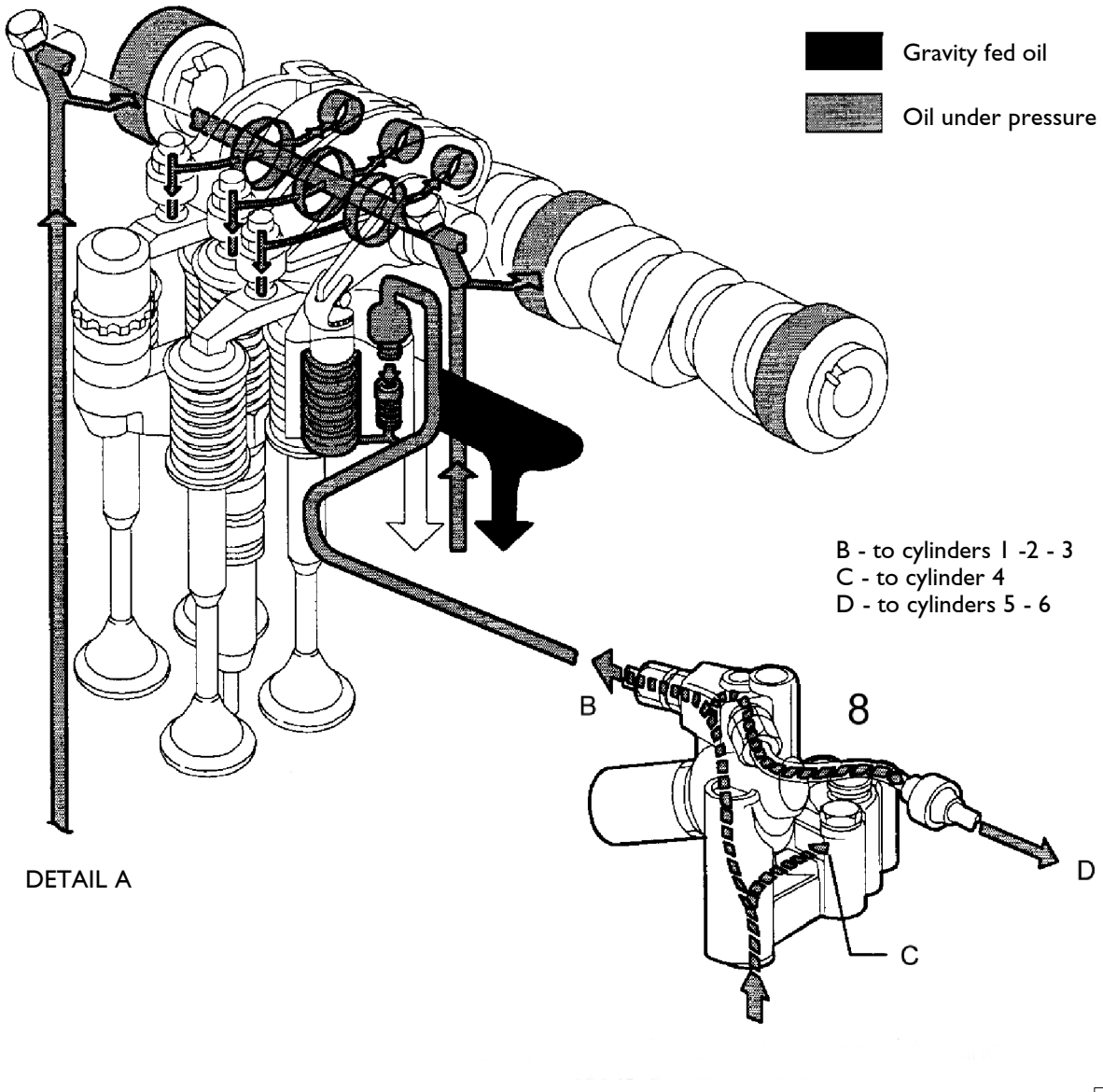
Figure 205



1. Oil sump. - 2. Crankshaft. - 3. Engine oil-water heat exchanger. - 4. Engine oil filter. - 5. Turbocompressor. - 6. Camshaft. - 7. Valve timing gears.

Lubrication system outline - Detail A

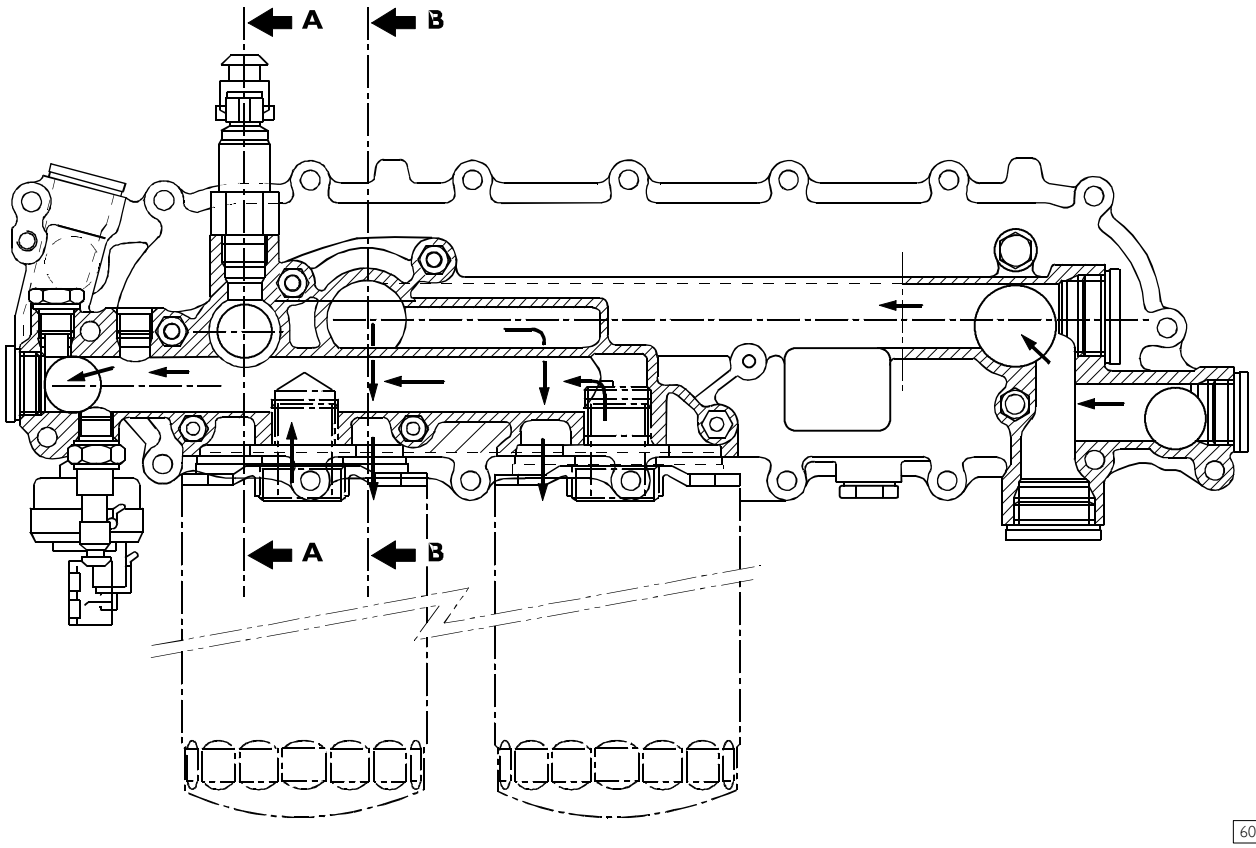
Figure 206



8. Engine brake solenoid valve with 4th cylinder command piston.

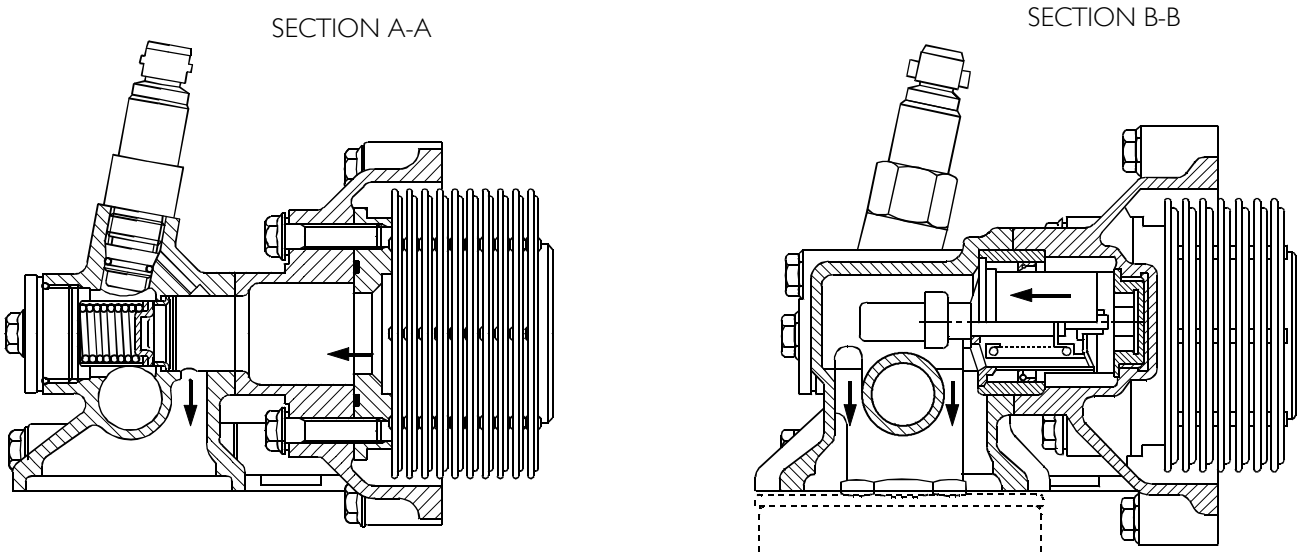
Heat exchanger

Figure 207



HEAT EXCHANGER SECTION

Figure 208



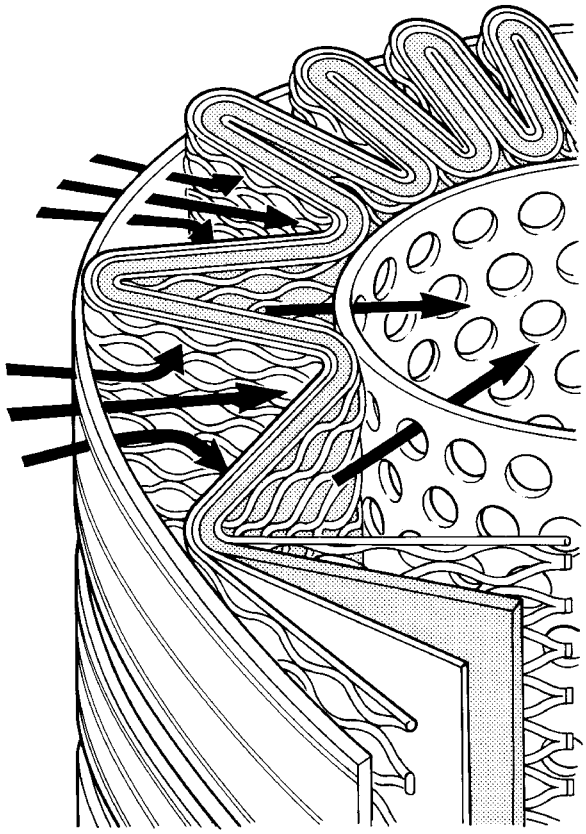
By-pass valve
Cut-in pressure 2 bar

Thermostatic valve
Cut-in temperature 82 ± 2°C

Engine oil filter

This is a new-generation filter, ensuring much more accurate filtering, since it can block a higher quantity of particles of smaller dimensions compared to traditional filters, with paper filtering septum.

Figure 209



47447

Outside spiral wrapping

The filtering elements are strictly wrapped by a spiral, so that each fold is strongly fixed to the spiral. This means a uniform use of the septum, also under the toughest conditions, such as cold start-ups with high viscosity fluids and flow peaks. Moreover, a uniform distribution of flow is ensured through the whole length of the filtering elements; thus the loading loss is optimized, as well as its operating time.

Upstream support

In order to optimize flow distribution and filtering element stiffness, the filtering element is equipped with an exclusive support consisting of a strong nylon mesh and high-strength synthetic material.

Filtering septum

It consists of inert inorganic fibers, connected by exclusively manufactured resin to a shifting pore structure; it is exclusively manufactured following precise procedures and strict quality controls.

Downstream support

Thanks to the filtering septum and the strong nylon mesh, the septum strength is improved, especially useful during cold start-ups and long use periods. Filter performance is constant and reliable for the entire service life, on each element, regardless of operating conditions changes.

Structural parts

The O-rings equipping the filtering element ensure perfect sealing between the filtering element and the container, thus eliminating any bypass risk and keeping filter performance constant. Corrosion-proof bottom sides, as well as a solid metal core, complete the filtering element structure.

These highly filtering elements, adopted only in industrial process up to now, make it possible to:

- ❑ reduce engine components wear;
- ❑ preserve oil performance/characteristics, thus extending the period of time between replacements.

COOLING

Forced-circulation cooling is obtained by means of a centrifugal pump, controlled by the crankshaft through a Poli-V type belt.

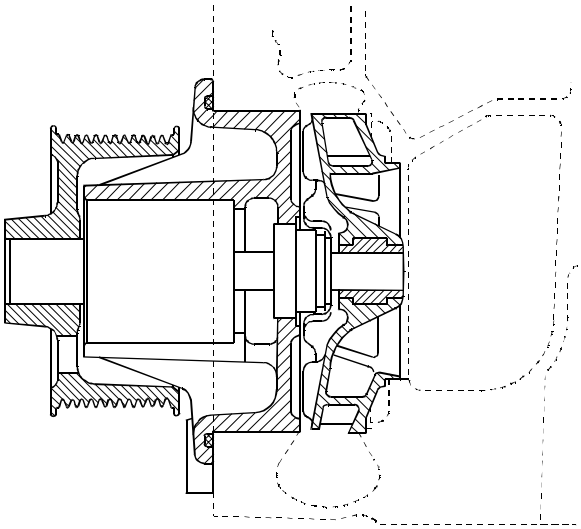
Water circulation is regulated by a thermostat.

The radiator is vertical.

Check that the pump body has no cracks or water leaks. Otherwise replace the complete water pump Check thermostat function. In case of doubt, replace the thermostat.

Water pump

Figure 210



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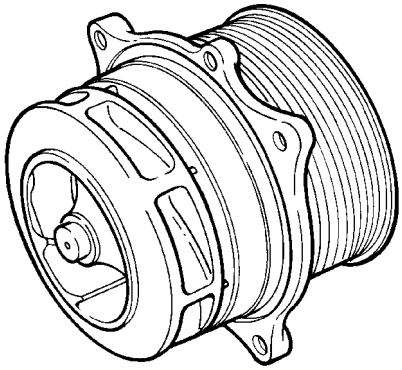
WATER PUMP SECTION

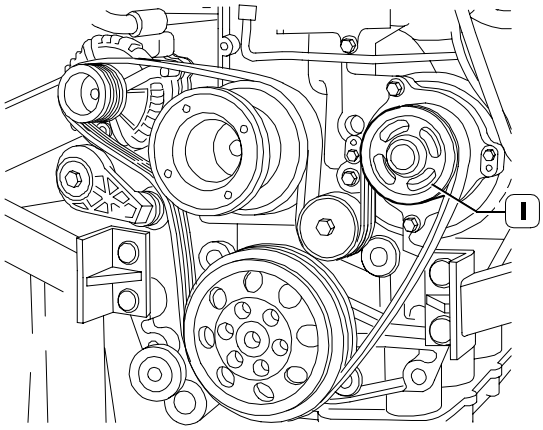
Figure 211



45159

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

Figure 212



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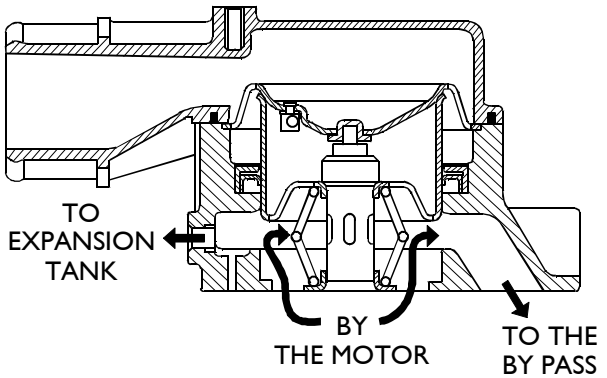
ENGINE WATER PUMP

Thermostat operation view

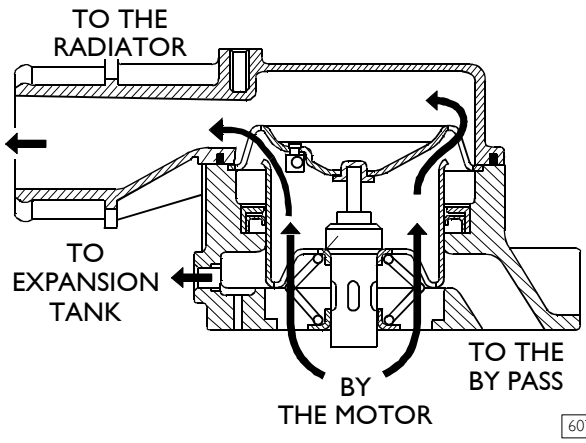
Figure 213



60747

Water circulating inside the engine

Figure 214



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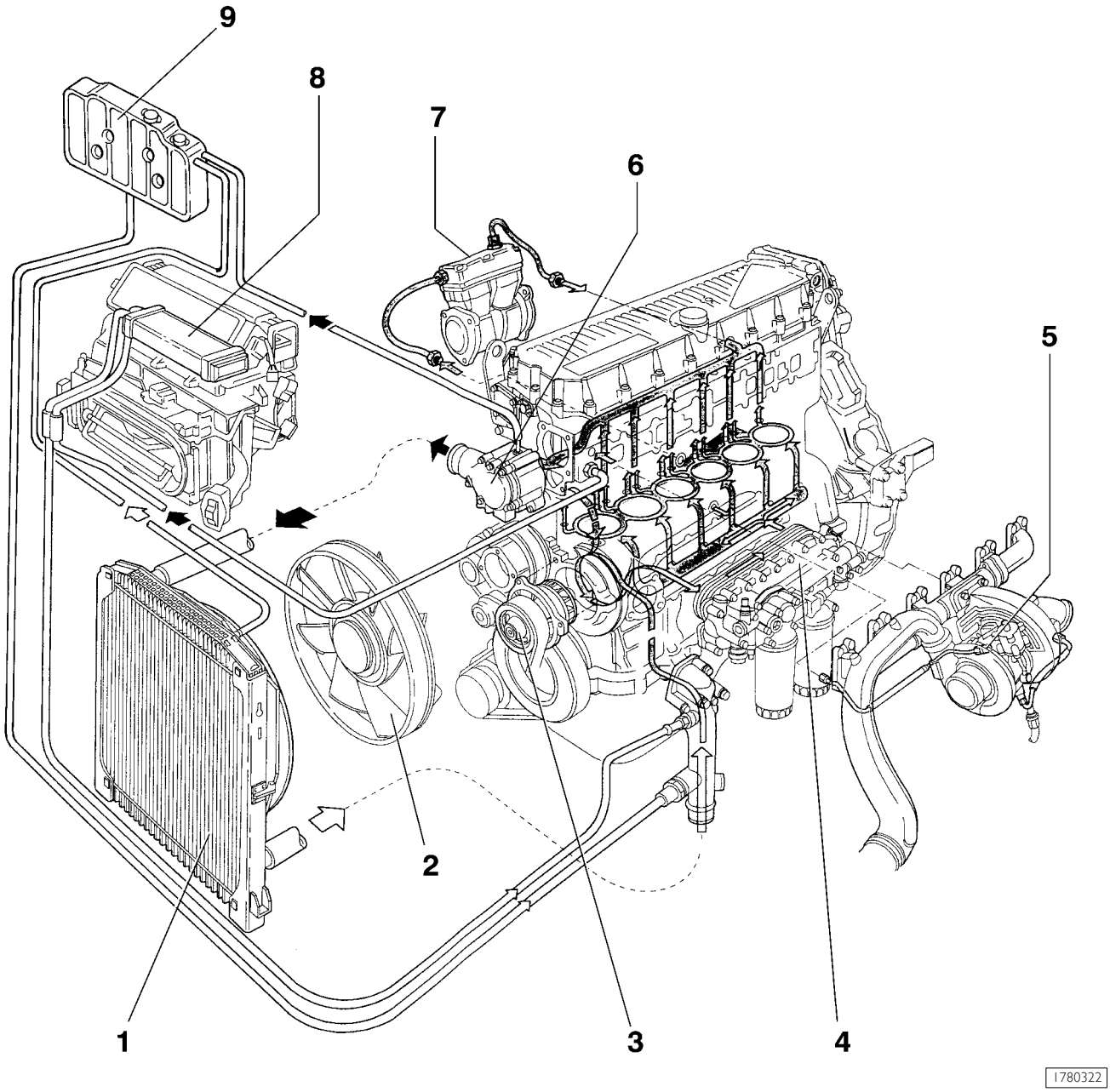
Water from the thermostat

Lubrication system outline

Standard version

Figure 215



1. Radiator. - 2. Fan. - 3. Water pump. - 4. Engine oil-water heat exchanger. - 5. Turbocompressor. - 6. Thermostat. - 7. Air compressor. - 8. Cab heater. - 9. Expansion chamber.

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Filling up the cooling system

Preliminary operation

For vehicles with driver seat heating or hand air-conditioning system:

❑ Turn on the tap of the warming liquid placed on the instrument board.

For vehicles with automatic air-conditioning system:

❑ Place the temperature control device in the driver's area on position HI.

For vehicles with a supplementary heating system:

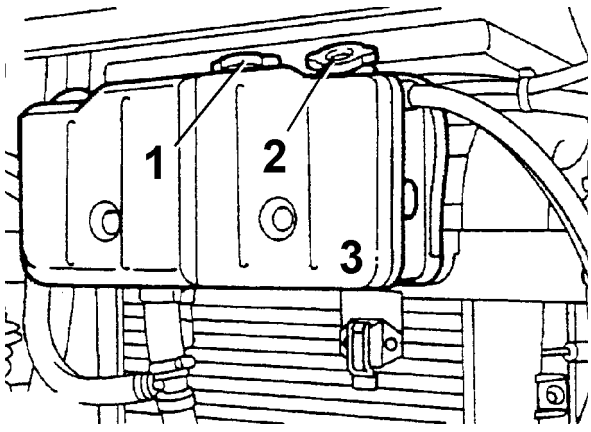
❑ This must be off.

Operations

Insert a sheet of cardboard between the radiator of the cooling liquid and the intercooler radiator, in order to shorten the time needed to reach the working temperature of the engine (~ 90°C).

Filling up the system

Figure 216



178315

GENERAL NOTICE
Filling up must be done when engine is cool.
The cap (1) cannot be removed.
In order to avoid air-bubbles in the system is recommended to pour out the liquid slowly (average quantity 8 Litre/Minute).
For vehicles with supplementary heating system, the percentage of glycol in the liquid cannot be higher than 50%.

After having followed all these instructions, proceed as follows:

❑ Remove cap (2) from the water cup (3);

❑ Fill in the cooling liquid into the water cup (3), till it is full.

Purging the air of the system

For vehicles with supplementary heating system

❑ Turn the heating device on.

❑ Start the engine and let the speed be a little higher than the minimum value for 5 minutes.

Should it happen, that the water cup during these minutes gets completely empty, stop the engine and fill in the cup more slowly than before.
Start the engine once again.

❑ After 5 Minutes, if necessary fill in the water cup;

❑ Close the fillers of the water cup with the corresponding cap (2).
Bring the speed to the maximum value, so that the cooling liquid can reach more quickly the temperature for the maximum opening of the thermo-stat (~ 90°C) and this can be maintained, till all air has been purged by the system.
In order to check if air is still present, check if in the water cup foam or air bubbles are visible.
The maximum time needed to purge all air out is about 15 minutes after the thermo-stat has opened (it starts opening with 79°C ± 2°C).

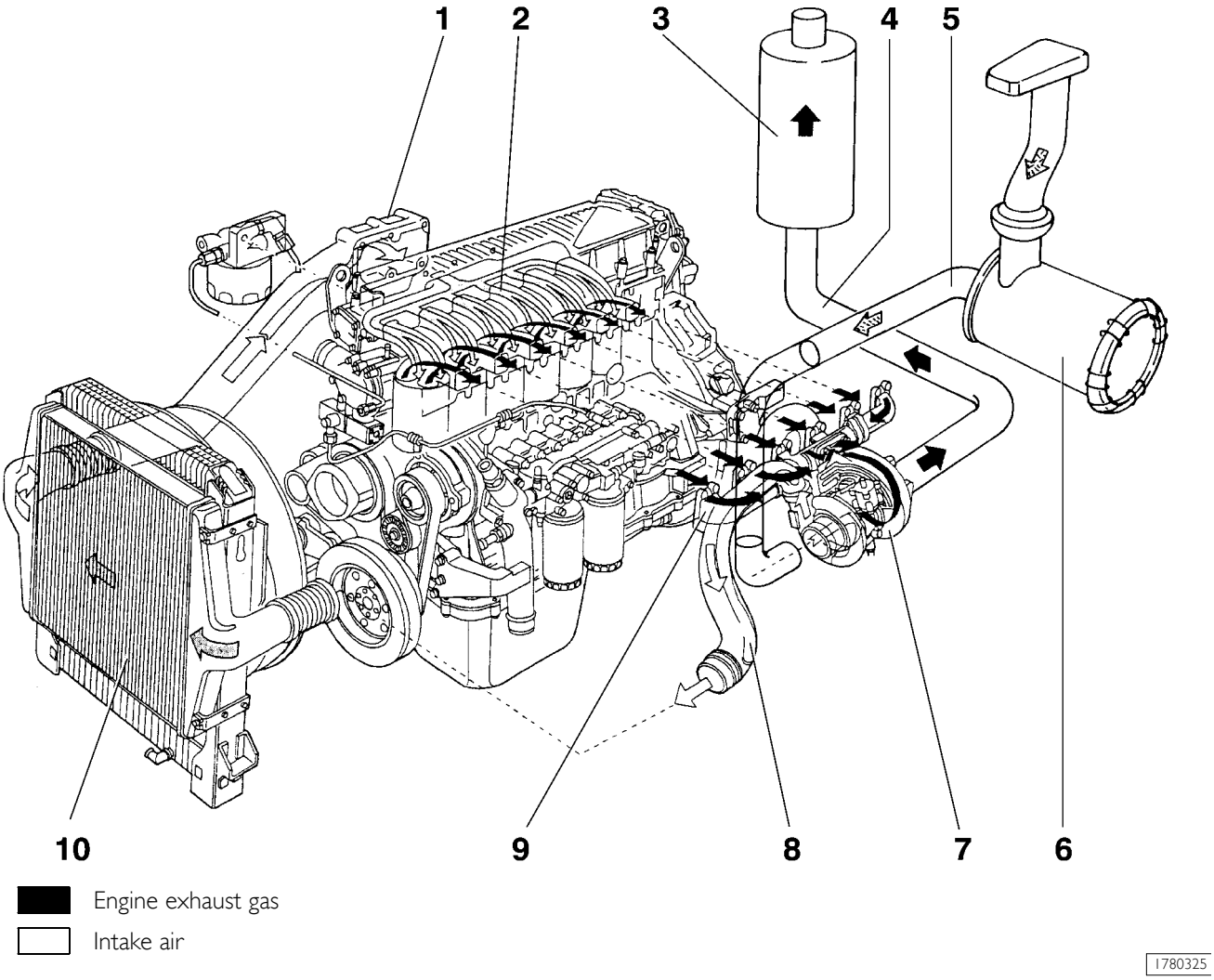
Do not remove the caps from the fillers of the water cup, till the liquid in the system is completely cool. If necessary, fill in only when the engine is cool.
This is to avoid:

☞ **Burning the operators;**

☞ **Damages to the engine, because the air is pressurised in the cooling system only if the engine is warmed up from a cold condition.**

TURBOCHARGING

Figure 217

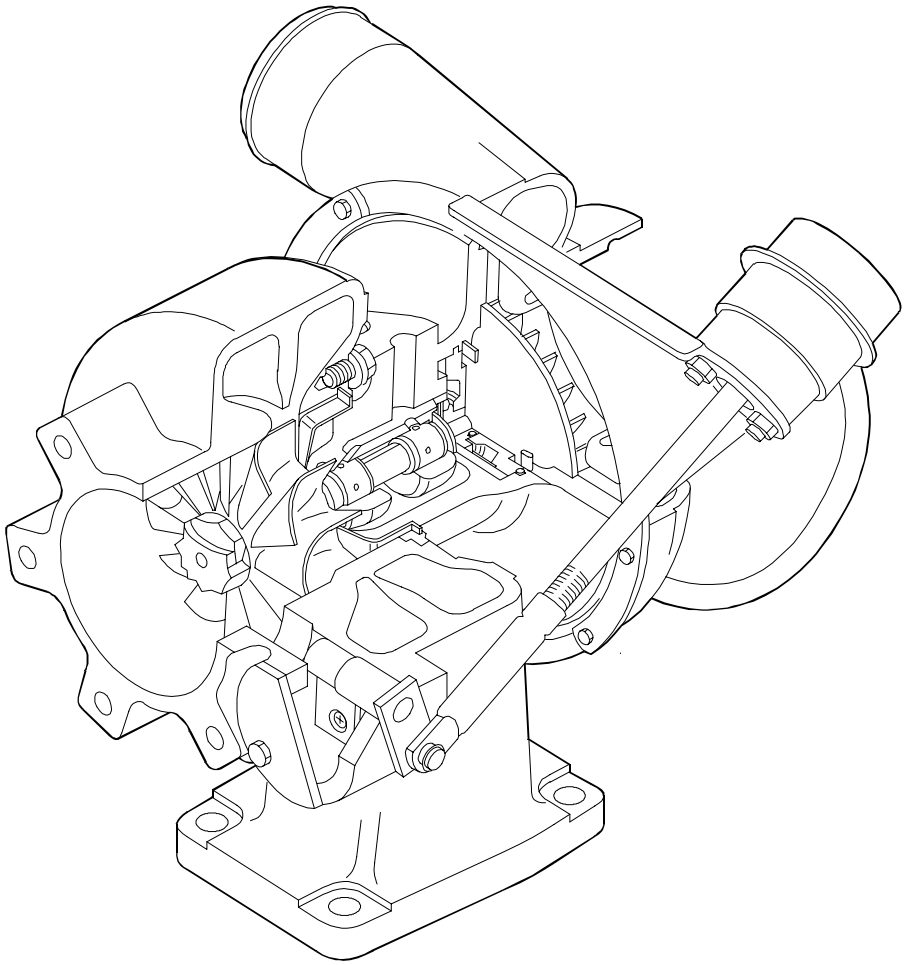


TURBOCHARGER AND EXHAUST SYSTEM OUTLINE

1. Air duct to intake manifold. - 2. Intake manifold - 3. Exhaust. - 4. Exhaust pipe - 5. Intake piping - 6. Air filter - 7. Turbocompressor - 8. Air duct to intercooler - 9. Exhaust manifold - 10. Intercooler.

HOLSET HX 50W (TURBINE WASTEGATE)

Figure 218



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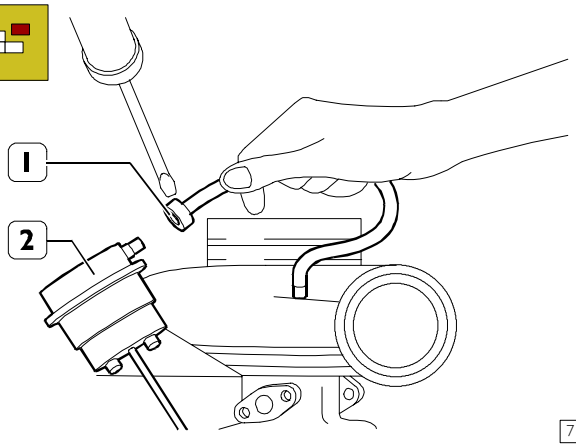
PRESSURE LIMITER VALVE

Pressure limiter valve control and adjustment

Remove the engine turbine and suitably fasten it to the bench.

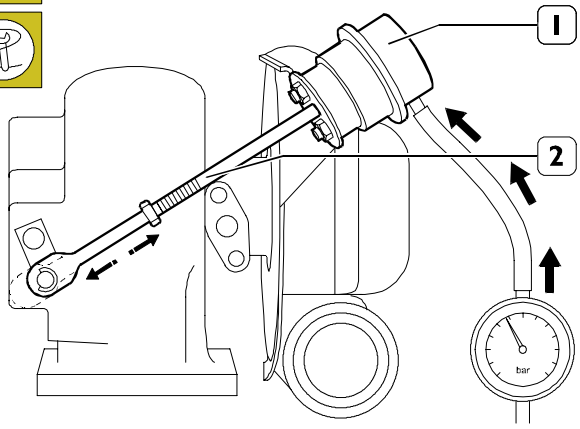
Figure 219



71767

Using screwdrivers, remove the air duct (1) of the actuator command (2).

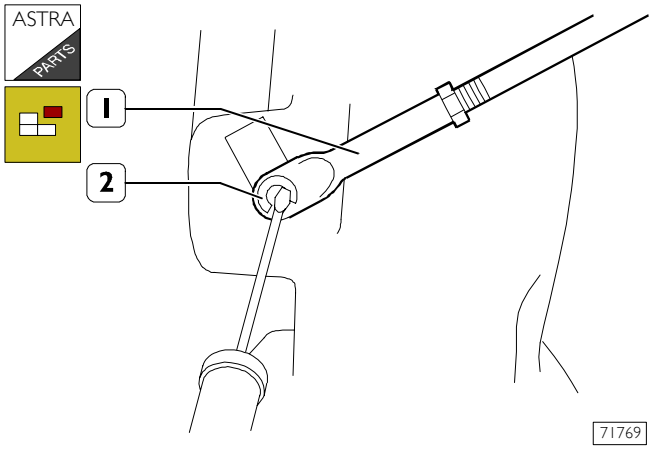
Figure 220



71768

Using tool 99309002, apply pressure variation from 0 to 3 bar to the actuator to verify shift of command rod (2).

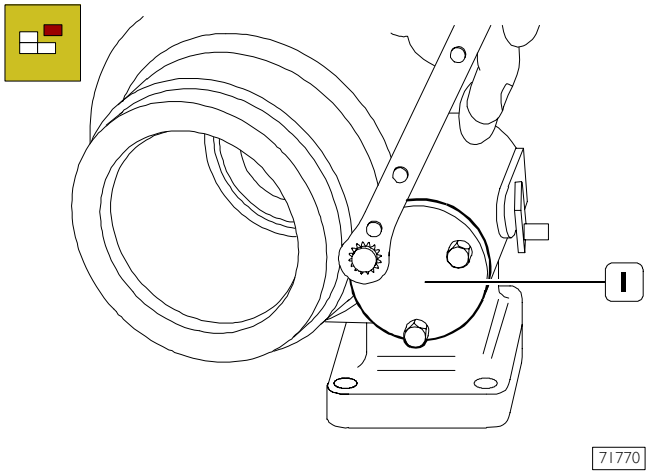
Figure 221



If the actuator is jammed, disconnect the rod from the turbine removing the safety ring (2).

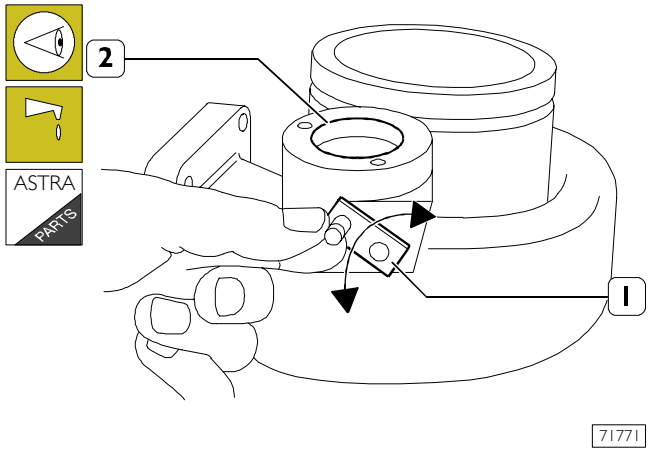
Apply slight pressure to the actuator (1) to check whether the rod is jammed. If so replace the actuator. Otherwise the cause of malfunction should be sought in the turbine internal mechanism.

Figure 222



Remove the cover (1) to inspect the turbine mechanism piloted by the actuator.

Figure 223

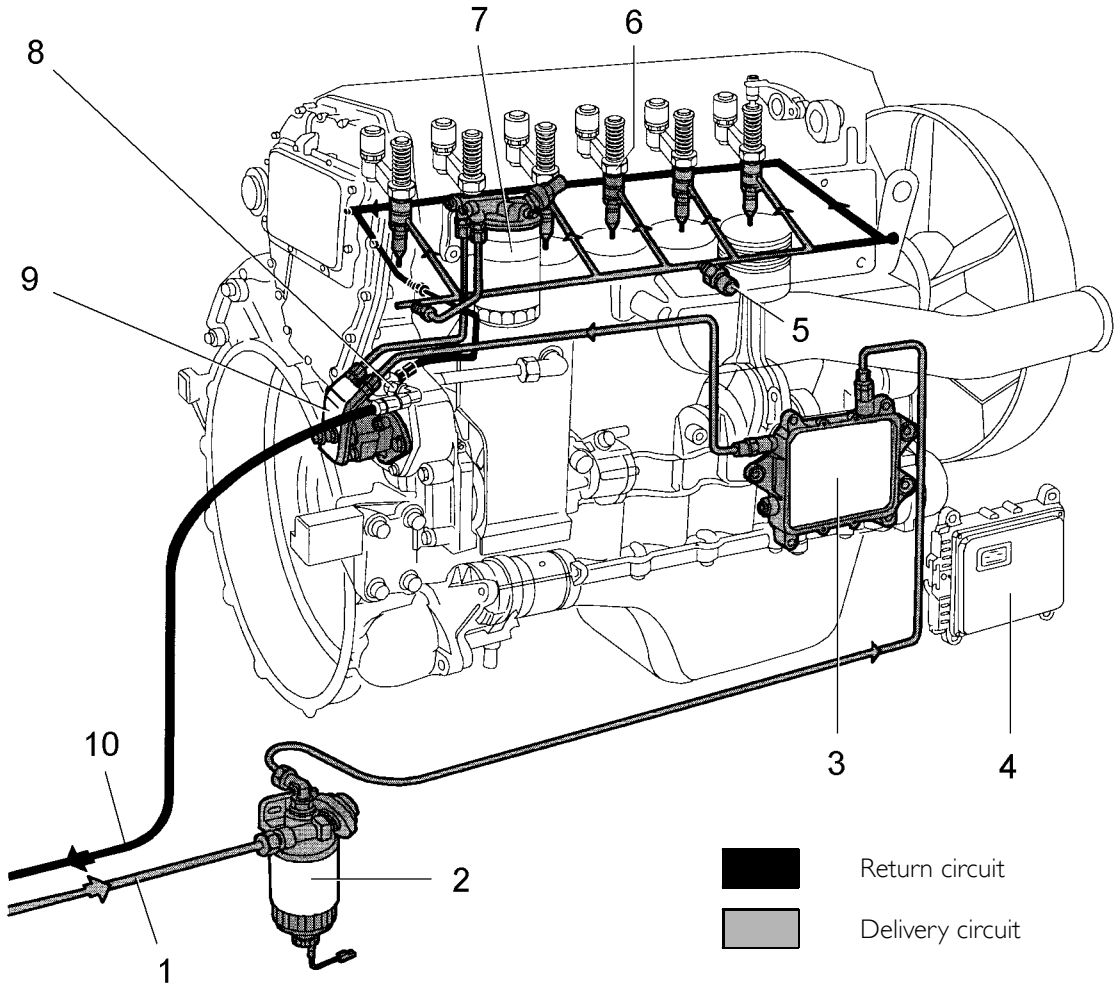


Through the inspection hole (2) check that the internal leverage command (1) is not stiff or jammed. If it is, lubricate it. If this does not solve the problem, replace the turbine.

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 224



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FUEL SUPPLY SYSTEM OUTLINE

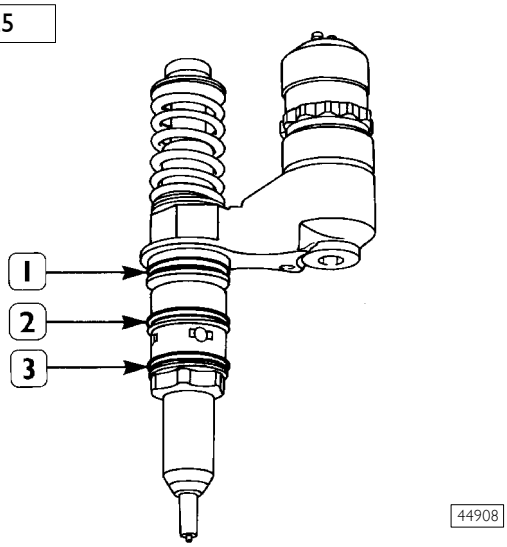
1. Fuel delivery. - 2. Prefilter. - 3. Fuel heat exchanger - 4. Engine Control Unit. - 5. Fuel temperature sensor - 6. Injector-pump. - 7. Filter. - 8. Pressure regulator - 9 Fuel pump - 10 Fuel return.

Pump-injector

The pump-injector consists of:

- pumping element;
- nozzle;
- solenoid valve;

Figure 225



PUMP-INJECTOR

1. Diesel/oil seal ring - 2. Diesel/diesel seal ring - 3. Diesel/exhaust gas seal ring

Pumping element

The pumping element is controlled by a rocker which, in turn, is directly controlled by the cam of the camshaft.

The pumping element is able to ensure a high delivery pressure.

A spring controls its return stroke.

Nozzle

Workshops will only be authorised to make the diagnosis of the whole injection system and may not make operations inside the pump-injector, which may be replaced only.

A fit diagnostic program, included in the unit, will be able to control the operation of each injector (by disabling one of them at a time and controlling the delivery of the other five).

The diagnosis allows to tell electric faults from mechanical/hydraulic faults.

It indicates malfunctioning pump-injectors.

Therefore, it will be necessary to correctly interpret all the error messages issued by the unit.

Possible faults of the injectors will be solved by replacing them.

Solenoid valve

The solenoid, energised at each cycle active phase by means of a signal coming from the control unit, controls a slide valve which cuts off the pumping element delivery duct.

When the solenoid is not energised, the valve is open.

Fuel is pumped but flows back in the return duct at the normal transfer pressure of approx. 5 bars.

When the solenoid is energised, the valve is closed.

Fuel, which cannot flow back in the return duct, is pumped in the high pressure nozzle causing the lifting of the metering rod.

The quantity of injected fuel depends on the slide valve closing time and therefore on the solenoid energising time.

The solenoid valve is joined to the injector body and cannot be disassembled.

Two screws fixing the cables transmitting the signal coming from the control unit are fitted on the upper part.

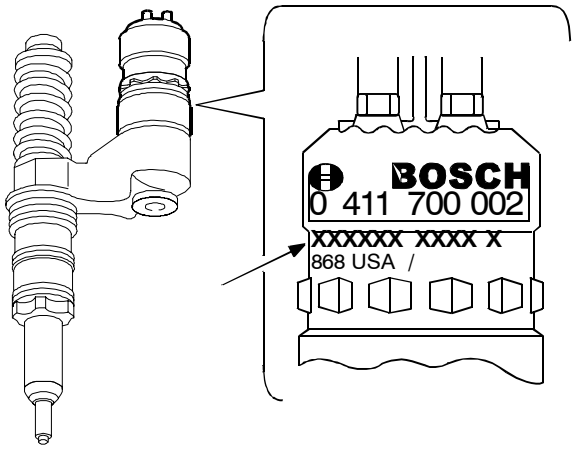
In order to ensure the signal transmission, tighten the screws at a torque of 1.36 to 1.92 Nm (0.136 to 0.192 kgm) using a torque wrench.

Replacing pump-injectors

The replacement of the injectors must be carried out very carefully (see description on pages 47-48 for disassembly).

If the operation is carried out with the motor assembled on the vehicle, discharge the fuel contained in the cylinder head ducts unscrewing the delivery and return unions on the cylinder head before disassembling the injectors.

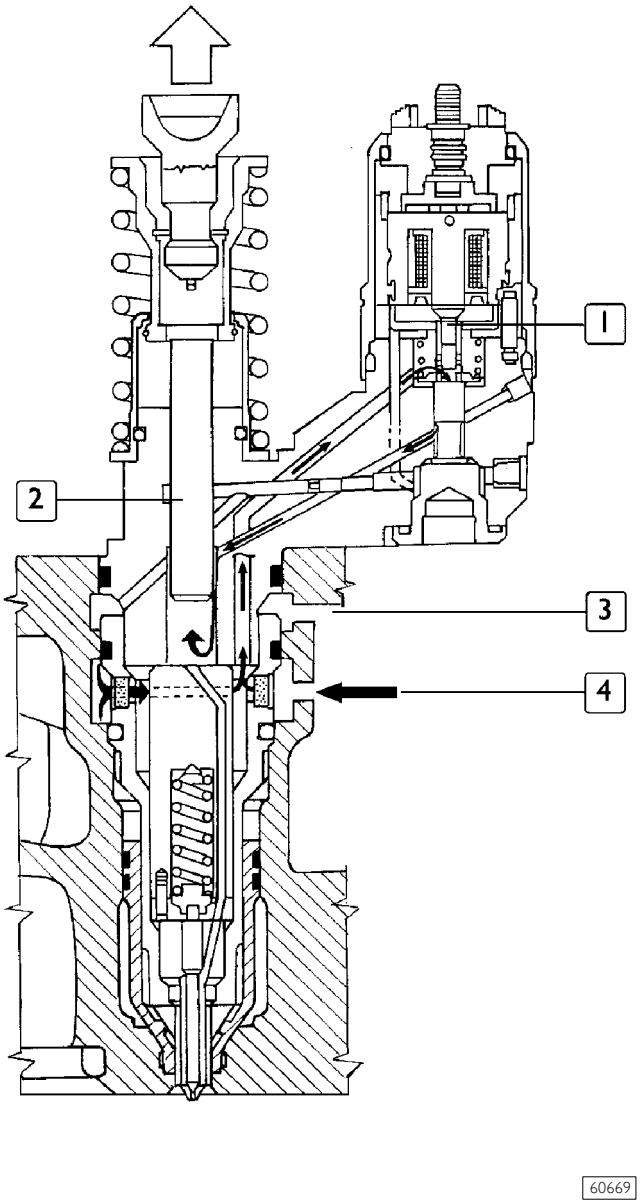
Figure 226



When rockers clearance is checked, it is important to check pump-injector pre-load

Injection phases

Figure 227



1. Fuel valve
2. Pumping element
3. Fuel discharge
4. Filling and flowing back channel

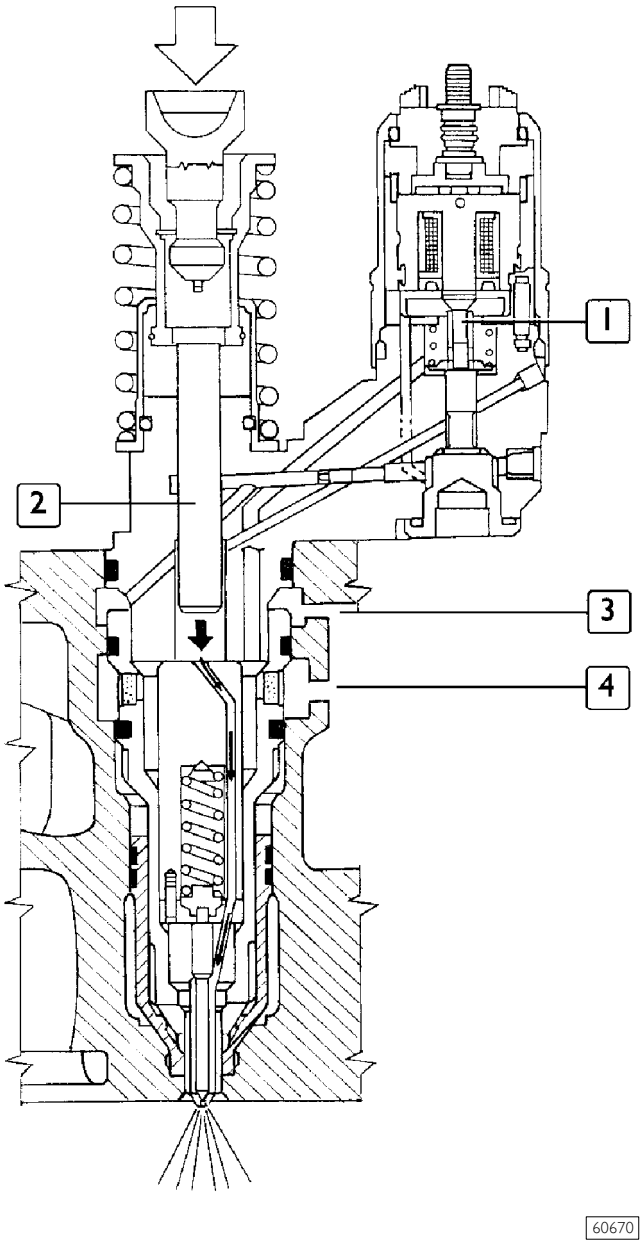
Filling phase

During the filling phase, the pumping element (2) moves to its upper position.
The highest cam position is passed and the rocker roller gets closer to the cam basic circle.

The fuel valve (1) is open and the fuel can flow into the injector from the lower channel (4) of the cylinder head.

The filling phase continues until the pumping element has reached its upper end-of-stroke position.

Figure 228

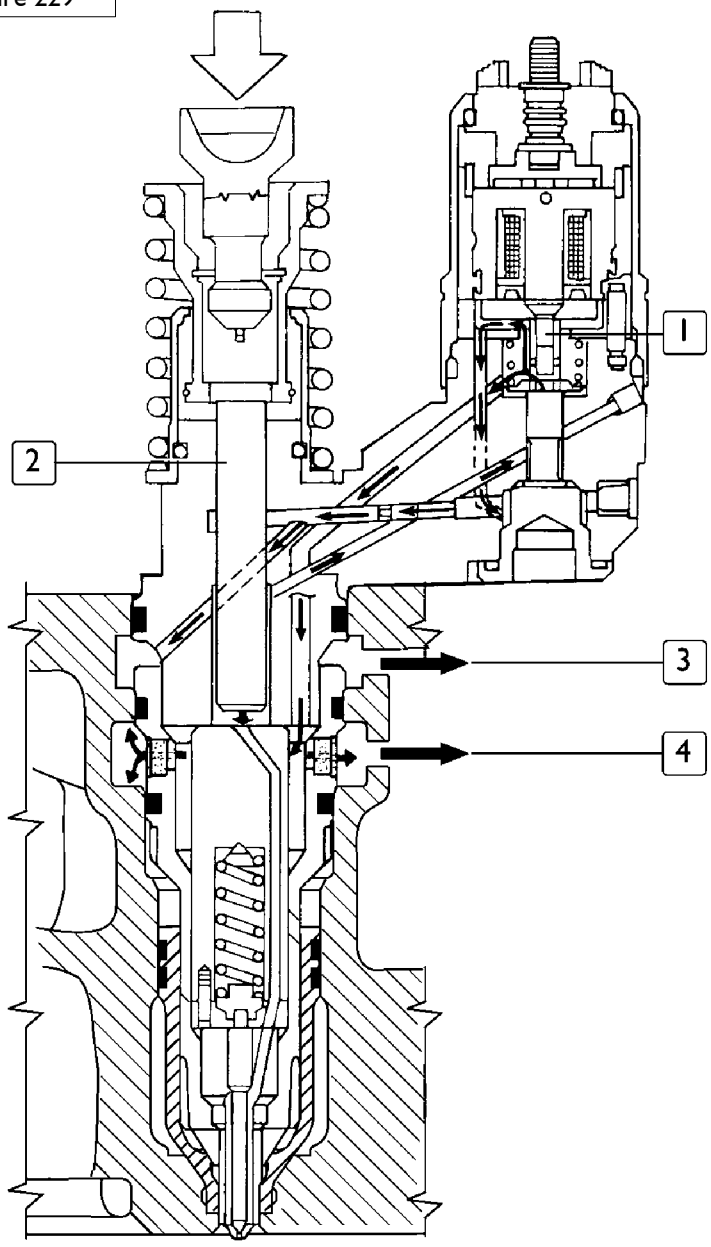


1. Fuel valve
2. Pumping element
3. Fuel discharge
4. Filling and flowing back channel

Injection phase

The injection phase starts when, during the pumping element descending phase, the solenoid valve is energized and the fuel valve (1) closes. Delivery start time, properly processed by the electronic control unit, depends on engine operating conditions. Through the rocker, the cam continues to activate the pumping element (2) and the injection phase continues as long as the fuel valve is closed (1).

Figure 229



1. Fuel valve
2. Pumping element
3. Fuel discharge
4. Filling and flowing back channel

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Pressure reduction phase

Injection stops when the fuel valve (1) opens, during the pumping element descending phase, following the solenoid valve de-energizing.
The fuel flows back, through the open valve (1), the injector holes and the channel (4), into the cylinder head.

The solenoid valve energizing period, properly processed by the electronic control unit, is the injection duration (capacity) and depends on the engine operating conditions.

CLUTCH

SECTION 4

SECTION 4

Clutch

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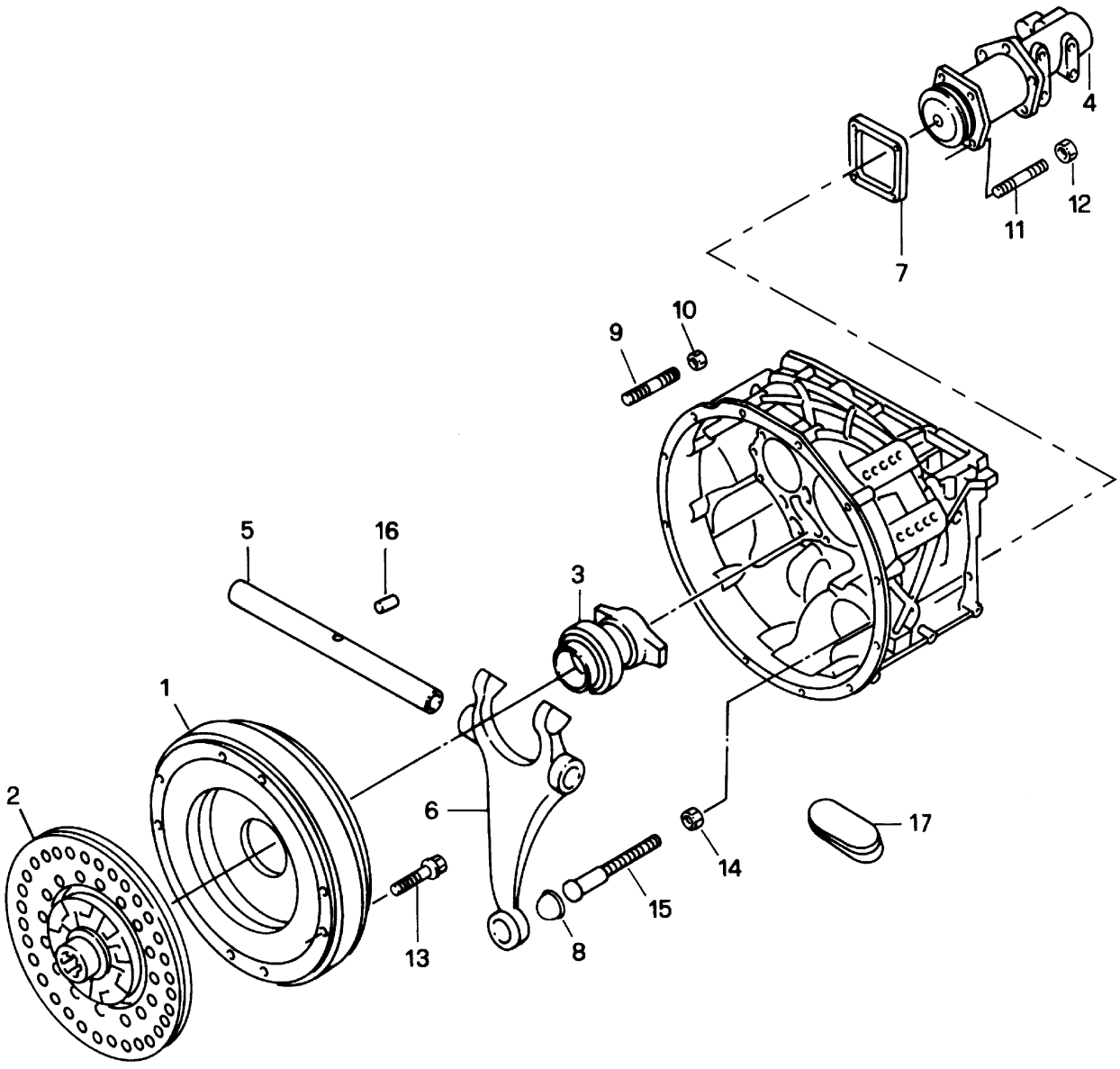
DESCRIPTION

The clutch is the single plate dry type, with a pull type engagement mechanism and a diaphragm spring.

Figure 1



1. Thrust pad – 2. Clutch disc – 3. Collar bearing – 4. Servo-clutch – 5. Fork shaft – 6. Fork – 7. Spacer – 8. Ball joint – 9. Stud – 10. Nut – 11. Stud – 12. Nut – 13. Bolt – 14. Nut – 15. Rod – 16. Pin – 17. Plug

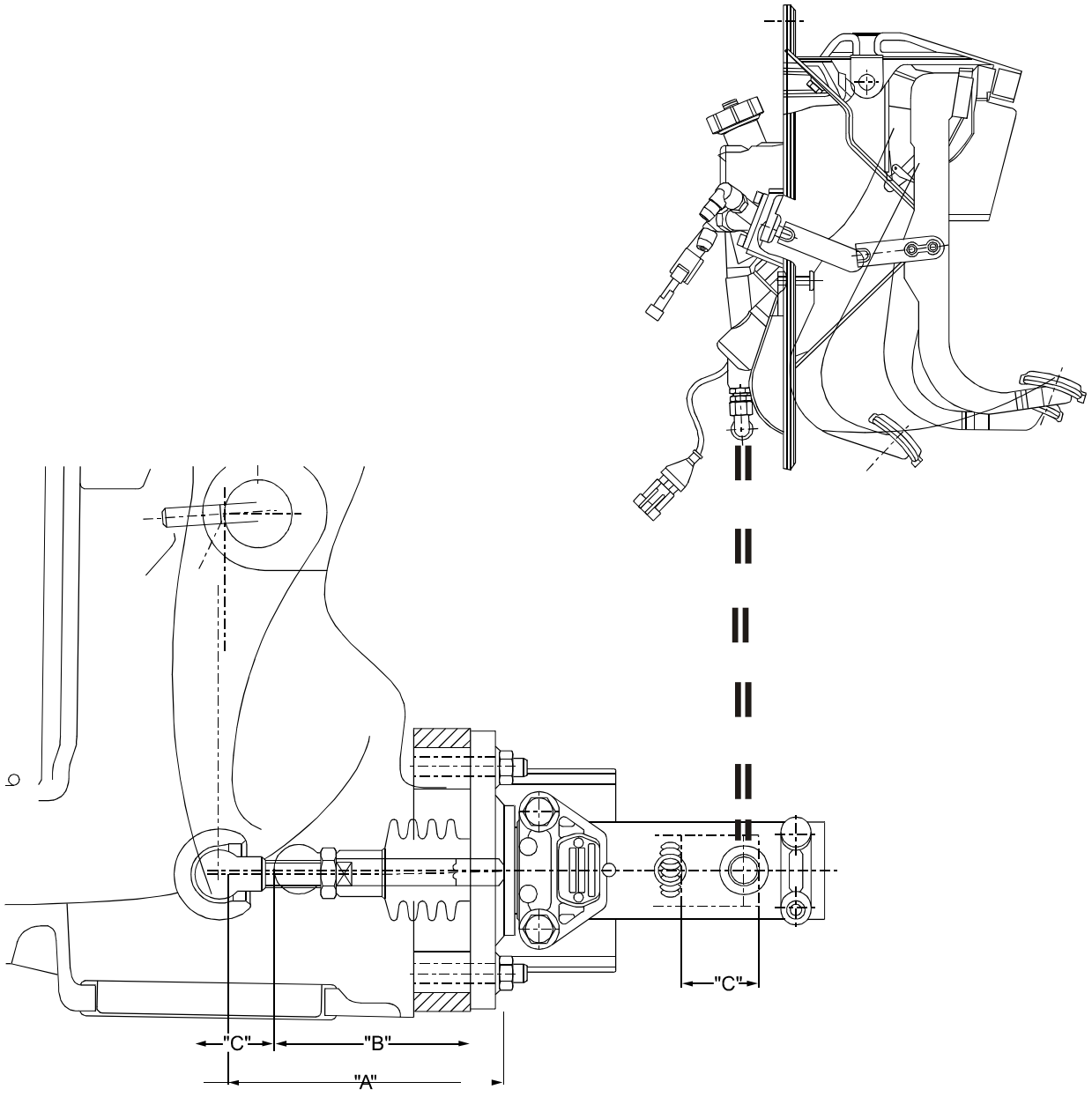
DESCRIPTION

Hydraulic control

The hydraulic control comprises:

- a pneumohydraulic master cylinder built in to the pedal board with integrated reservoir;
- a hydraulic actuator located beneath the gearbox bell end;
- a connector pipe.

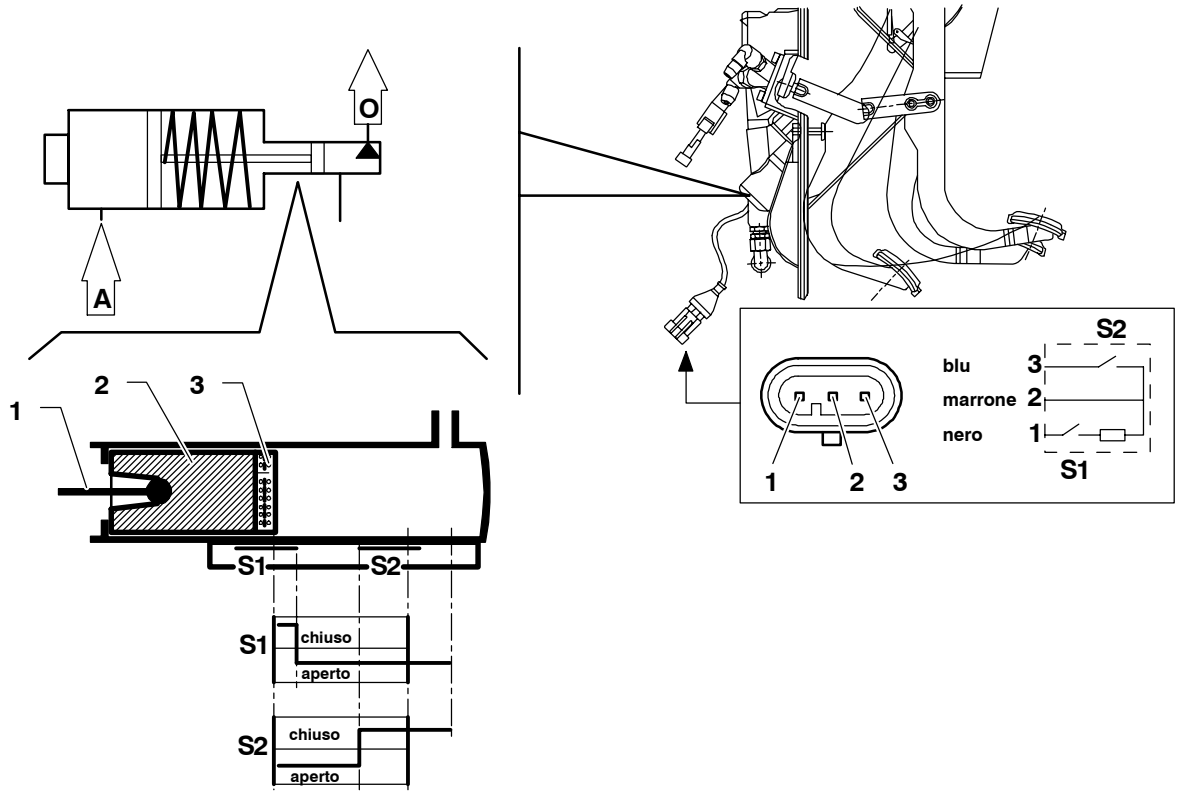
Figure 2



27204001

Master cylinder

Figure 3



Master cylinder circuit diagram

The following proximity (read) switches are mounted on the master cylinder:

- S1 (N.C. type), to disable the Cruise Control;
- S2 (N.O. type) for synchro protection.

Switch S2 is only present on vehicles with synchro protection type gearbox.

1. Push rod
2. Piston
3. Magnetic ring

S1 Proximity switch for Cruise Control disable

S2 Gearbox synchro protection proximity switch

A Pneumatic pressure from distributor

O Clutch servo hydraulic pressure

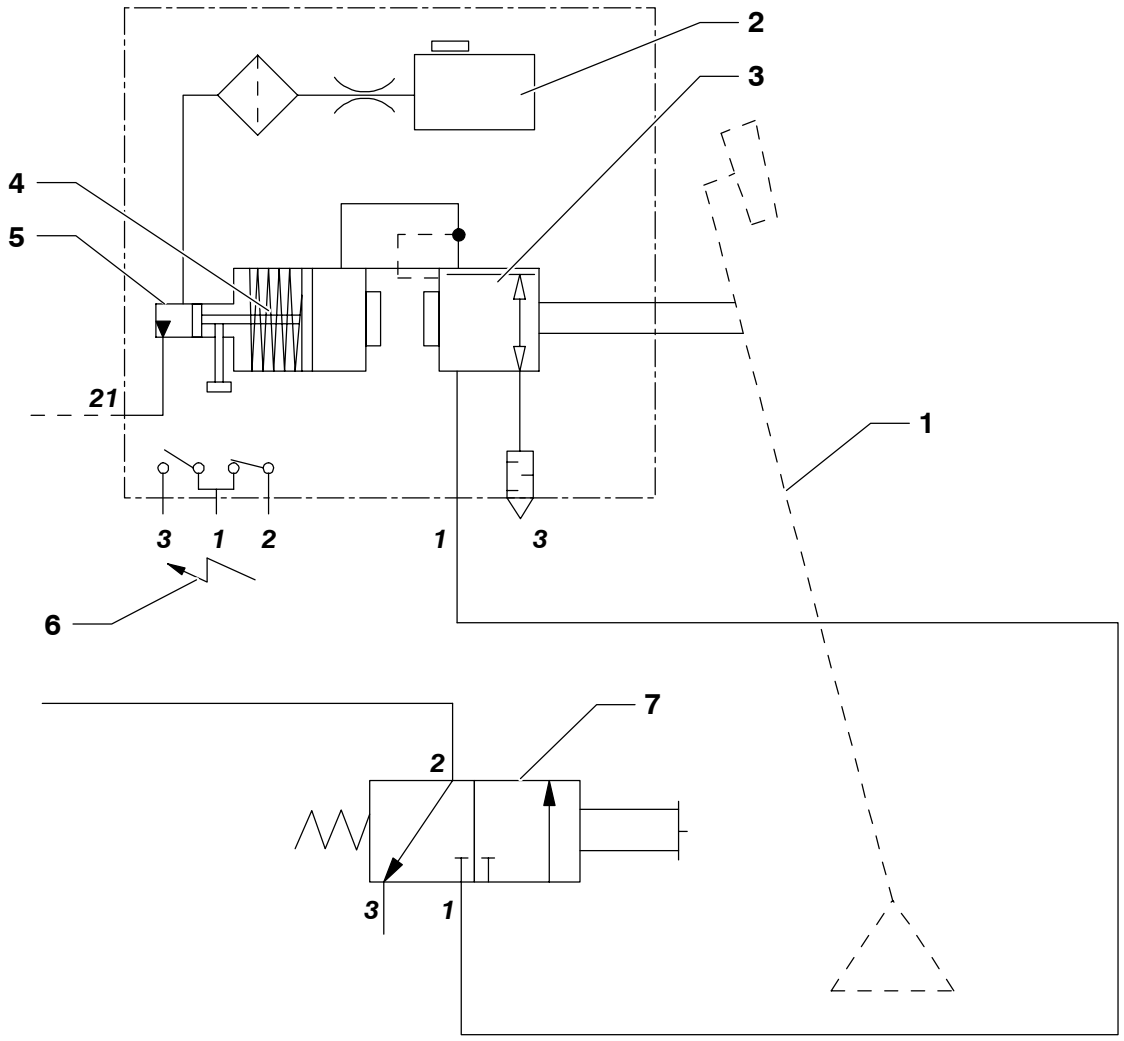
Switch S1 opens during the first part of the stroke: the signal to disable Cruise Control during gear shift is transmitted to the engine control system.

In the second part switch S2 closes to enable the servoshift control solenoid valve, to prevent gear shift with the clutch insufficiently depressed.

Switch S2 closes with 21.5 mm stroke of the piston (2), equal to 70% of the clutch pedal disengage stroke, corresponding to the point of intervention of the servoshift.

Hydropneumatic functional outline

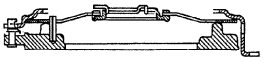
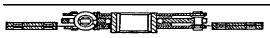
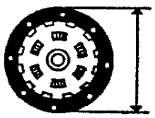
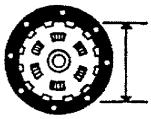
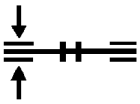
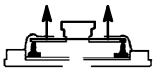
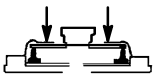
Figure 4



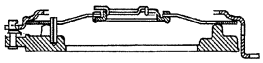
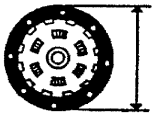
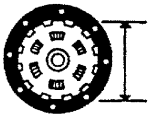
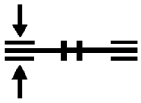
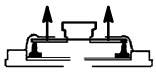
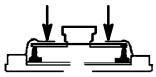
27204003

1. Clutch pedal – 2. Hydraulic oil reservoir – 3. Pneumatic distributor – 4. Pneumohydraulic servo actuator – 5. Master cylinder – 6. Switches S1 and S2 – 7- Splitter actuator pedal

SPECIFICATIONS AND DATA

15/16" CLUTCH			VALEO	BORG & BECK	FICHTEL & SACHS
	Type		Dry, single-plate		
	Engagement mechanism		"Pull" type with diaphragm spring		
	Driven plate		With friction facings		
	Driven plate hub		With damper springs		
	Ø External diameter of friction Facings	mm	400	400	400 ± 1
	Ø Internal diameter of friction Facings	mm	235	220	220 + 1,5
	Plate thickness (new)	mm	10 ± 0,3		
	Max. permitted driven plate	mm	~ 0,2		
	Withdrawal stroke	mm	12 + 2		
	Wear stroke	mm	15 + 2		
	Hydraulic control		Master cylinder with built-in oil reservoir-Slave cylinder with full driven plate self-adjustment		
	Oil type		-		

* For the correct type of fluid, see section 2 - HYDRAULIC FLUID AND LUBRICANTS TABLE

17" CLUTCH		VALEO	BORG & BECK	FICHTEL & SACHS
	Type	Dry, single-plate		
	Engagement mechanism	"Pull" type with diaphragm spring		
	Driven plate	With friction facings		
	Driven plate hub	With damper springs		
	Ø External diameter of friction Facings mm	430	430	430 ± 1
	Ø Internal diameter of friction Facings mm	242	240	240
	Plate thickness (new) mm	10 ± 0,3		
	Max. permitted driven plate mm	~ 0,2		
	Withdrawal stroke mm	12 + 2		
	Wear stroke mm	15 + 2		
	Hydraulic control	Master cylinder with built-in oil reservoir-Slave cylinder with full driven plate self-adjustment		
	Oil type	(*)		

* For the correct type of fluid, see section 2 - HYDRAULIC FLUID AND LUBRICANTS TABLE

DIAGNOSTICS

Main operating faults in the clutch :

1 - Noise when the clutch pedal is depressed.
2 - Noise when the pedal is released
3 - The clutch snatches
4 - The clutch does not disengage
5 - The clutch slips
6 - Abnormal wear of driven plate linings.

1 NOISE WHEN CLUTCH PEDAL IS DEPRESSED

Thrust bearing excessively worn, damaged or not properly lubricated – YES → Replace thrust bearing

NO

Excessive play between the splines on the transmission input shaft and the splined portion of the driven plate – YES → Replace the shaft and also the driven plate If necessary

2 NOISE WHEN THE PEDAL IS RELEASED

Springs of driven plate broken or weak – YES → Replace driven plate.

NO

Transmission input shaft worn – YES → Replace the shaft and also the driven plate if necessary

NO

Thrust bearing has play in engagement sleeve – YES → Replace the thrust bearing

3 THE CLUTCH SNATCHES

Oil or grease on engine flywheel or on driven plate linings – YES → Eliminate the problem causing the contamination; clean flywheel thoroughly then replace driven plate

NO

Pressure plate distorted – YES → Replace the clutch.

NO

Uneven wear of friction linings due to run-out of driven plate – YES → Replace the driven plate.

NO

Diaphragm spring weak or fingers broken – YES → Replace the driven plate.

4 THE CLUTCH DOES NOT DISENGAGE

Oil or grease on driven plate linings. – YES → Replace the driven plate.

NO

Transmission input spline damaged thus preventing driven plate from sliding – YES → Replace the shaft and also the driven plate if necessary

(continued)

5 THE CLUTCH SLIPS

Driven plate linings worn or burnt – YES → Replace the driven plate.

NO ↓

Diaphragm spring weak or fingers broken – YES → Replace the clutch.

NO ↓

Oil or grease on driven plate linings. – YES → Eliminate the problem causing the contamination and replace driven plate

6 ABNORMAL WEAR OF DRIVEN PLATE LININGS

Driver resting his foot on the clutch pedal while driving – YES → Driver must avoid the harmful habit and rest his foot on the clutch pedal only when necessary

NO ↓

Diaphragm spring with weakened or broken fingers – YES → Replace the clutch.

MAINTENANCE

Before carrying out any operation, check that all precautions have been taken and all aspects regarding safety of the personnel involved have been clarified.
Read the related instructions given in SECTION 1 of this manual.
If in doubt, speak to a more experienced person.
Respect all general recommendations for correct execution of maintenance works.

Hydraulic oil change

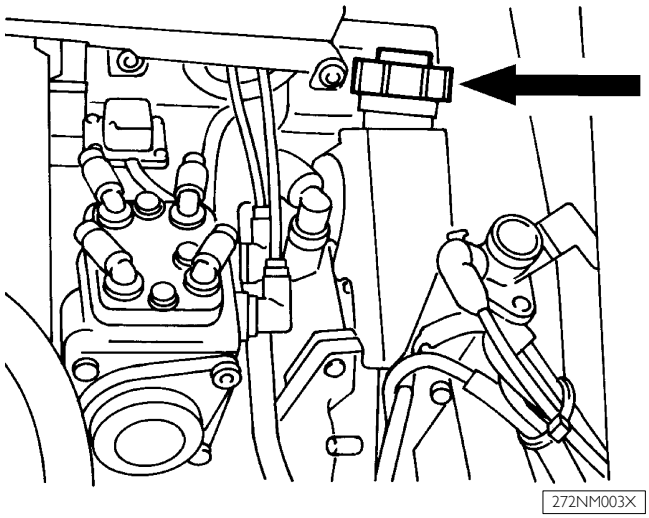
Exhausted oil and fluids must be collected and disposed of according to standards in force.

The fluid is corrosive: always wear protective gloves.

The fluid will corrode any paintwork it comes into contact with.
Use only the specified type of fluid for topping up.

Proceed as follows:

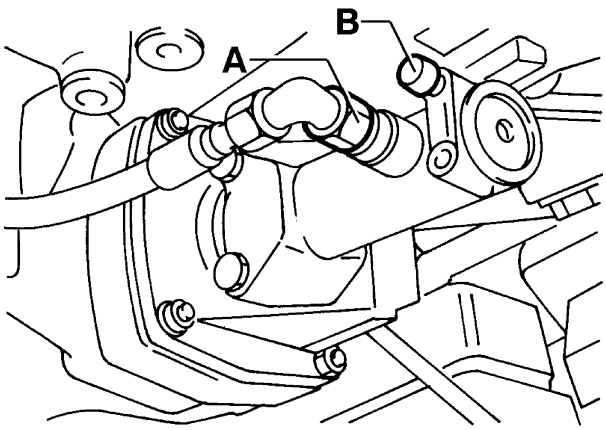
Figure 5



272NM003X

- ❑ arrange an adequately sized container underneath and then open the reservoir drain plug (arrow);

Figure 6



272NM004X

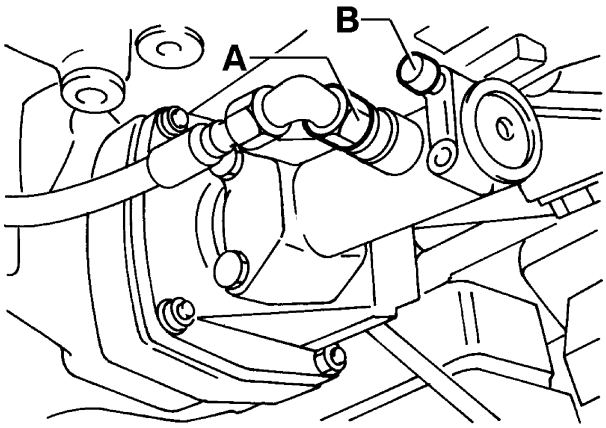
- ❑ Unscrew the drain pipe (A) and fully drain off the oil;
- ❑ replace the plug and fill to maximum oil level;
- ❑ proceed to bleed the system as instructed in the next paragraph.

Bleeding off air

Proceed as follows:

- ❑ check that fluid level in reservoir is at maximum;

Figure 7



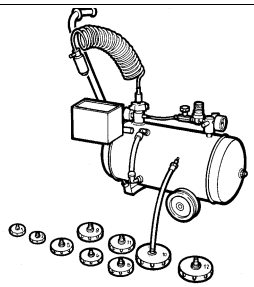
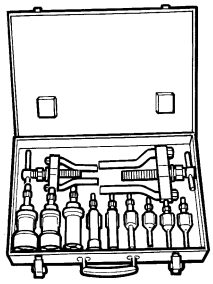
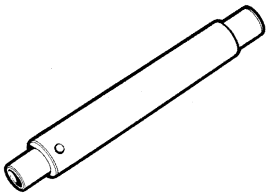
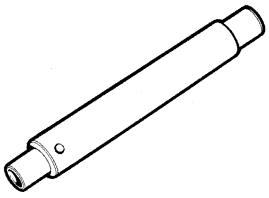
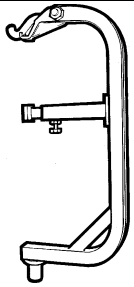
272NM004X

- ❑ using a section of transparent pipe, fit one end to the bleed valve (B) and the other end into a clean container;
- ❑ depress the clutch pedal and hold it down;
- ❑ loosen the upper bleed valve allowing oil and air bubbles to flow out, and close it after a few seconds;
- ❑ fully release the clutch pedal;
- ❑ repeat the operation unitl oil flows from the bleed valve without air bubbles.

TIGHTENING TORQUES

DETAIL	TORQUE	
	Nm	(kgm)
Disk pusher to flywheel M12 hex head flanged screw	65 ± 7	(6.5 ± 0.7)
M10 nut for clutch casing to crankcase fastening stud	46 ± 5	(4.6 ± 0.5)
M10x80 clutch casing to crankcase fastening stud	19 ± 2	(2 ± 0.2)

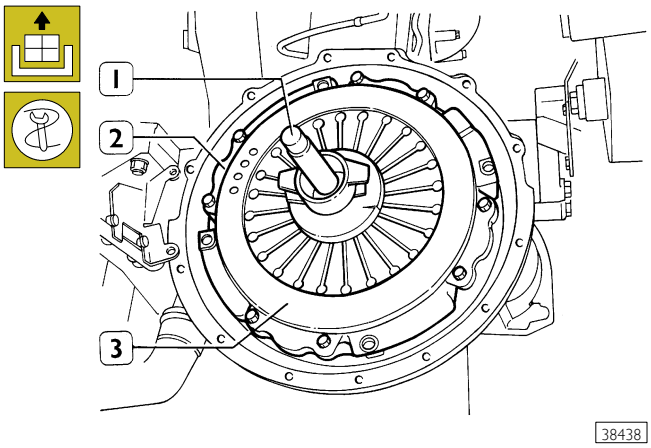
TOOLS

TOOL NO.		DESCRIPTION
99306010		Air remover for bleeding air from clutch control circuit
99348004		Universal 5 to 70 mm internal extractor
99370264		Guide pin for clutch disk centring
99370280		Guide pin for clutch disk centring
99370547		Suport for clutch group removal and replacement (to apply to hydraulic jack)

REMOVING AND REFITTING
Removal

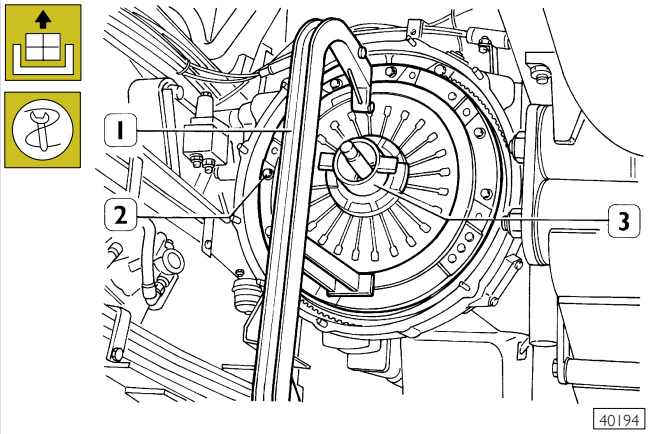
After removing the transmission input shaft and the transmission, as described in the sections, remove the clutch assembly as follows:

Figure 8



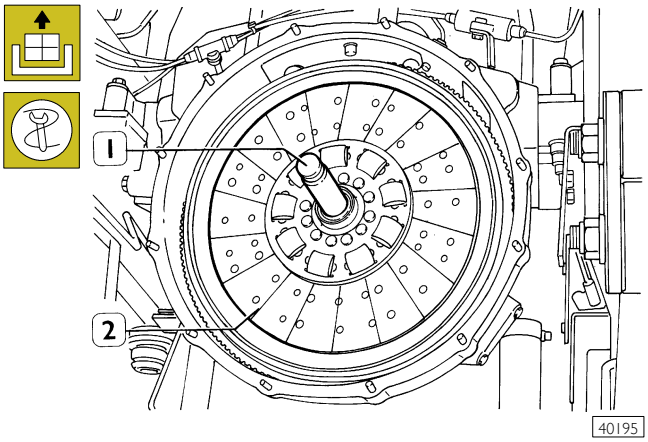
Insert clutch centring pin 99370280 (1) into the gearbox input shaft support bearing.

Figure 9



On the hydraulic jack fit support 99370547 (1) and apply it to the disk pusher (3). Unscrew the screws (2) and remove the disk pusher from the engine flywheel

Figure 10



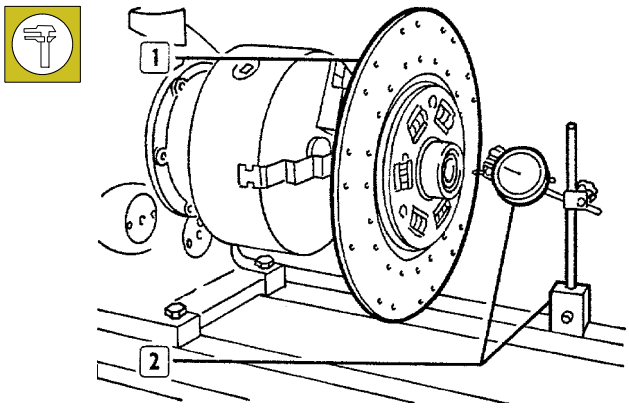
Withdraw centring pin 99370280 (1) and at the same time take off driven plate (2).

Checks

Check the faying surface of the engine flywheel, it must not be excessively worn or scored, the teeth of the toothed crown must not be worn or broken, otherwise remove the engine flywheel and carry out the procedures described in section 2.
Check that there are no oil leaks, even of a slight entity, from the seal of the rear drive shaft; otherwise remove the flywheel and replace the sealing rings.
Check that the support bearing of the take up shaft on the gears fitted to the drive shaft are not worn or broken and if necessary replace them.
Check all parts for wear and damage.
The thrust pad must not be scored or excessively worn.
The driven gear should be replaced if any of the following problems is found:

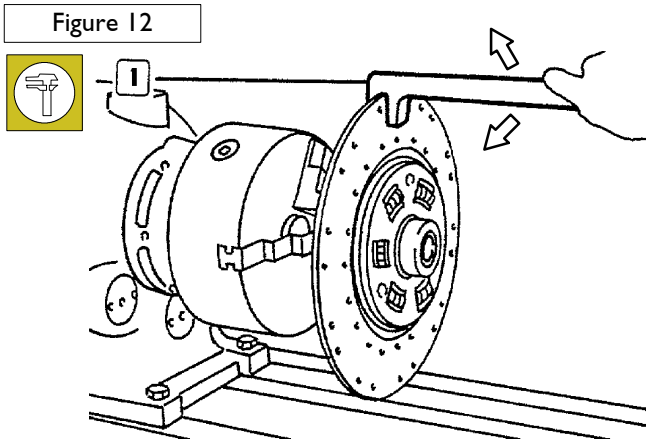
- ❑ metal ring cracked or broken
- ❑ springs broken
- ❑ excessive wear in the grooves on the hub
- ❑ metal ring or hub springs loose
- ❑ excessive consumption of the seal
- ❑ considerable quantities of oil or grease on the friction seals

Figure 11



Before fitting a new driven plate, it should be checked for run-out as follows :
Mount the driven plate (1) in a lathe, then using a dial gauge with a magnetic base (2) check the surface of the disc for run-out.
Maximum run-out permitted for the driven plate is 0.20 mm.

Figure 12



If the disc is out of line use a hook wrench (1) as in the figure.

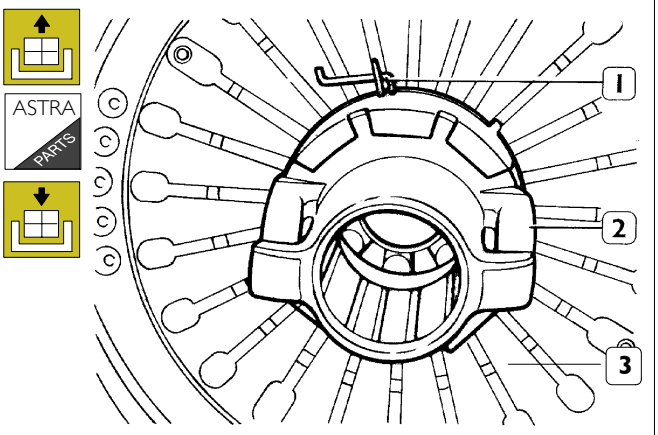
Refitting

Follow the same procedures as for removal in reverse order and:

- ❑ carefully clean the faying surface of the flywheel disc using methylated spirit or petrol; if any slight scratches are noted remove an abrasive cloth.
- ❑ Position the driven disc, using the guide pin to obtain perfect centring and to avoid straining the hub when the gears are reconnected.
- ❑ using support 99370547 on the hydraulic jack, position the thrust pad on the flywheel fit the fixing screws and tighten them to the prescribed torque.
- ❑ reconnect the gears after spreading the grooved shaft with molybdenum disulphide "Molikote" grease

REMOVING-REFITTING COLLAR BEARING

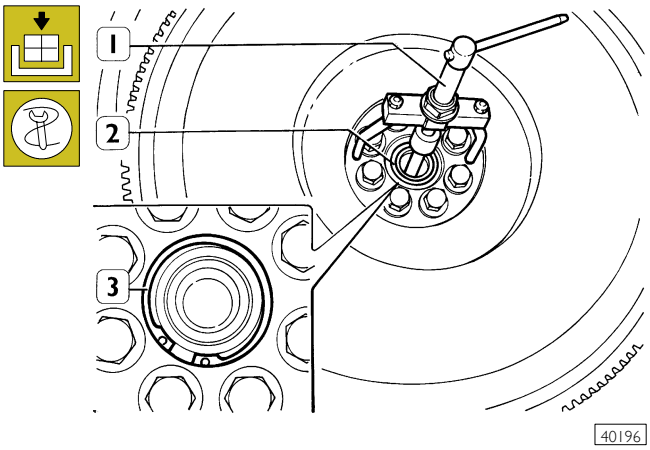
Figure 13



Use the appropriate pliers to open retaining circlip (1) and withdraw thrust bearing (2).
Reverse order of operations to refit.

REPLACING THE SUPPORT BEARING OF THE CLUTCH SHAFT

Figure 14



Using the appropriate pliers remove the split ring (3).
Using the universal extractor 99348004 (1) remove the bearing (2).
For refitting use the appropriate beater.
Refit the split ring.

Clutch pedal adjustment

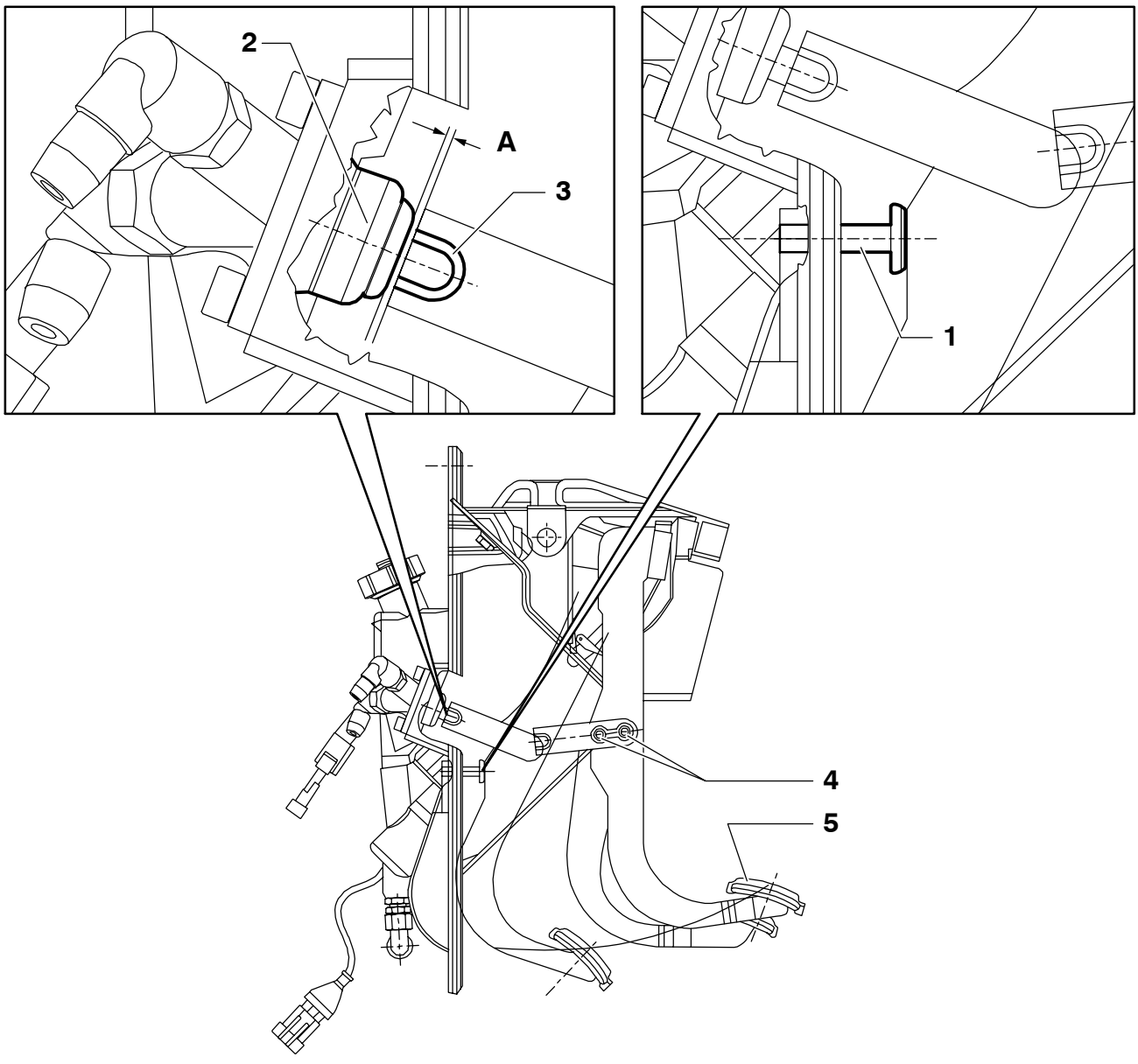
Proceed as follows:

- ❑ Loosen the angle bracket bolts (4) without removing them.
- ❑ Place a spacer of predetermined thickness (A = 1 mm) in front of the button (2) of the splitter control distributor.
- ❑ Bring the clutch pedal (5) into contact with the stop screw (1) and hold it down.
- ❑ Bring the angle bracket (3) into contact with the spacer.

Fitting the spacer prevents the splitter control distributor working as a stop for the clutch pedal.

- ❑ Tighten the angle bracket bolts (4).
- ❑ Release the clutch pedal (5).

Figure 15



27204004

Clutch actuator adjustment

Proceed as follows:

- ❑ measure the distance **A** between the bottom of the lever cavity and the servoclutch mounting plane.

The clutch lever must be in contact with the thrust bearing.

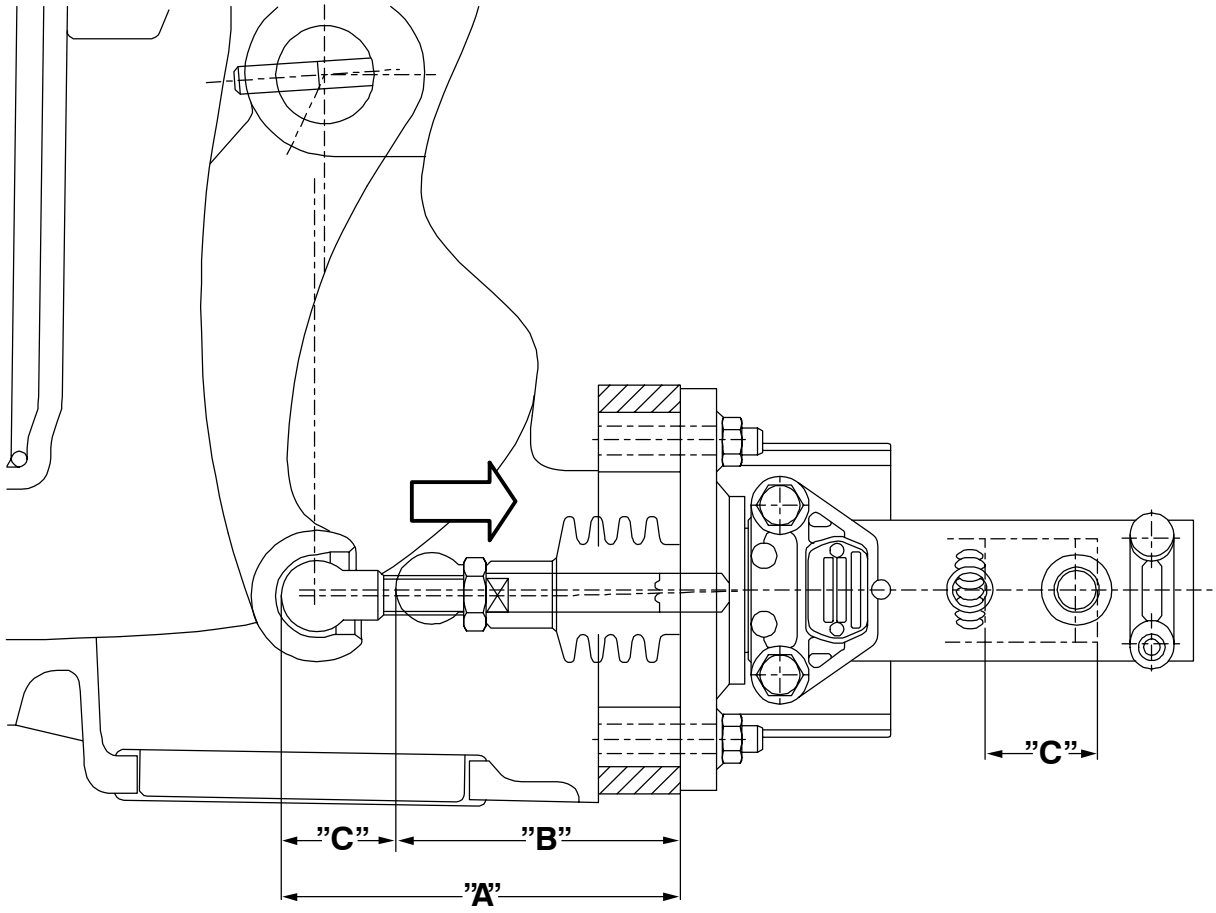
- ❑ press the spherical push-rod to its limit (arrow);
- ❑ loosen the lock nut and adjust push-rod position until obtaining the required distance B.

B = A – C mm

C being the actuator excursion, according to clutch type:
C = 25 mm (VALEO, BORG & BECK)
C = 33 mm (FICHTEL & SACHS).

Disk wear (90% of the lining) is indicated by a significant increase in load on the pedal during clutch disengage.

Figure 16



27204005

Vehicles with robotic transmission

Servoclutch adjustment

Proceed as follows:

❑ Measure the distance **A** between the bottom of the lever cavity and the servoclutch mounting plane.

The clutch lever must be in contact with the thrust bearing.

❑ Adjust the push-rod H as below:

B = (A -13,9 mm) + 33 mm

Where:

B = distance between the push rod H and the servoclutch mounting plane

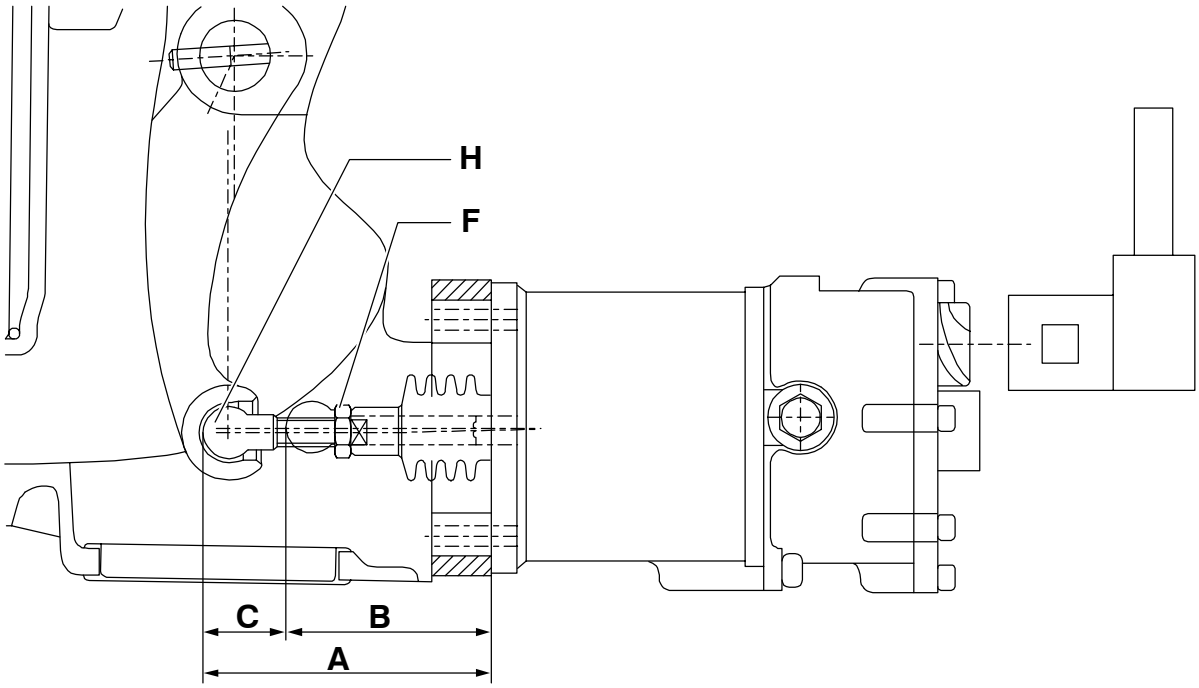
A = distance between the bottom of the lever cavity and the servoclutch mounting plane.

C = actuator stroke (33 mm)

❑ Tightent the lock nut **F**.

The clutch wear stroke at servoclutch (set in the transmission control unit) is 25 mm, which corresponds to disk wear of 2.5 mm (minimum guaranteed wear on clutch disk).

Figure 17



27204006

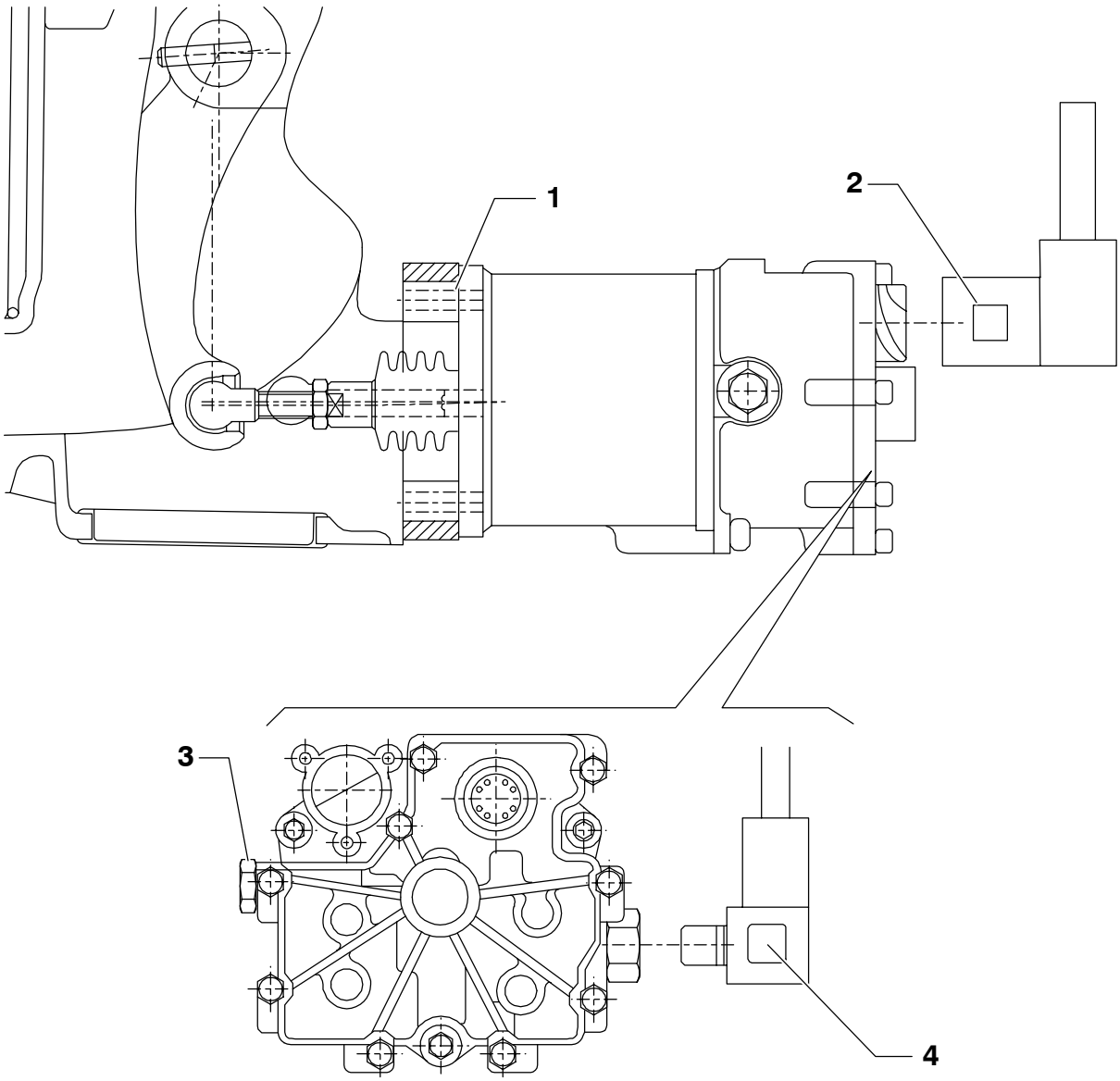
Mounting servoclutch in clutch housing

Proceed as follows:

- ❑ Unscrew the plug (3) from the inspection hole, to release air from the chamber.
- ❑ Manually bring the servoclutch piston backwards against the pressure of the internal spring
- ❑ Replace the cap (3) to lock the piston back.
- ❑ Fit the push rod in the lever cavity
- ❑ Mount the servoclutch and secure it with the four nuts (1).
- ❑ Unscrew the cap (3) and move the piston forward
- ❑ Retighten the cap (3).
- ❑ Connect the electrical connector (2) and the air delivery pipe (4)

Before connecting the air line check that the servo-clutch is correctly fastened to the clutch housing.

Figure 18



27204007

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POWER TAKE-OFF

SECTION 5

SECTION 5

Power take off

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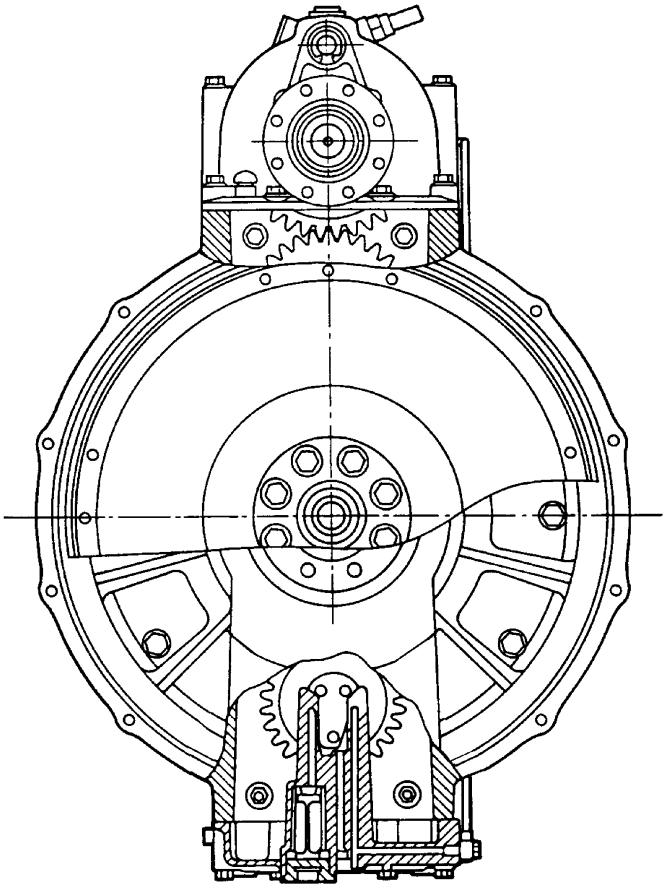
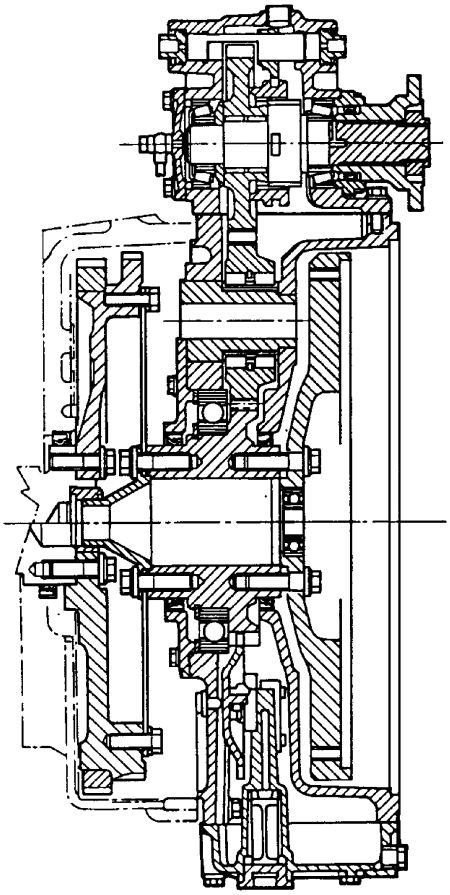
DESCRIPTION

The power take off is situated between the engine flywheel and the clutch assembly and is fitted with a non-synchronised pneumo-mechanical positive clutch to transfer the movement from the engine drive shaft to the pick up flange. Lubrication is ensured by an oil pump.

Figure 1



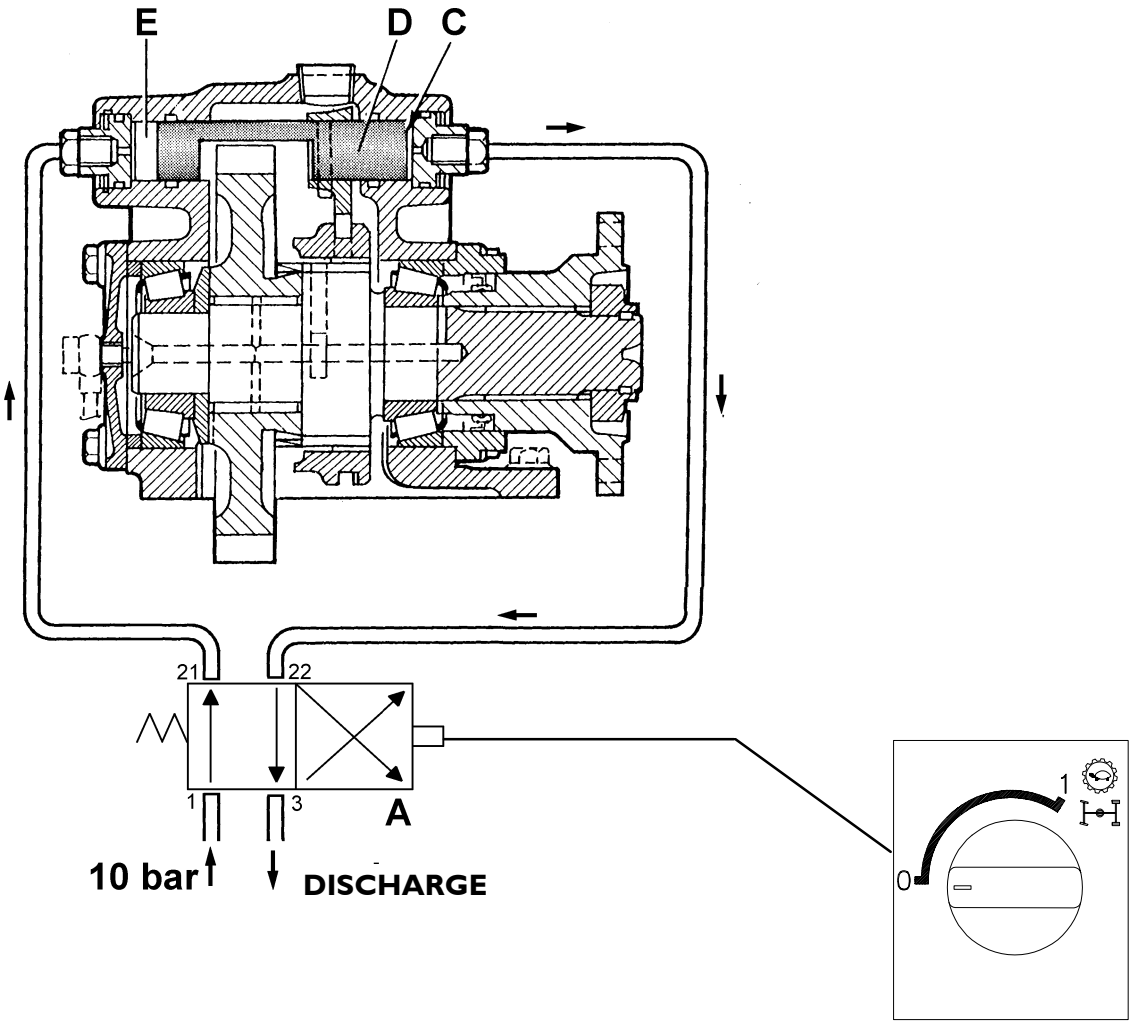
1780501



1780502

Operation

Figure 2

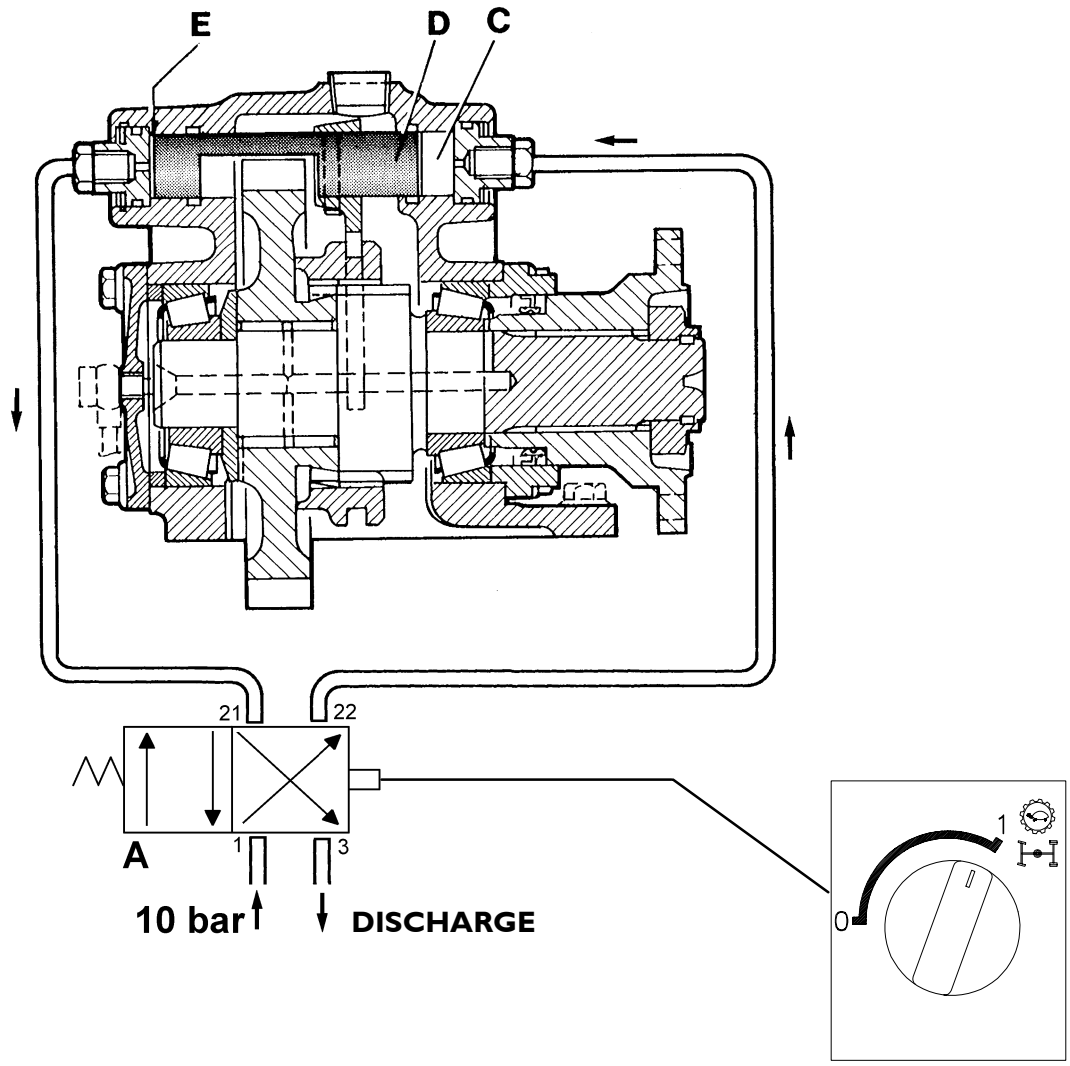


40787

Power take off disengaged

With the switch in position **0** (disengaged) the air taken in enters valve **A** by link (1), leaves by link (21) and passes through the pipes to chamber **E**, moving the control rod with fork **D** in power take off position disengaged.
At the same time the air in chamber **C** passes through the piping to the link (22) and passes into the air by link (3).

Figure 3

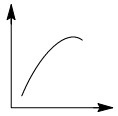
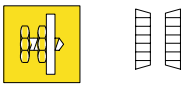
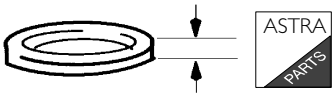
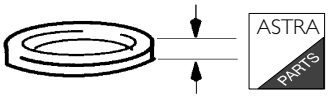
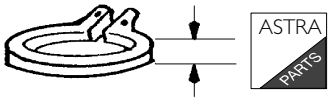


40787

Power take off engaged

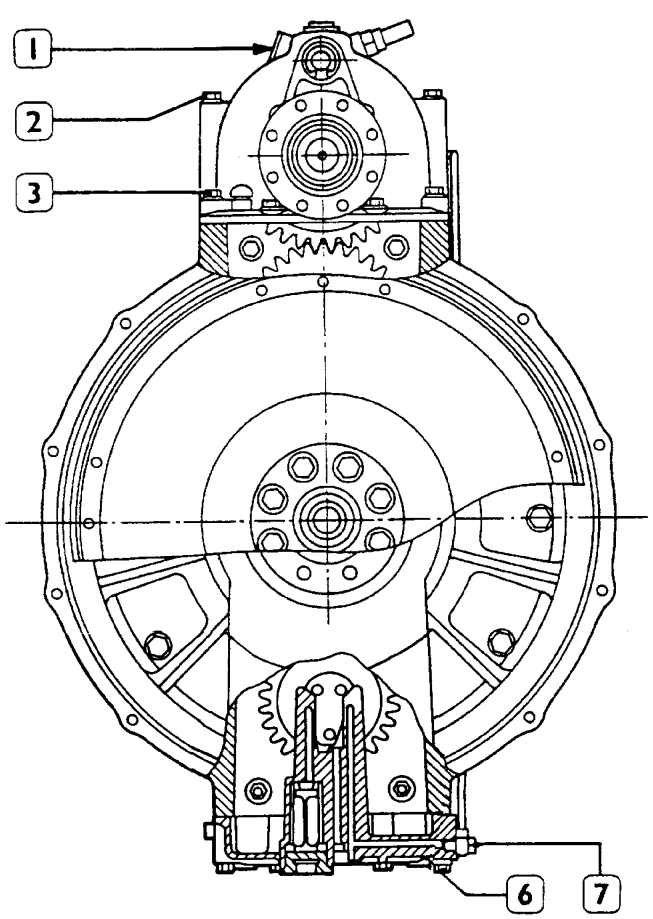
With the switch in position **I** (engaged) the air taken in through link (1) enters valve **A** leaves by link (22) and passes through the pipes to chamber **C**, moving the control rod with fork **D** in power take off position engaged.
At the same time the air in chamber **E** passes through the piping to the link (21) into valve **A** and passes into the air by link (3).

FEATURES AND DATA

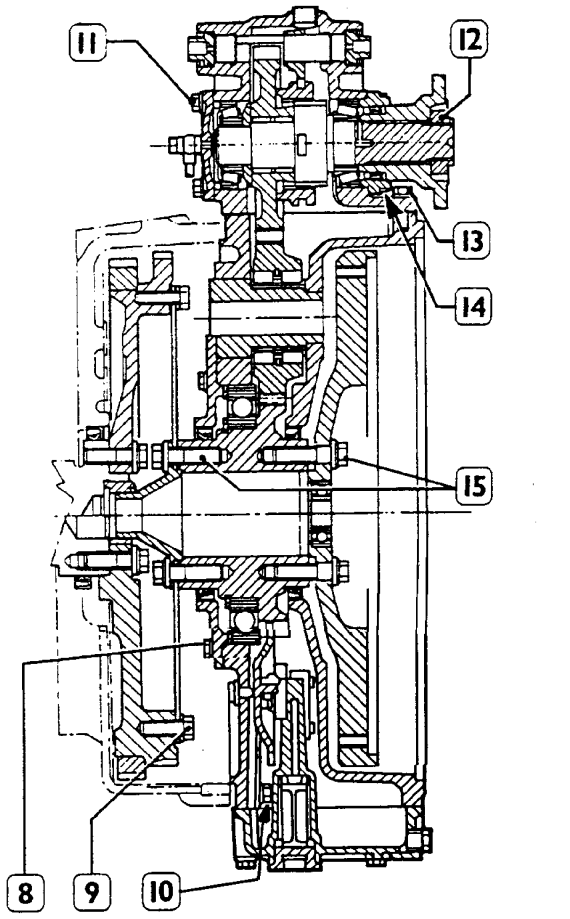
	Ratio revolutions - rpm	1 : 1,29
	Torque	900 Nm
	Direction of rotation	Same as engine
Type of engagement/release control		Electro - pneumatic
	Bearings for output shaft	2 tapered roller bearings
	Bearing settings	Using setting rings
	Distances setting rings	5,5 – 5,6 – 5,7 – 5,8 – 5,9 6 – 6,1 – 6,2 mm
	Bearing for control shaft	1 ball bearing
	Bearing settings	Using setting rings
	Thickness setting rings	3,95 – 4 – 4,05 – 4,10 – 4,15 – 4,20 4,25 – 4,30 mm
	Thickness safety split ring	3,60 – 3,65 – 3,70 – 3,80 3,85 – 3,90 mm
	Quantity (*)	

(*) For the correct type of fluid, see section 2 - HYDRAULIC FLUID AND LUBRICANTS TABLE

Figure 4



1780503



1780504

DRIVING TORQUES

	DESCRIPTION	TORQUE	
		Nm	Kgm
1	Plug	27,5	2,75
2	Screws M 10 x 140	43	4,3
3	Screws	43	4,3
4	Pipe		
5	Screws		
6	Screws M 8 x 60	18	1,8
7	Joint	5,5	0,55
8	Screws for cover	22	2,2
9	Screws	82	8,2
10	Nut with flange for stud	29	2,9
11	Screws M 8 x 30	18	1,8
12	Nut M 33 x 1.5	380	38
13	Screws M 10 x 30	43	4,3
14	Screws M 8 x 30	18	1,8
15	Screws	*	*
	* The screws must be tightened in two stages 1st stage pre-torque 2nd stage to angle	95	9,5 60°

NB: Apply "LOCTITE 242e" to the plugs and joints in contact with the lubricant

TOOLS

TOOL NO.	DESCRIPTION
99322205	Revolving stand for unit overhaul
99341009	Pair of brackets (to be used with extractor 99341002)
99341015	Clamp
99341016	Grips (to be used with extractor 99341002)
99345049	Thrust block for extractors
99360503	Eyebolt
99363241	Output shaft adjusting plates
99370317	Reaction rod with flange holding extension
99395216	Angle tightening tool

SPECIAL MAINTENANCE
Oil replacement

Proceed as follows:

- ❑ unscrew the cap (1) and drain off the oil completely
- ❑ pour in new oil through the cap (2)
- ❑ having finished this operation, move the vehicle for about 5 minutes. Stop it on level ground.
- ❑ check the oil level through the screw (arrow), waiting until the oil has finished pouring out.

After the first 25 hours of use, it is necessary to clean the filter on the intake pipe. To do so, proceed as follows:

- take out the filter unscrewing the retaining cap (3), clean it with diesel oil and dry it with compressed air. If it is not in good condition replace it;
- check the gaskets and if necessary replace them.

Figure 5

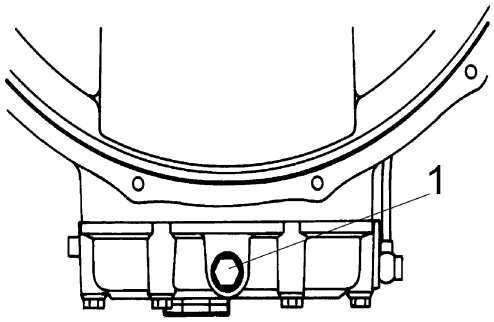


Figure 6

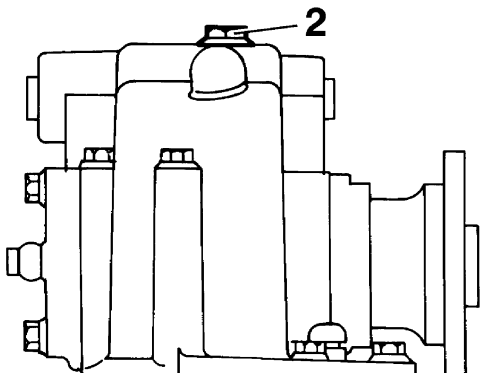
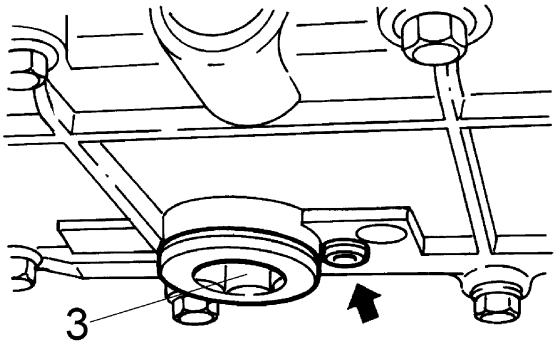


Figure 7



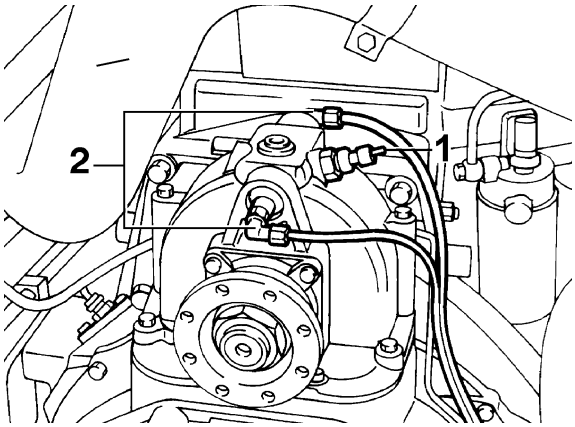
STRIPPING DOWN - REFITTING INTEGRAL POWER TAKE-OFF

Stripping down

To remove the power take-off unit proceed as follows:

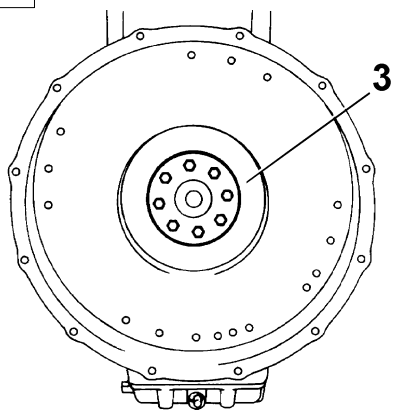
- ❑ set the vehicle on a pit or on a hoist;
- ❑ open the battery case and disconnect the cables to avoid short-circuits;

Figure 8



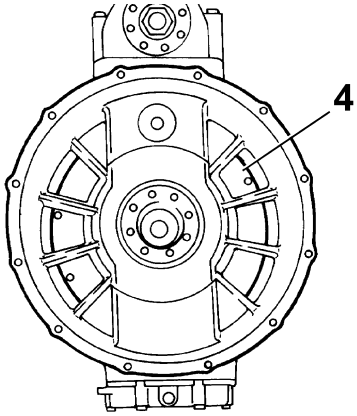
- ❑ disconnect the gearbox as described in Section 6;
- ❑ disconnect power take-off electrical (1) and pneumatic (2) connections;

Figure 9



- ❑ undo internal flywheel fixing screws and remove it;

Figure 10



- ❑ undo hub fixing screws (4) with engine flywheel, rotate the drive shaft to reach every screw;
- ❑ suitably support the unit, then undo engine connecting screws and remove the unit.

Refitting

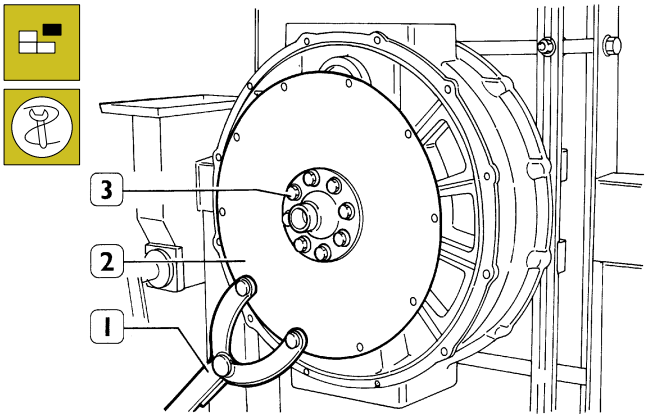
Reverse the operations for removal.

Before refitting the power take-off unit and the cover with oil pump spread surfaces with LOCTITE 510.

Plugs and screws in touch with oil shall be fitted with LOCTITE 242.

STRIP DOWN MAIN HOUSING

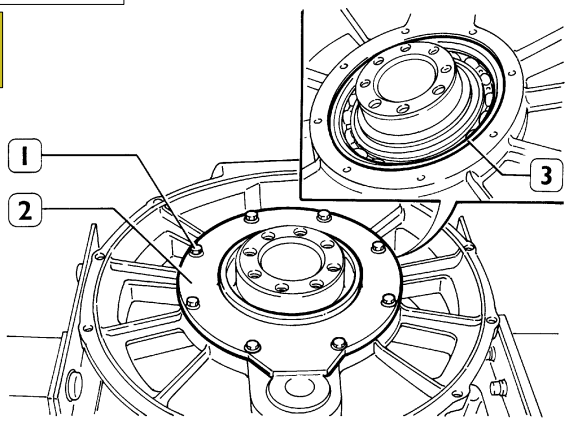
Figure 11



41019

Position the group on the rotating stand 99322205.
Block the rotation of the plate joint (2) using the tool 99370317 (1) and the appropriate wrench loosen the retaining screws (3) remove the plate joint and the flange.

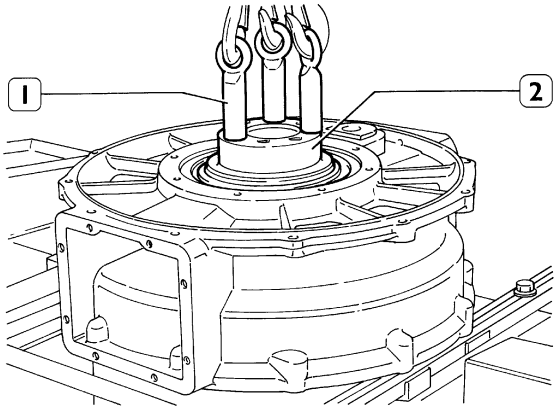
Figure 12



41020

Loosen the screws (1), remove the cover (2) complete with the choke ring and lift out the setting ring (3).

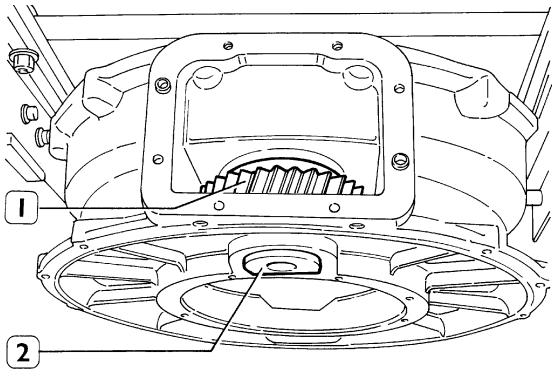
Figure 13



41021

Using tool 99360503 (1) and a hoist remove the shaft with toothed crown (2).

Figure 14

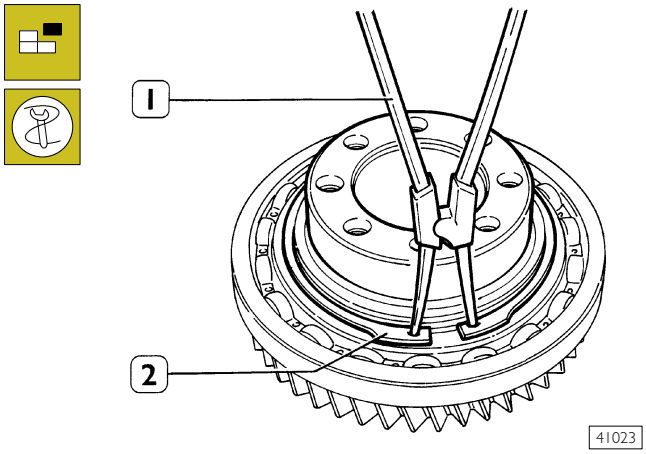


41022

Using the appropriate beater remove the shaft (2) and withdraw the return gear (1). Remove the choke ring from the housing.

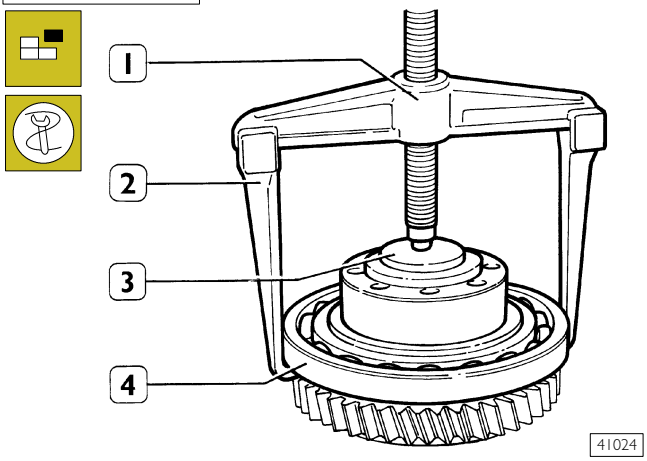
STRIP DOWN BEARING FOR SHAFT WITH TOOTHED CROWN

Figure 15



Using the appropriate pliers (1) remove the choke ring (2).

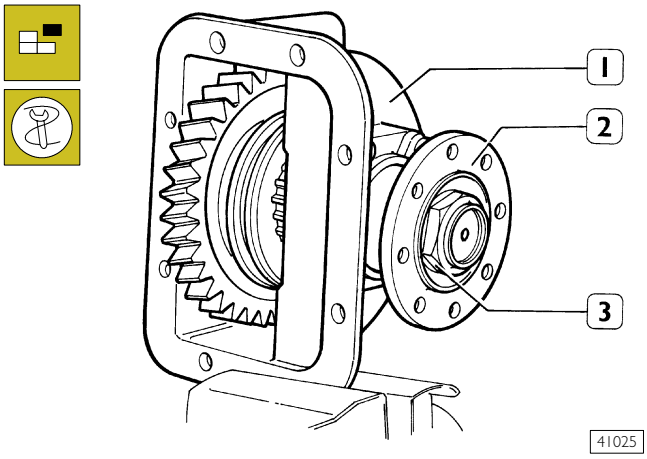
Figure 16



Remove the ball bearings (4) using tools 99341003 (1), 99341009 (2) and 99345049 (3).

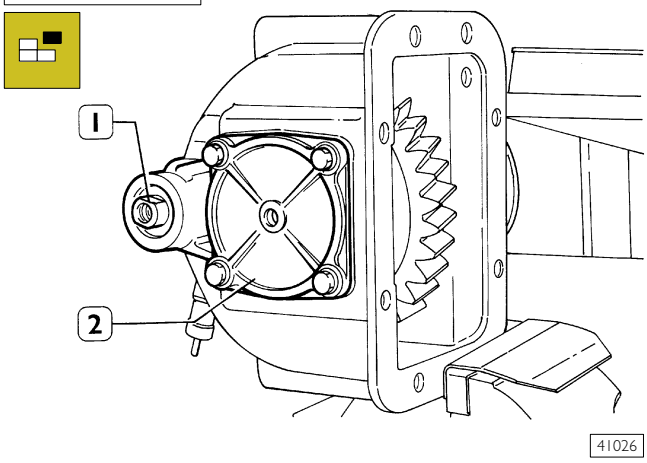
STRIP DOWN OUTPUT SHAFT

Figure 17



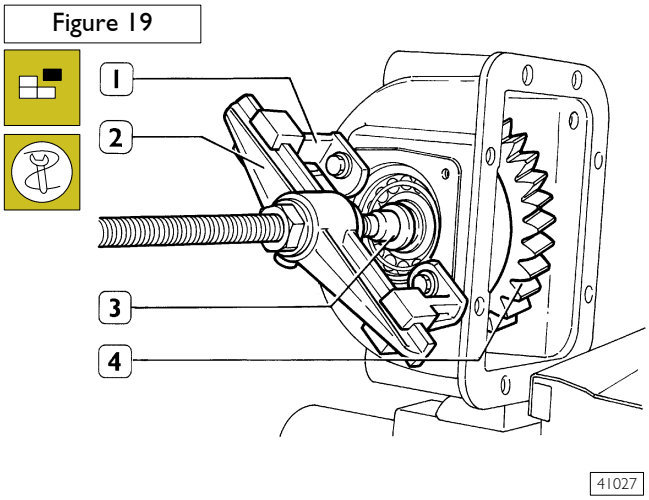
Position the group in a vice, unscrew the nut (3) remove the flange (2), loosen the screws and remove the cover (1).

Figure 18



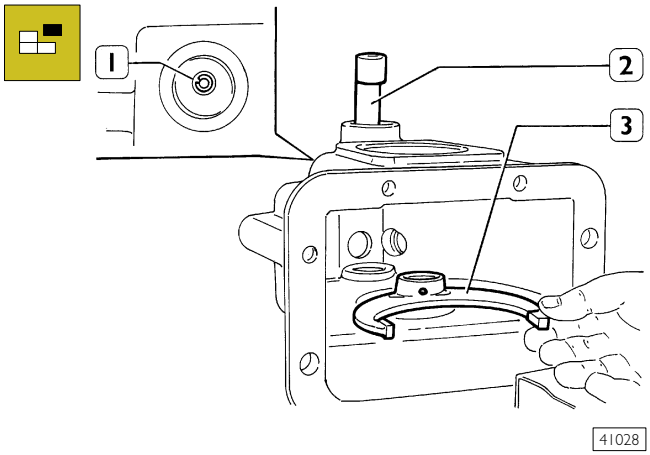
Loosen the screws and remove the cover (2); remove the setting ring.
Remove the safety ring and the joint (1), unscrew the electrical sensor.

Figure 19



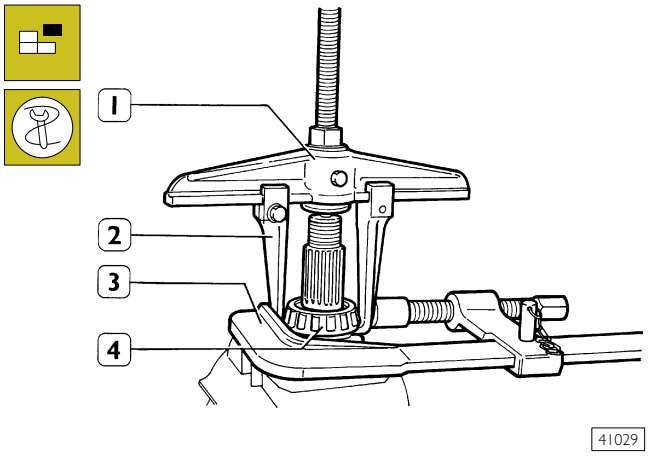
Fit tool 99341002 (2) and with tool 99341016 (1) withdraw the toothed shaft (3).
Remove the gear. (4).

Figure 20



Remove the spring cotter (1) remove the shaft (2) and the selector fork (3).

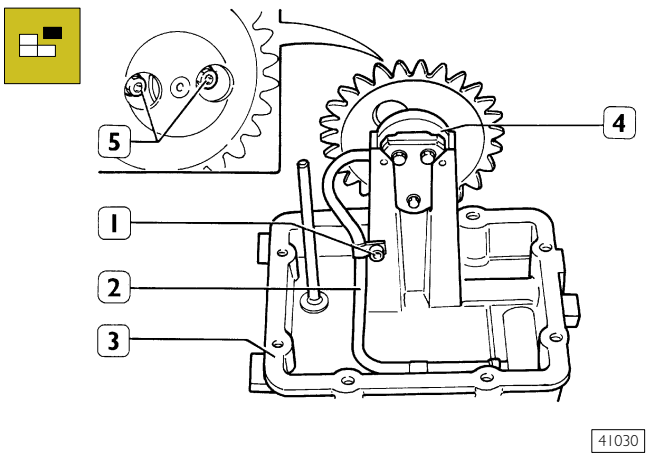
Figure 21



Fit the transmission shaft in a vice and using tools 99341002 (1), 99341009 (2) and 99341015 (3) remove the taper bearings (4).

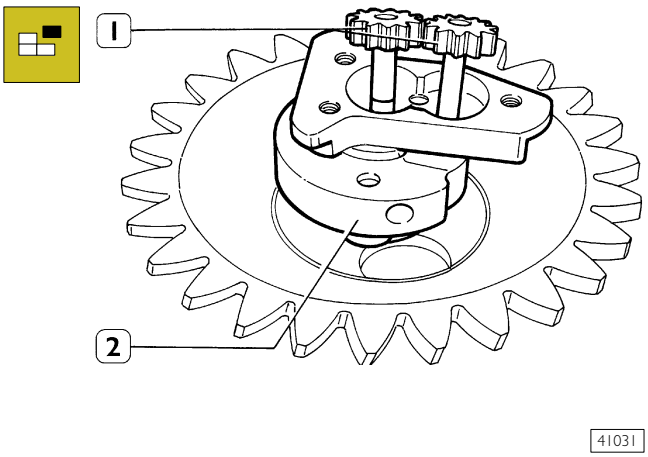
STRIP DOWN OIL PUMP

Figure 22



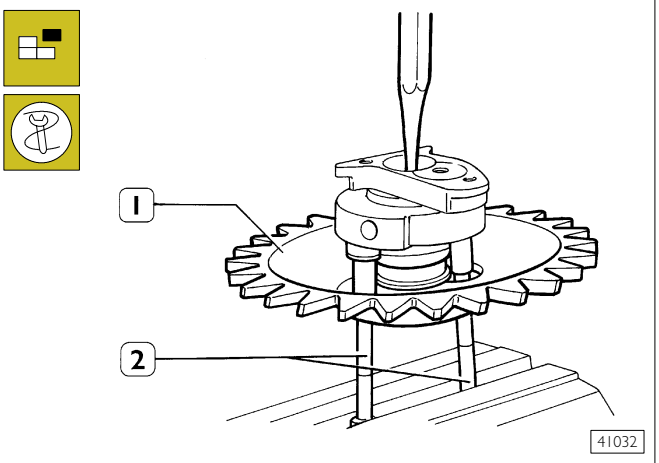
Loosen the screws (1) holding the oil intake pipes (2), loosen the screws (5) holding the oil pump (4) and remove the cover (3).

Figure 23



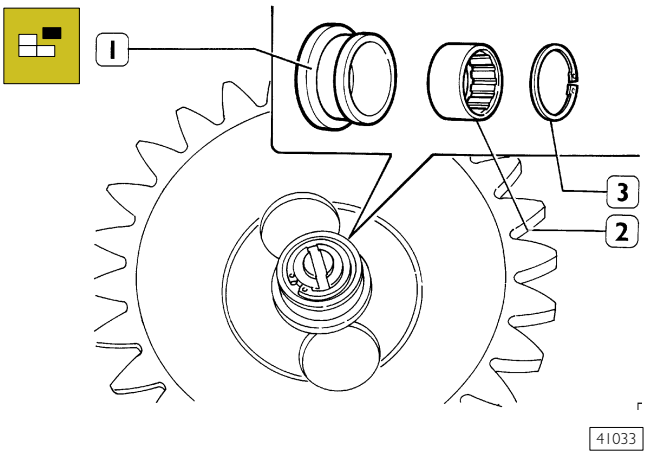
Unscrew the three screws, remove the cover and withdraw the gears (1) of the oil pump (2).

Figure 24



Using the two pins (2) remove the gear (1) complete with support and bearing.

Figure 25



Remove the support (1), the split ring (3) and the roller bearings (2) from the gear.

CLEANING AND CHECKING THE PARTS

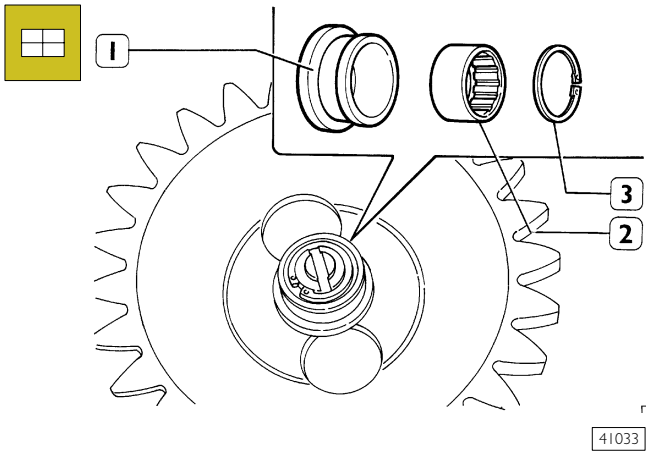
When the strip down is completed immerse all the parts except for the bearings in wash tanks containing a solution of water and soda heated to 80 ÷ 85°C until all residues of lubricant dissolve.
Clean the parts thoroughly using a metal brush and a scraper, taking care not to damage them.
Repeat the wash and dry the parts using compressed air.
Using an electrical polishing machine with metal brushes eliminate all traces of sealant from the thread of the screws.
Clean the bearings in a petrol bath and use a paintbrush to remove all traces of lubricant.

Dry the bearings using compressed air - do not let the air roll the bearings.
Lubricate the bearings using the same oil as the gears.
Press the bearings down with one hand and roll them around, there must be no noise, and they must move smoothly.
Check the rollers and respective cages, the external and internal tracks for wear.
Check all parts and decide whether they can be reused or must be replaced.

FITTING

Oil pump

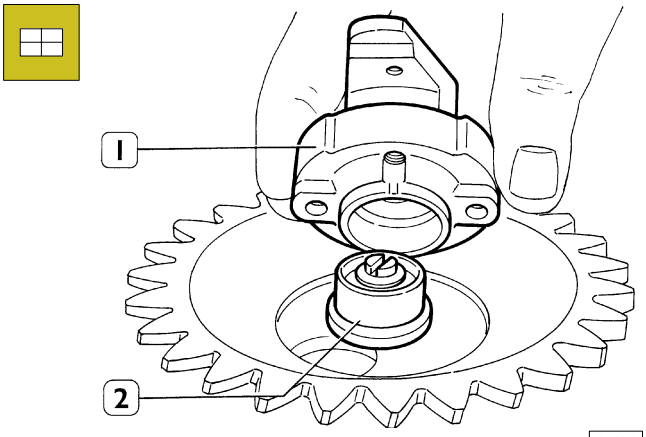
Figure 26



41033

Fit the roller bearings (2) on the gear, block them with the split ring (3) and fit the support (1).

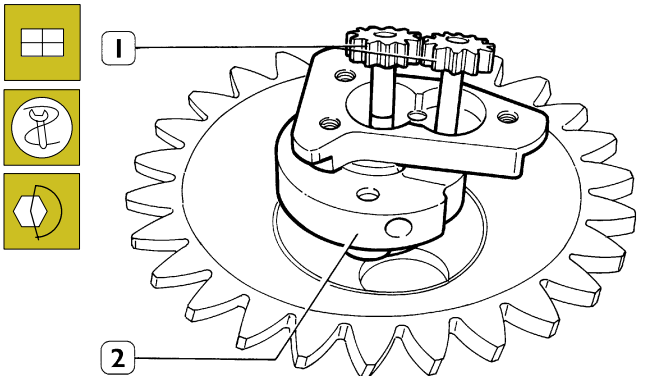
Figure 27



41034

Fit the support (2), the oil pump body (1).

Figure 28

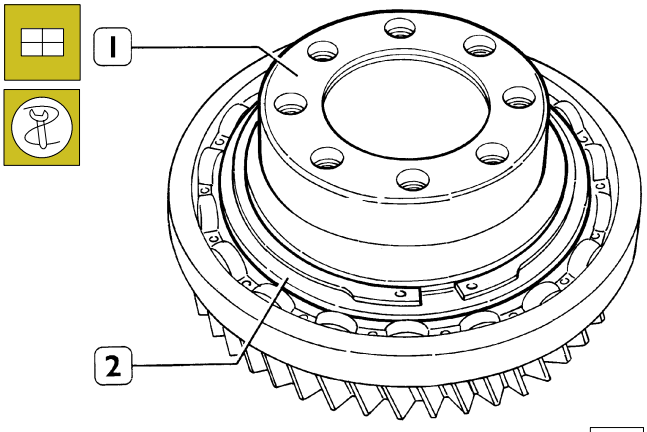


41031

Fit the gears (1) in the oil pump body (2) oil them and fit the cover, blocking the three screws to torque 0.7 ÷ 0.8 kg.

Fitting the bearings for shaft with toothed crown

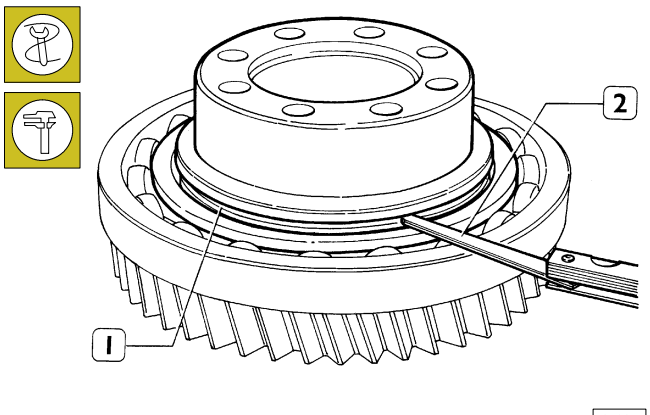
Figure 29



41035

Heat the inner ring of the bearing (2) to ~ 80°C and key it onto the shaft (1).
Allow it to cool before continuing work.

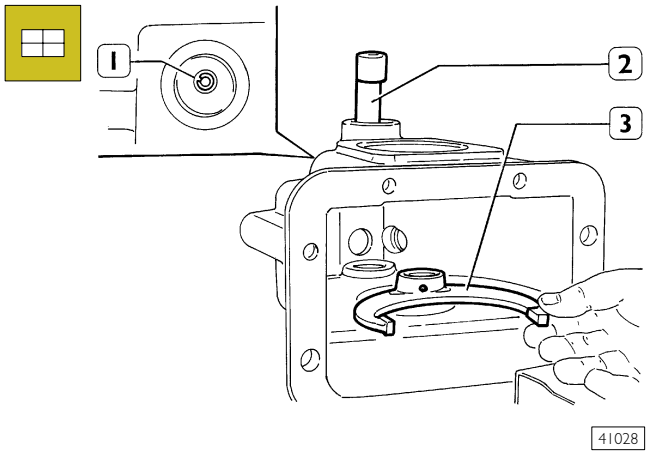
Figure 30



Using a feeler gauge (2) measure the play (1) between the bearing and the seat of the safety split ring and decide which of the safety split rings with allow the least possible play.

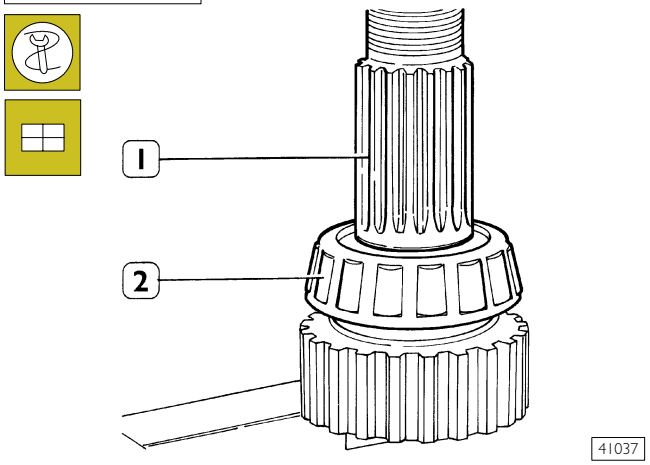
Output shaft unit

Figure 31



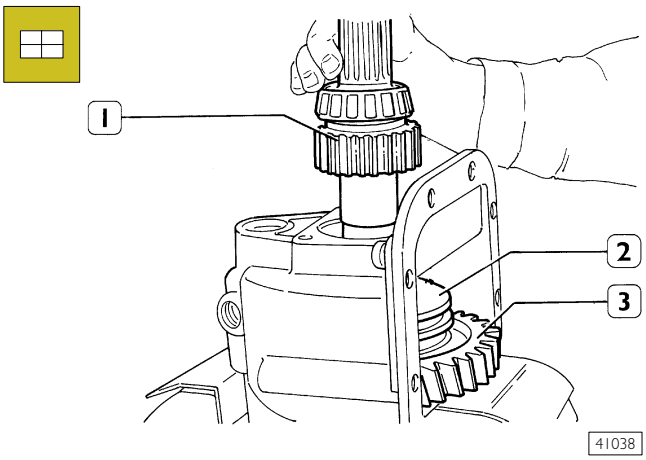
Fit the housing in a vice. Fit the fork (3), key on the shaft (2) and fit the spring cotter (1).

Figure 32



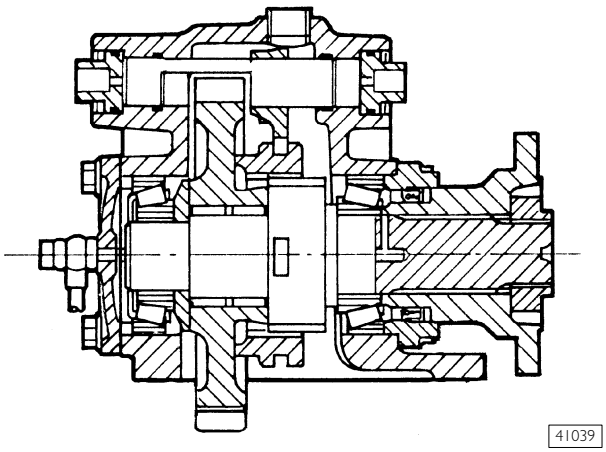
Heat the inner ring of the bearing (2) to 80°C and key it onto the transmission shaft (1).

Figure 33



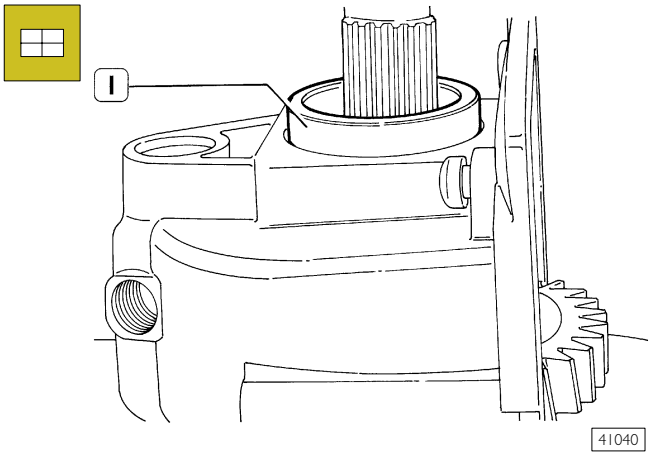
Fit the gear box (3) complete with collar (2) fit the transmission shaft (1).

Figure 34



OUTPUT SHAFT UNIT SECTION

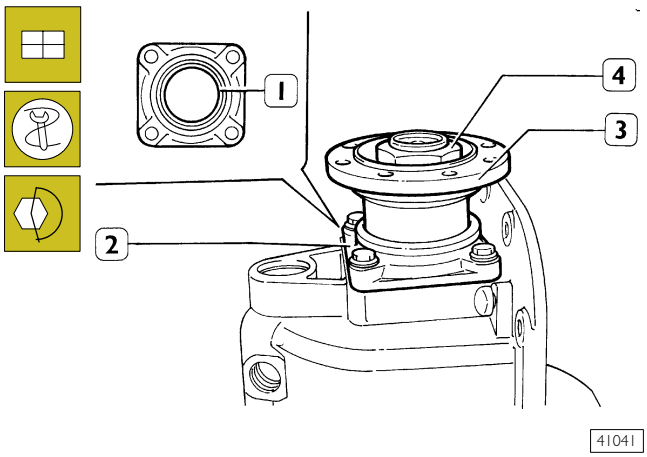
Figure 35



Fit the outer bearing ring (1).

Setting the taper bearings on the output shaft

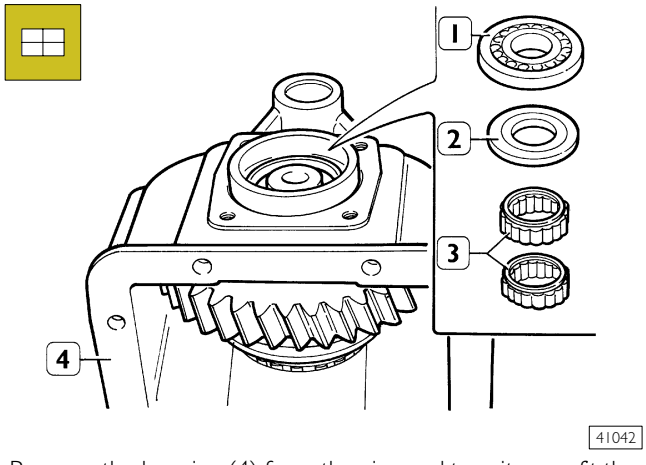
Figure 36



Using the appropriate beater fit the choke ring (1) on the cover (2), apply LOCTITE 510 to the contact surfaces, fit the cover (2) and tighten the screws to torque 18 Nm; fit the flange (3) and tighten the nut (4) by hand.

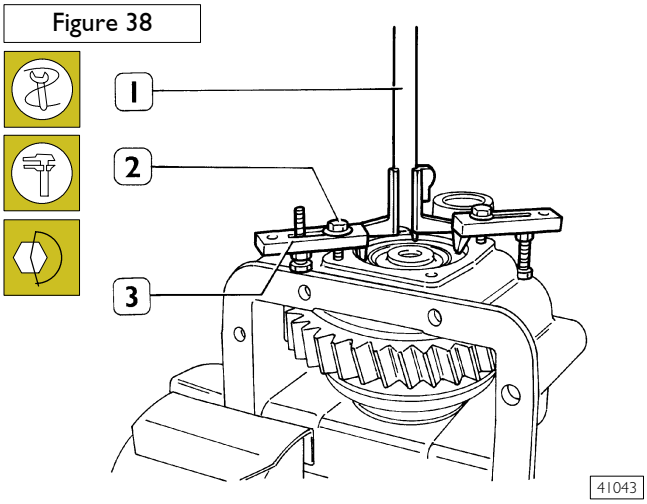
The nut (4) must be tightened to torque 380 Nm (38 kgm) on the vehicle after linking up the output shaft unit.

Figure 37



Remove the housing (4) from the vice and turn it over; fit the roller bearings (3) on the shaft, the shoulder ring (2) and the taper bearings (1).

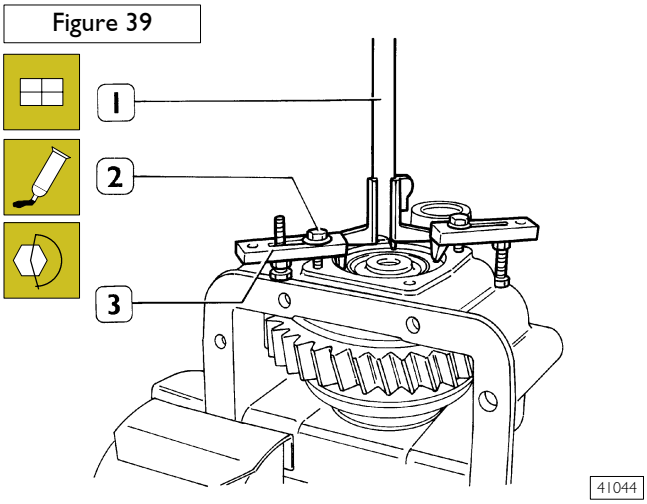
Figure 38



Fit the plates 99363241 (3) onto the outside ring of the bearing, tighten the screws (2) to torque 18 Nm (1.8 kgm) corresponding to an axial load of 250 kg, rotate the output shaft.
Using a gauge (1) determine the distance between the contact surface and the outer ring of the bearing.
The distance will correspond to the thickness of the setting ring.

The choice of the setting ring thickness must be approximate:
Example distance 6 ÷ 6.04 mm = setting ring 6 mm
distance 6.05 ÷ 6.09 mm = setting ring 6.1 mm

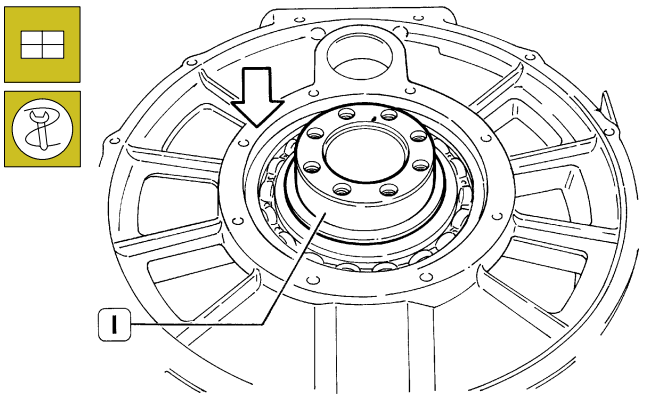
Figure 39



Fit the setting ring (1), apply LOCTITE 510 sealant to the contact surface (2), fit the cover (3) and tighten the screws to torque 18 Nm (1.8 kgm)
Replace and fit the choke rings on the joints fit the safety split rings, screw on the transmitter (7).

Fitting the main housing

Figure 40

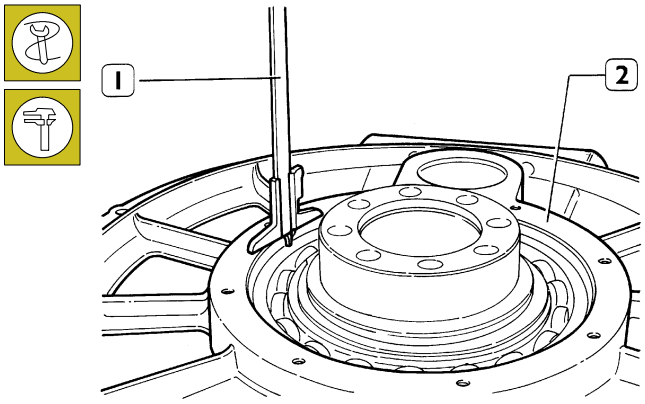


41045

Heat the seat (⇓) of the ball bearings slightly and fit the shaft with toothed crown (1) complete with bearings.

Setting the ball bearings

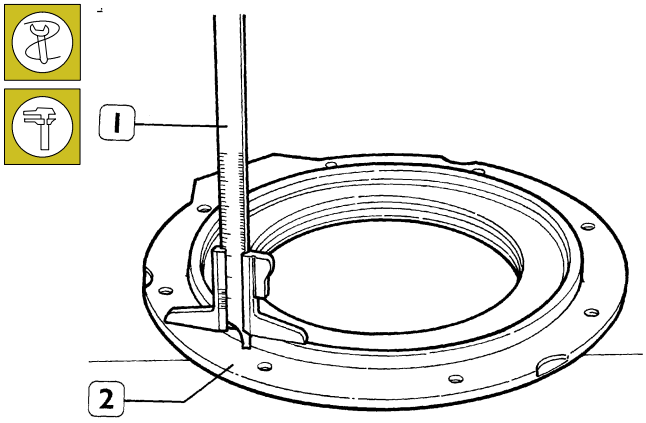
Figure 41



41046

Using a feeler gauge (1) determine the value (A, figure 39) on the main housing.

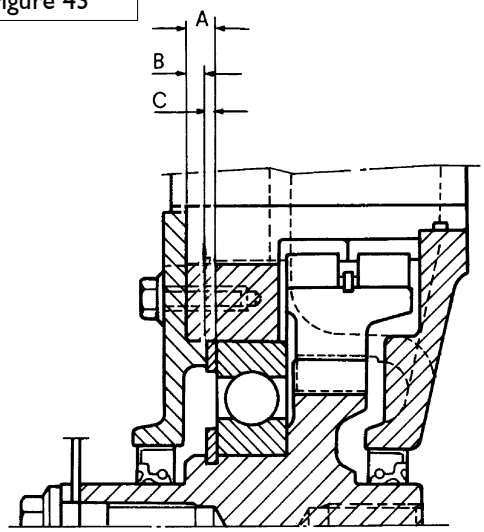
Figure 42



41047

Using a gauge (1) determine the value (B, figure 40) on the bearing cover (2).

Figure 43



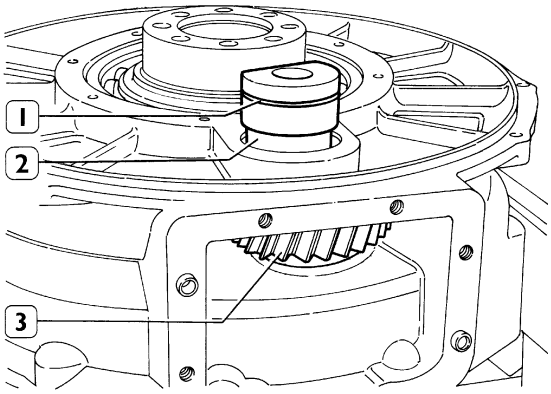
41048

PARTIAL CROSS SECTION OF THE BEARING AND SHAFT WITH TOOTHED CROWN

The value "C" of the setting ring is given by the formula: A - B = C.

If the value "C" is equal to the nominal thickness of the setting ring (see table on page 6) fit the ring.
If the value "C" is different fit a setting ring of a lower value.
Example "C" = 4.14 mm ÷ 4.11, fit setting ring 4.1 mm.

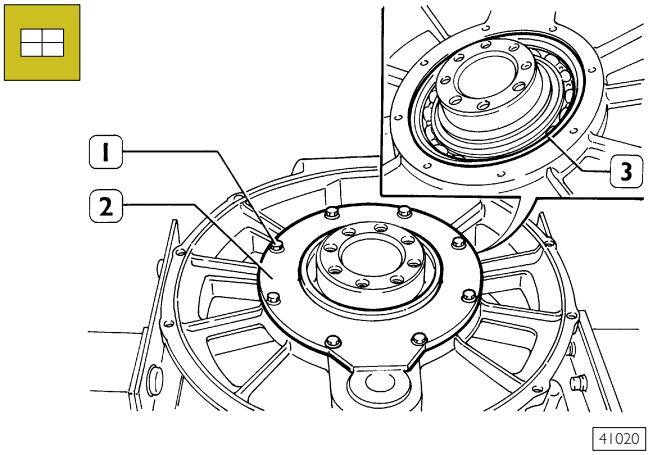
Figure 44



41049

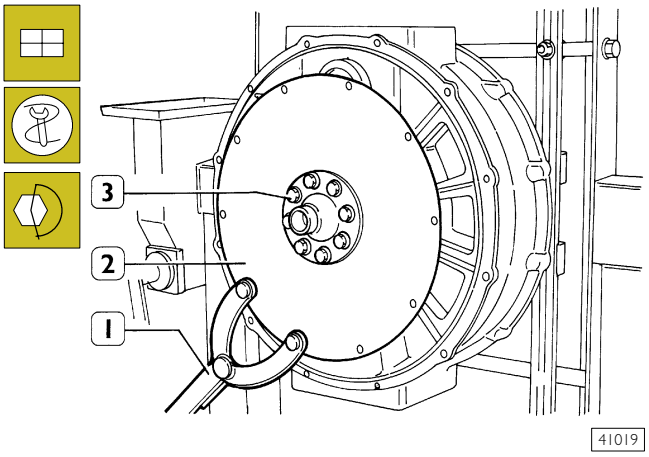
Fit the return gear housing (3), replace the choke rings (1) and fit the gear housing (2).

Figure 45



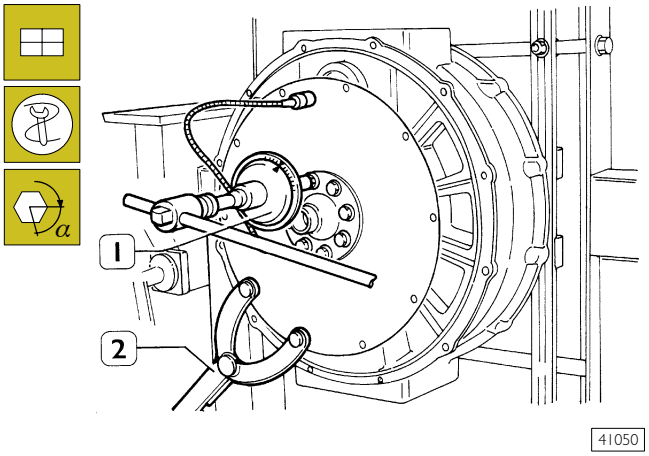
Fit the setting ring (3), apply LOCTITE 510 sealant to the contact surface; fit the cover (2) complete with choke ring and tighten the screws to torque 22 Nm (2.2 kgm).

Figure 46



Fit the plate joint (2) with the flange, block it using tool 99370317 (1) and tighten the screws to torque 95 Nm (9.5 kgm). 1st stage.

Figure 47



Fit tool 99395216 (1) to a box spanner and tighten the screws by a further 60°, 2nd stage

MANUAL GEARBOX (ZF 16S 1620 TD - ZF 16S 2320 TD)

SECTION 6

SECTION 6

Manual gearbox

DESCRIPTION

The ZF 16S 1620 and ZF 16S 2320 TD version consist of:

- a central box containing the primary shaft, drive input shaft, secondary shaft and the cogs of the four forward and one reverse gear;
- a rear casing containing the Epicyclical Reducer Group (G.R.E). The function of this is to double the number of forward gears by means of epicyclical gears with helical teeth.
  This gives a range of gears that starting with four input ratios permits eight different output ratios (four normal ratio and four low ratio gears);
- a front casing containing the "splitter", that gives a further double selection for each of the eight forward gears and for the reverse gear.
  The "splitter" halves the difference between two successive gears, effectively splitting each gear into a slow ratio (L = slow ratio) and a fast ratio (S = fast ratio).

These gearboxes therefore have a total of sixteen forward gears with finely scaled ratios, all engageable in succession, and two reverse gears.

The synchronisers are single cone type.

Lubrication is by means of a gear pump.

The double H type gear shift control is equipped with a pneumatically powered "servoshift" device to improve gear selection and engagement.

The servoshift is a device consisting of a mechanical/pneumatic functional unit and a dual action cylinder.

The advantages of this device are:

- gear selection and engagement more rapid and with less effort;
- it dampens the vibration of the control linkages, reducing noise;
- less strain to the synchronisers.

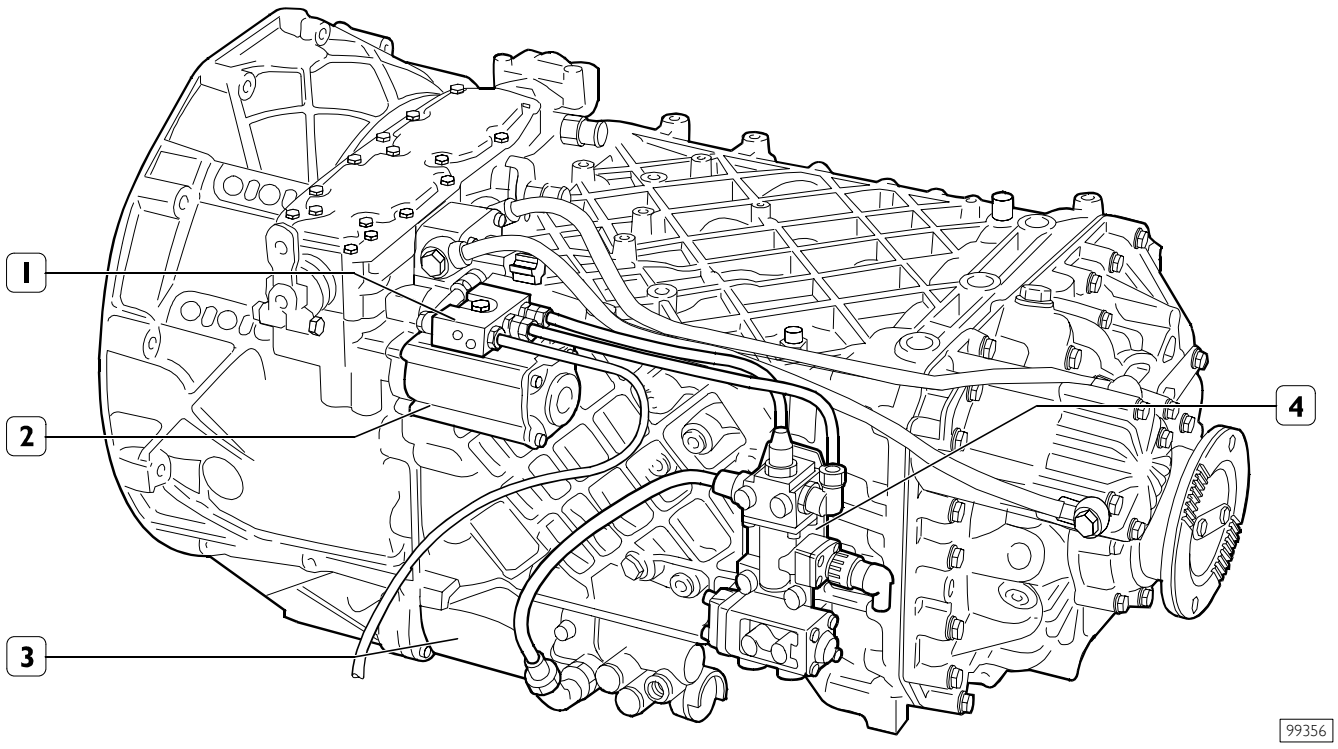
The device functions mechanically in case of pneumatic system failure.

The gearboxes mounted of vehicles with F3B engines are fitted with a synchro protection device.

This permits pneumatic power to the servoshift for gear engagement only after the clutch pedal has completed 70% of the disengagement stroke.

It consists of an electrovalve controlled by a proximity switch mounted on the clutch disengage master cylinder.

Figure 1

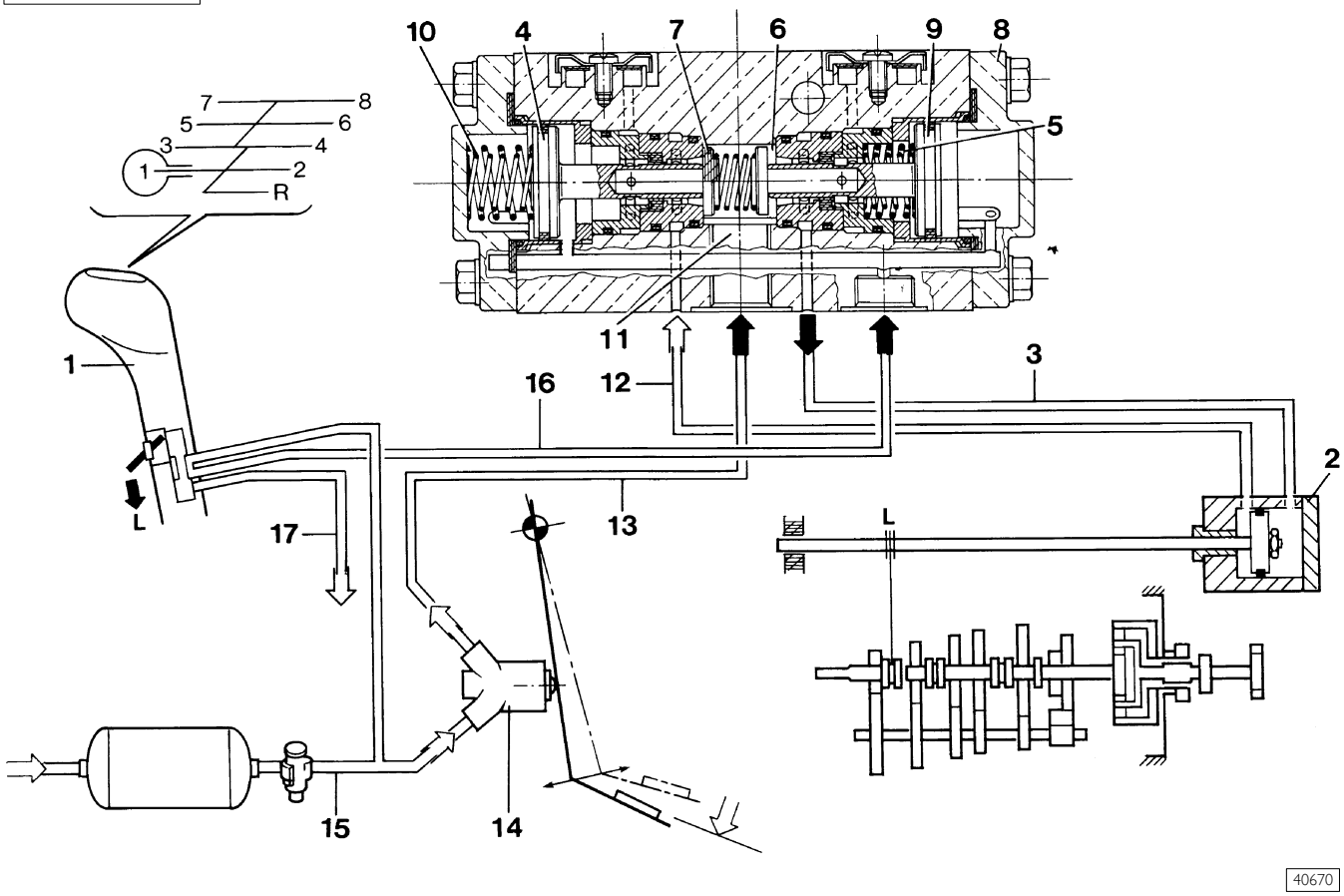


1. Distributor – 2. Servoshift – 3. Servoclutch – 4. *Servoshift power electrovalve

* only for vehicles with F3B engine

OPERATION
SLOW RANGE

Figure 2



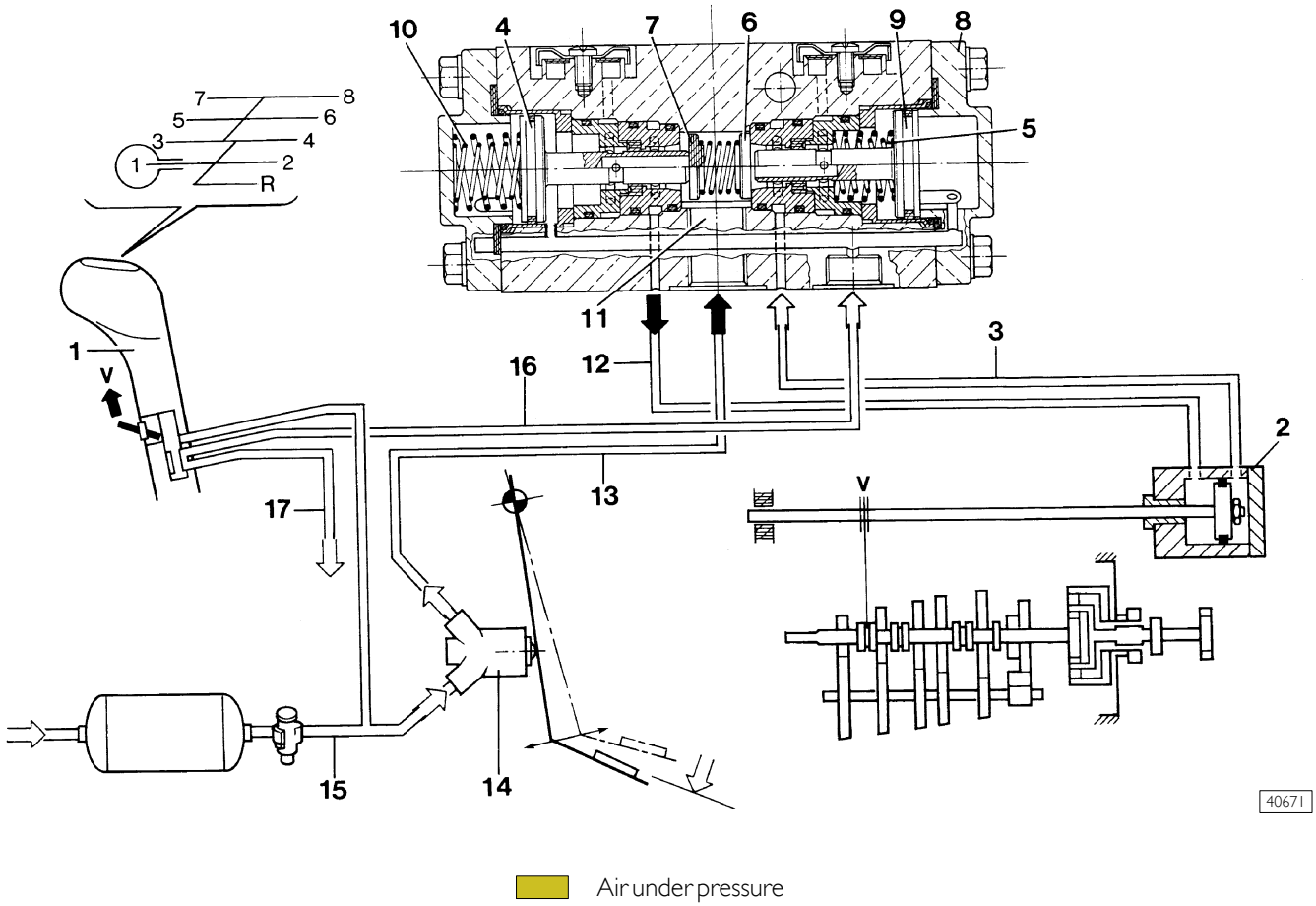
PNEUMATIC DIAGRAM FOR SLOW RANGE PRESELECTION

The air coming from the tank, through the connecting pipe (15), feeds the control valve(14) and the preselector (1) at the same time.
Moving the preselector(1) downward (slow range) makes the air coming to the preselector(1) through the connecting pipe (16) feed the double acting valve (8). As it feeds the above valve (8), the air under pressure moves to the left the pistons (4 and 9). The move of pistons (4 and 9) enables the valve (7) returning to its seat and then releasing, via the connecting pipe (12), the air under pressure that was contained in the left chamber of the splitter control cylinder (2).

At the same time, valve (6) moves and opens the air ducting between the inlet duct (11) and the one (3) to connect the right chamber of the splitter cylinder(2).
Depressing the clutch pedal makes the air that comes to the control valve(14) through the connecting pipes(13) feed the double acting valve (8).
The air coming to the valve (8) goes through the inlet duct (11), it feeds, through the connecting pipe (3), the right chamber of the splitter cylinder (2) and moves the control piston to the left, thus engaging the slow range .

FAST RANGE

Figure 3

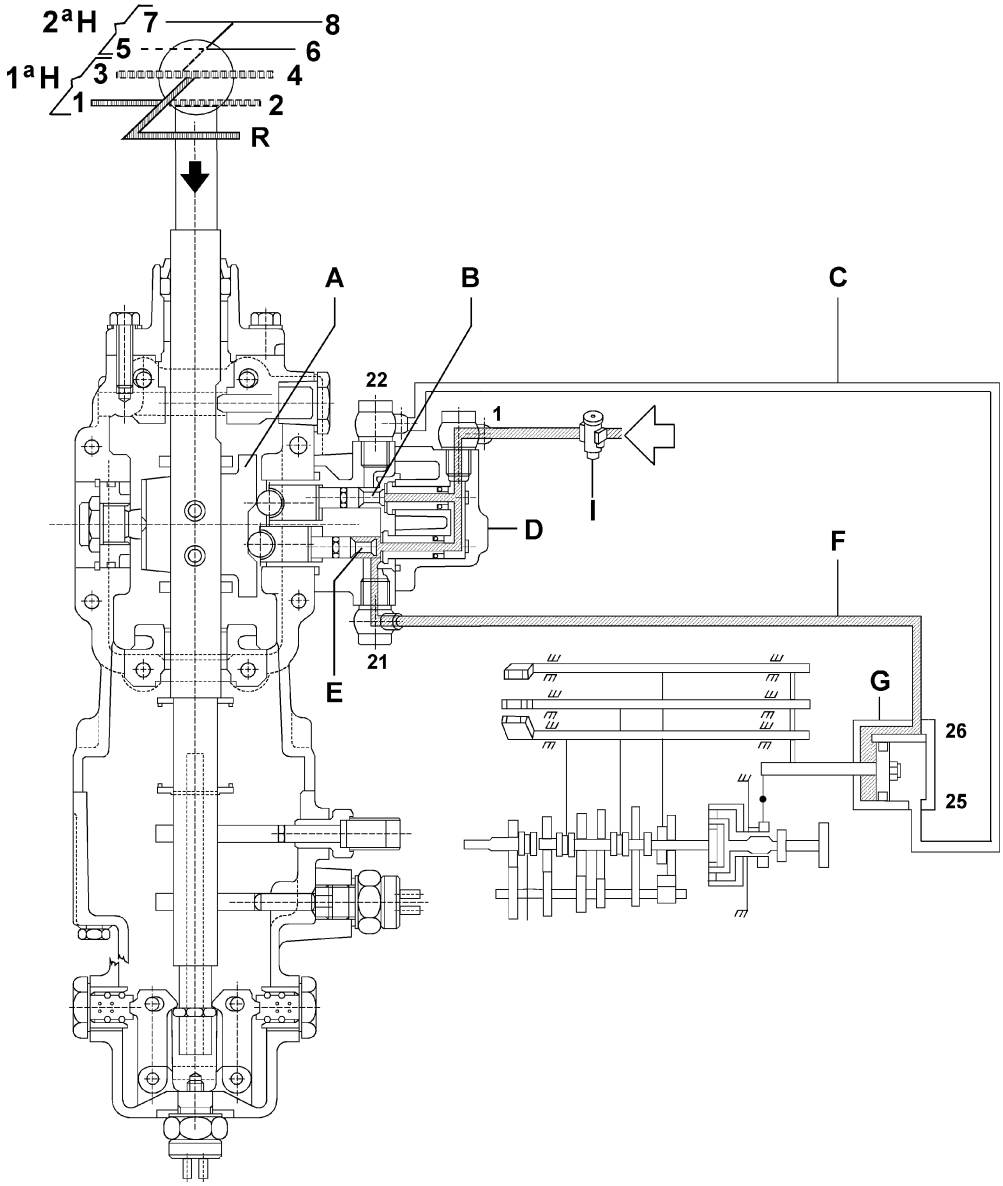


PNEUMATIC DIAGRAM FOR FAST RANGE PRESELECTION

The air coming from the tank, through the connecting pipe (15), feeds the control valve(14) and the preselector (1) at the same time.
Moving the preselector (1) upwward (fast range) cuts the air flow between the feeding pipe (15) and the double acting valve (8), thus the connecting pipe (16) enters into communication with the exhaust pipe (17).
As a consequence of the air release from the double acting valve (8), the springs (10) and (5) move the pistons to the right. The move of pistons (4 and 9) enables the valve (6) returning to its seat and then releasing, via the connecting pipe (3), the air that was contained in the left chamber of the splitter control cylinder (2).
At the same time, valve (7) moves and opens the air ducting between the inlet duct (11) and the one (12) to connect the left chamber of the splitter cylinder (2).
Depressing the clutch pedal makes the air that comes to the control valve (14) through the connecting pipes (13) feed the double acting valve (8).
The air coming to the valve (8) goes through the inlet duct (11), it feeds, through the connecting pipe (12), the left chamber of the splitter cylinder (2) and moves the control piston to the left, thus engaging the fast range.

REDUCED GEARS

Figure 4



GRAPHIC REPRESENTATION OF THE PNEUMATIC SYSTEM TO CONTROL THE ENGAGEMENT OF REDUCED GEARS

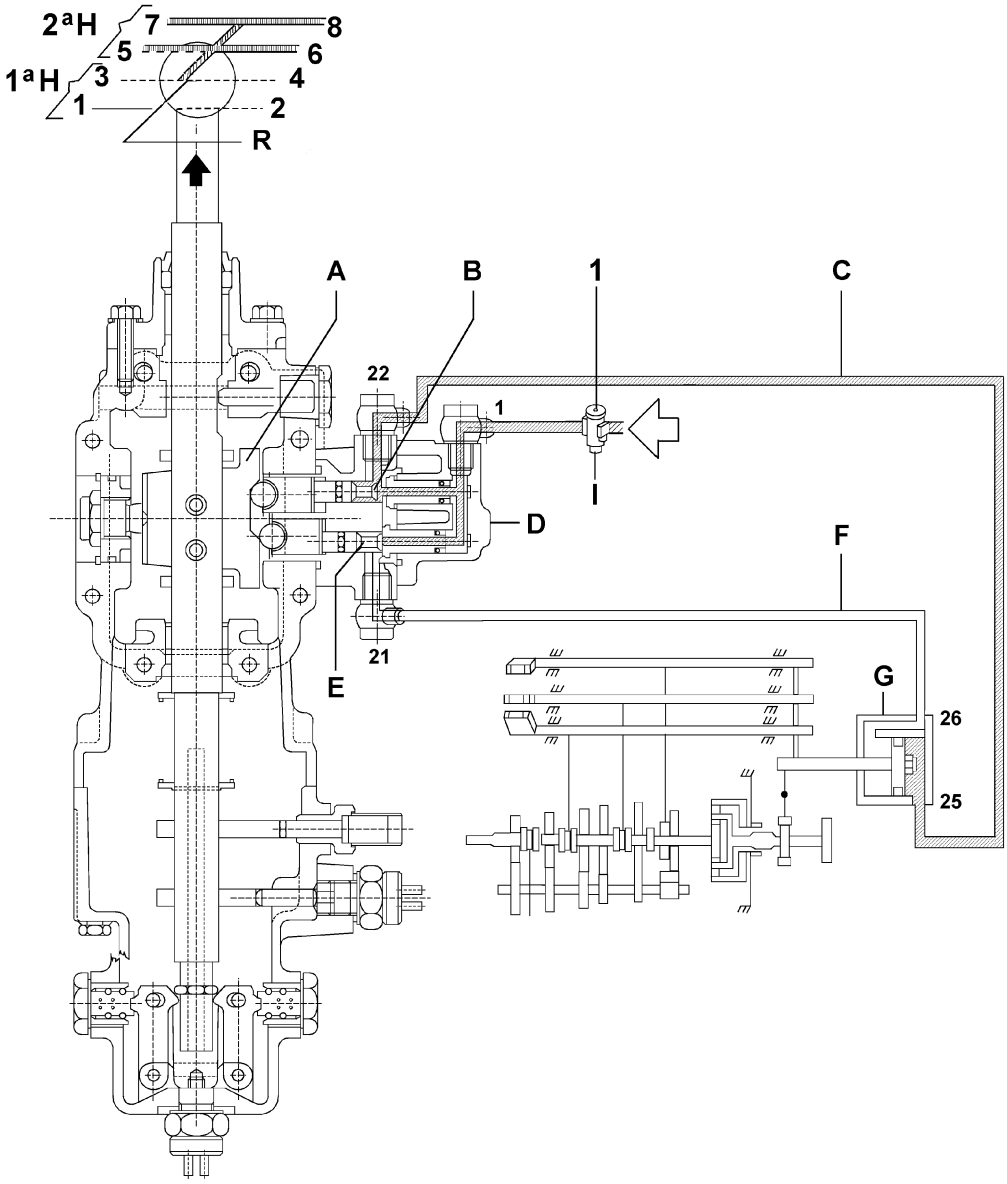
The air coming from the tank, through the reduction unit, reaches the pressureof 9.5 bar, then it feeds the control valve (D). Now, if we move the control lever to reduced gear position, the body (A) integral with the gear control rod opens the valve (E) that feeds the cylinder (G) through the pipe (F) The piston of this cylinder, when moving to the right, controls the kinematic chain downstream, thus enabling the engagement of the selected gear.

At the same time, the valve (B) of the control valve (D) closes,which enables the air coming from the pipe (C) to release to the atmosphere.

Reduced speeds can be selected in both fast and slow range according to the preselection position.

NORMAL GEARS

Figure 5



Air under pressure

GRAPHIC REPRESENTATION OF THE PNEUMATIC SYSTEM TO CONTROL THE ENGAGEMENT OF NORMAL GEAR

The air coming from the tank, through the reduction unit, reaches the pressureof 9.5 bar, then it feeds the control valve (D). Now, if we move the control lever to normal gear position, the body (A) integral with the gear control rod opens the valve (B) that feeds the cylinder (G) through the pipe (C) The piston of this cylinder, when moving to the left, controls the kinematic chain downstream, thus enabling the engagement of the selected gear.

At the same time, the valve (E) of the control valve (D) closes,which enables the air coming from the pipe (F) to release to the atmosphere.

Normal speeds can be selected in both fast and slow range according to the preselection position.

Figure 6

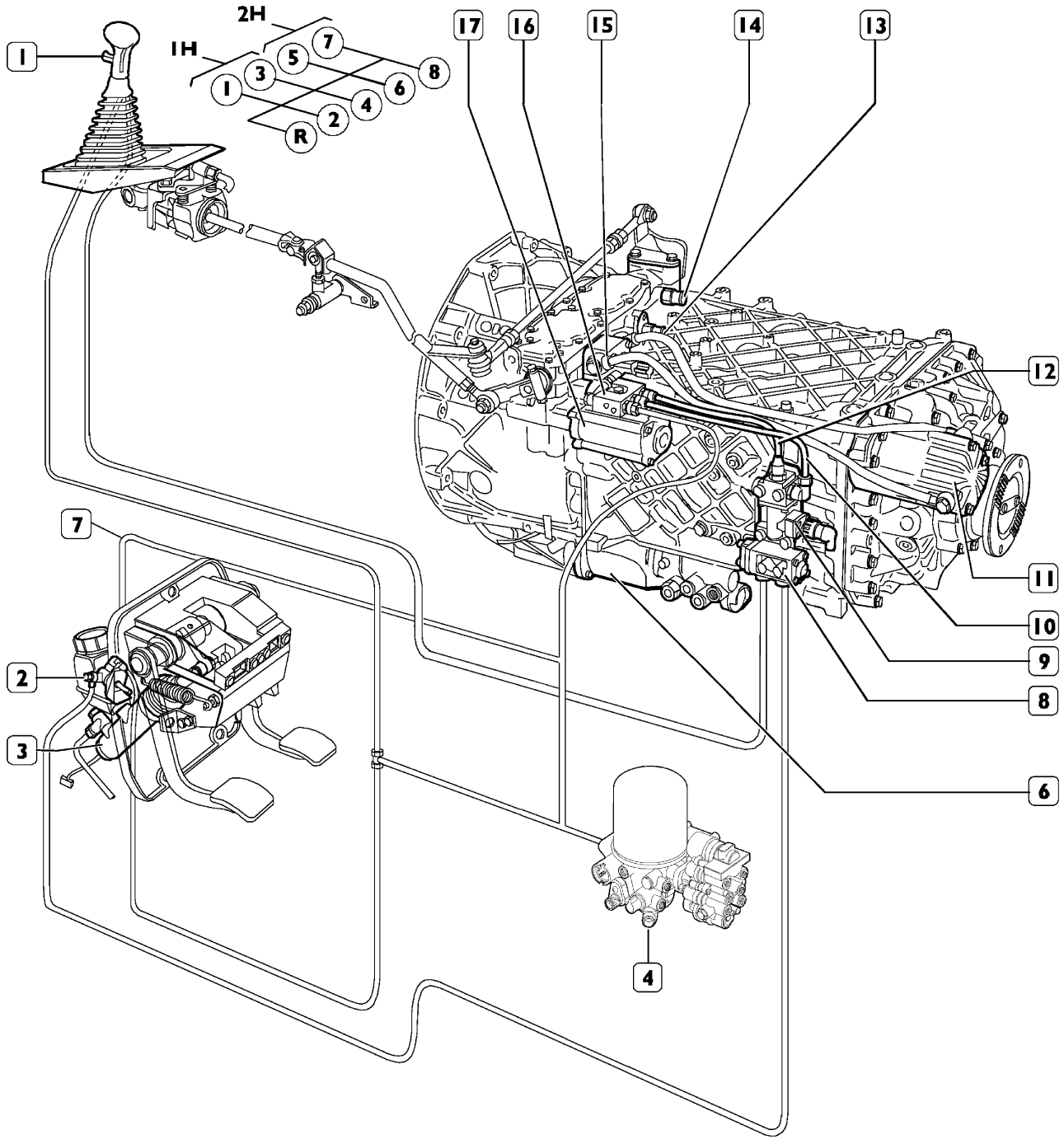


DIAGRAM OF PNEUMATIC COMMAND FOR GEARBOX WITH SERVOSHIFT

1. Splitter control selector - 2. Enable valve - 3. Master cylinder with proximity switch - 4. Pressure reducer - 5. Not used - 6. Clutch actuator - 7. Servoclutch feed pipe - 8. Two-way valve - 9. Electrovalve - 10. Pipe - 11. Epicyclical reducer group command cylinder. - 12. Pipe - 13. Neutral indicator switch -14. Pipe - 15. Command valve - 16. Distributor - 17. Servoshift

The splitter control (slow range gears – fast range gears) and the epicyclical reducer group control is pneumatic and built-in to the gearshift lever.
The selector (1) is used to preselect the L range (slow) and B range (fast) by means of the two-way control valve (8). These are engaged through the enable valve (2) when the clutch pedal is pressed.

The epicyclical group engages or disengages automatically when shifting from 1 H to 2 H and vice-versa.

When the gearbox is in neutral, the command cylinder (11) is actuated by pressurised air through the command valve (15).

Through the APU (4) the vehicle pneumatic system powers the distributor (16).

Through the pipe (10) the distributor (16) powers the electrovalve (9), which in turn powers the clutch actuator (6) through pipe (7), and the servoshift (17) through pipe (12), when enabled by the proximity switch mounted on the master cylinder (3). The proximity switch enables the electrovalve (9) when the clutch pedal has completed 70% of the clutch disengage stroke.
A switch (14) on the transmission control activates the reversing light when reverse gear is engaged. The neutral indicator switch (13) is on the transmssion control cover. Another switch on the epicyclical reducer group command cylinder (11) switches on the warning light in the cabin (with turtle ideogram), when the epicyclical reducer is engaged.

Servoshift

The servoshift is a device consisting of a mechanical/pneumatic module and a double-acting cylinder.

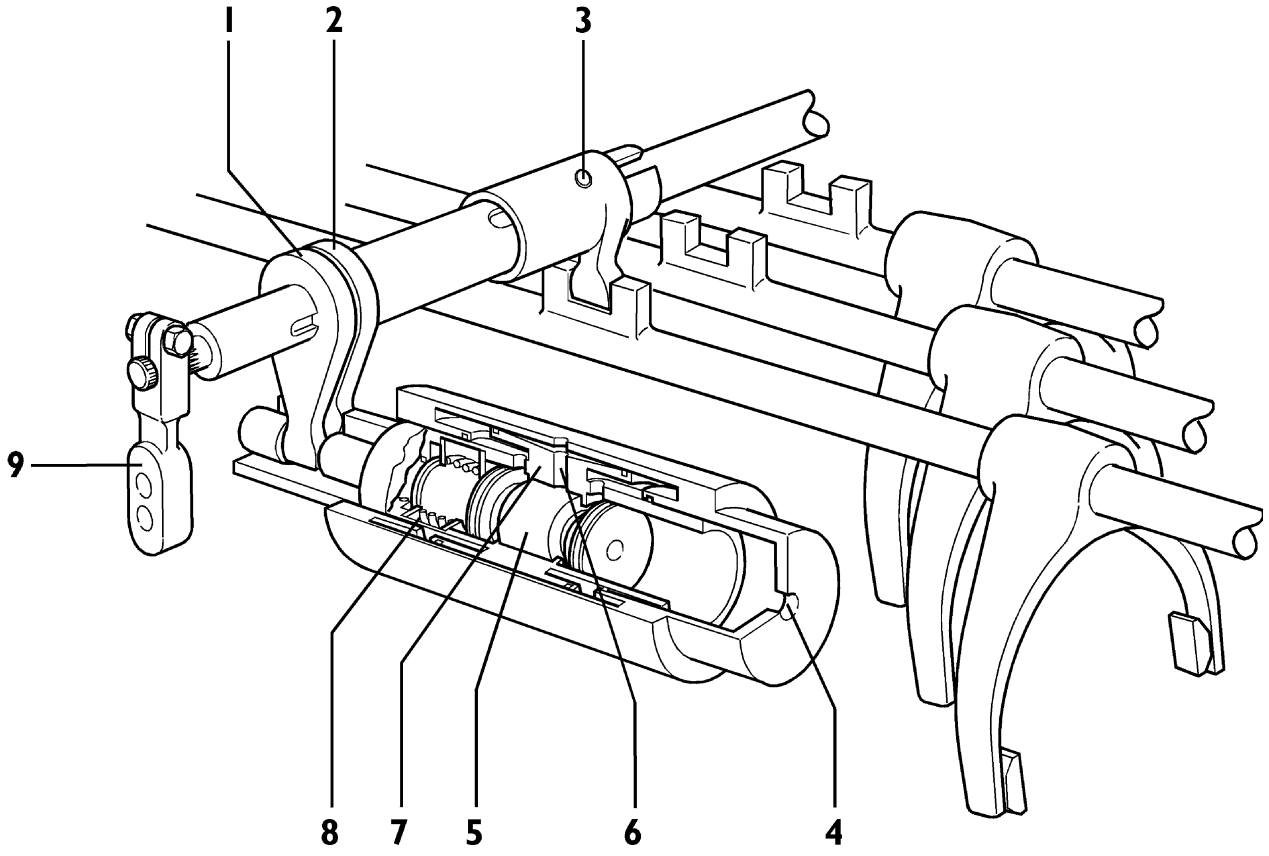
It operates during the engagement of the separate gears in the longitudinal movement of the gear control lever.

When the clutch is pressed to change gear, air under pressure is sent through the pneumatic servo clutch to the servoshift device inlet union (6).

The piston (5), moved by the valve control lever (1), feeds compressed air to the cylinder (7) which turns the gear engagement lever (2) in the same direction as the driver in the cab moves the tie-rod mounting lever (9) through the gear lever, making the axial movement of the gear engagement rod easier.

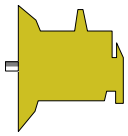
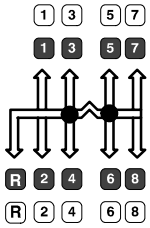
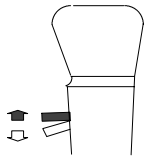
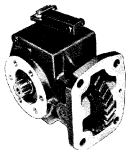
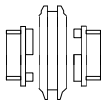
At the end of the useful stroke the discharge gap (4) is opened and the manoeuvre finishes, whilst a thrust spring (8) brings the device to neutral position.

Figure 7

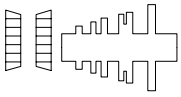
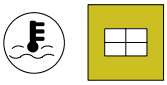
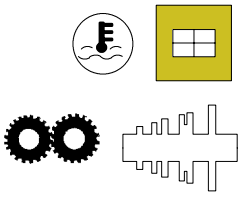


1. Control valve lever - 2. Gear engagement lever - 3. Driving roller - 4. Exhaust union - 5. Piston - 6. Feed union - 7. Cylinder - 8. Thrust spring - 9. Gear tie-rod mounting lever.

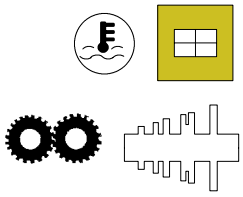
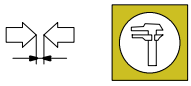
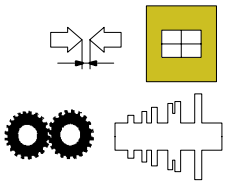
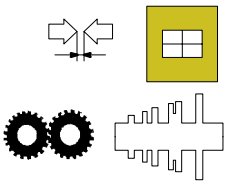
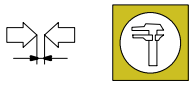
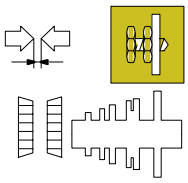
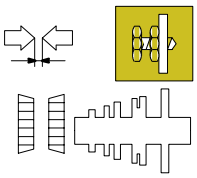
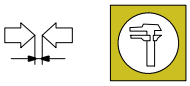
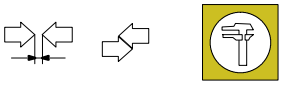
SPECIFICATIONS AND DATA

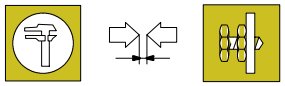
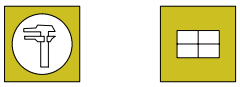
	Type	**ZF 16 S 1620 TD**	**ZF 16 S 2320 TD**
	Gears	16 Forward and 2 Reverse Gear	
	Control for 4 main speeds E.R.U* control Splitter control	Mechanical Pneumatic Pneumatic	
	PTO	On request	
	Gear engagement: Forward gear Gear change without servoshift Gear change with servoshift Reverse gear Anti gear-slip	 Type BK single cone 1st – 2nd – 3rd - 4th -5th - 6th speed Quick coupling Sliding sleeves restrained by pawls and springs	
	Type of gears	Helical toothing	

E.R.U* = epicyclic reduction gear unit

		ZF 16 S 1620 TD	ZF 16 S 2320 TD
	Gear ratios: First L First S Second L Second S Third L Third S Fourth L Fourth S Fifth L Fifth S Sixth L Sixth S Seventh L Seventh S Eighth L Eighth S Reverse L Reverse S (L = Slow speed F = Fast speed)	1 : 16.47 1 : 13.79 1 : 11.32 1 : 9.48 1 : 7.79 1 : 6.52 1 : 5.48 1 : 4.58 1 : 3.59 1 : 3.01 1 : 2.47 1 : 2.07 1 : 1.70 1 : 1.42 1 : 1.20 1 : 1.00 1 : 15.42 1 : 12.91	
 (*)	Quantity (after revision,)	11 liter (9.8 kg)	13 liter (11.6 kg)
	Main and transmission shaft bearings	tapered rollers	
	Assembling temperature for output flange	70 °C Max.	
	Assembling temperature for transmission shaft gears	160 ÷ 180 °C	

(*) See Section 2 - LUBRICANT AND HYDRAULIC FLUID TABLE for the required type of fluid.

		ZF 16 S 1620 TD	ZF 16 S 2320 TD
	Assembling temperature for fixedhubs and main/transmission shaft bearings	100 °C	
	Axial backlash: bearing in the E.R.U* spider shaft split ring in the fixed hub of the E.R.U* split ring of the transmission shaft bearing	0 ÷ 0.1 mm	
	Axial backlash for input shaft, first, 2nd and 3rd speed gear.	> 0.2 mm	
	Axial backlash for 4th speed gear.	> 0.05 mm	
	Axial backlash between spider shaft and planeary gears in the E.R.U*	0.4 ÷ 1.3 mm	
	Axial backlash for the bearings in main and transmission shafts at input side.	0.0 ÷ 0.1 mm	
	Axial backlash for the rear bearing split ring of the main shaft.	0.0 ÷ 0.05 mm	
	Value to check wear of: synchronizing rings for: - 1st/2nd speed - 3rd/4th speed - E.R.U.*	1.5 mm to 50 Nm (5 kgm) 0.8 mm 1.2 mm	
	Axial backlash for the reverse speed transmission gear	0.4 ÷ 1.5 mm	
	Axial backlash or preloading for the halfrings in main and driving shafts.	– 0.05 **to** + 0.05 mm	

		ZF 16 S 1620 TD	ZF 16 S 2320 TD
	Value to adjust clearance of the splitter control fork sliding shoes on the relevant sliding sleeve	94.1 mm	107.9 mm
	Clearance for the sliding shoes of forks in the seats in the moving sleevs.	0.6 ÷ 1.2 mm	
	Value to fit in place the two-lip retaining ring on the rear cover.	$12.5^{+1.0}$ mm	

DIAGNOSTICS

Main operating troubles of the gearbox are the following:

1 - Noise
2 - Spontaneous speed disengagment and uneven engagement
3 - Difficult and rough speed engagement
4 - Faulty or inefficient Pneumatic system

1 NOISE

Too much backlash of gears	YES →	Check the gearbox and replace the gears worn out

NO ↓

Gears, bearings, synchronizer rings and coupling elements worn out.	YES →	Replace the shaft and the driven disc, if required.

NO ↓

Inadequate oil level in the box	YES →	Top up with the specified oil to the required level.

2 SPONTANEOUS DISENGAGEMENT OR UNEVEN ENGAGEMENT OF GEARS

Uncorrect engagement operation	YES →	Engage the gears to bottom before releasing the clutch pedal.

NO ↓

Forks broken	YES →	Remove the gearbox, check the elements and replace where required.

NO ↓

Synchronizer rings worn out.	YES →	Check the engaging gears and sliding sleeves, replace those worn out, replace the synchronizer rings.

(continue)

Faulty operation of the E.R.U. – YES → Check and replacer the parts worn out

3 DIFFICULT AND ROUGH GEAR ENGAGEMENT

Rod forks bound. – YES → Remove the gearbox and find cause of binding; carry out the required repair operations.

NO

Move of sliding sleeves hindered. – YES → Check and repair

NO

Not suitable type of oil in the box – YES → Drain the oil and fill in.

NO

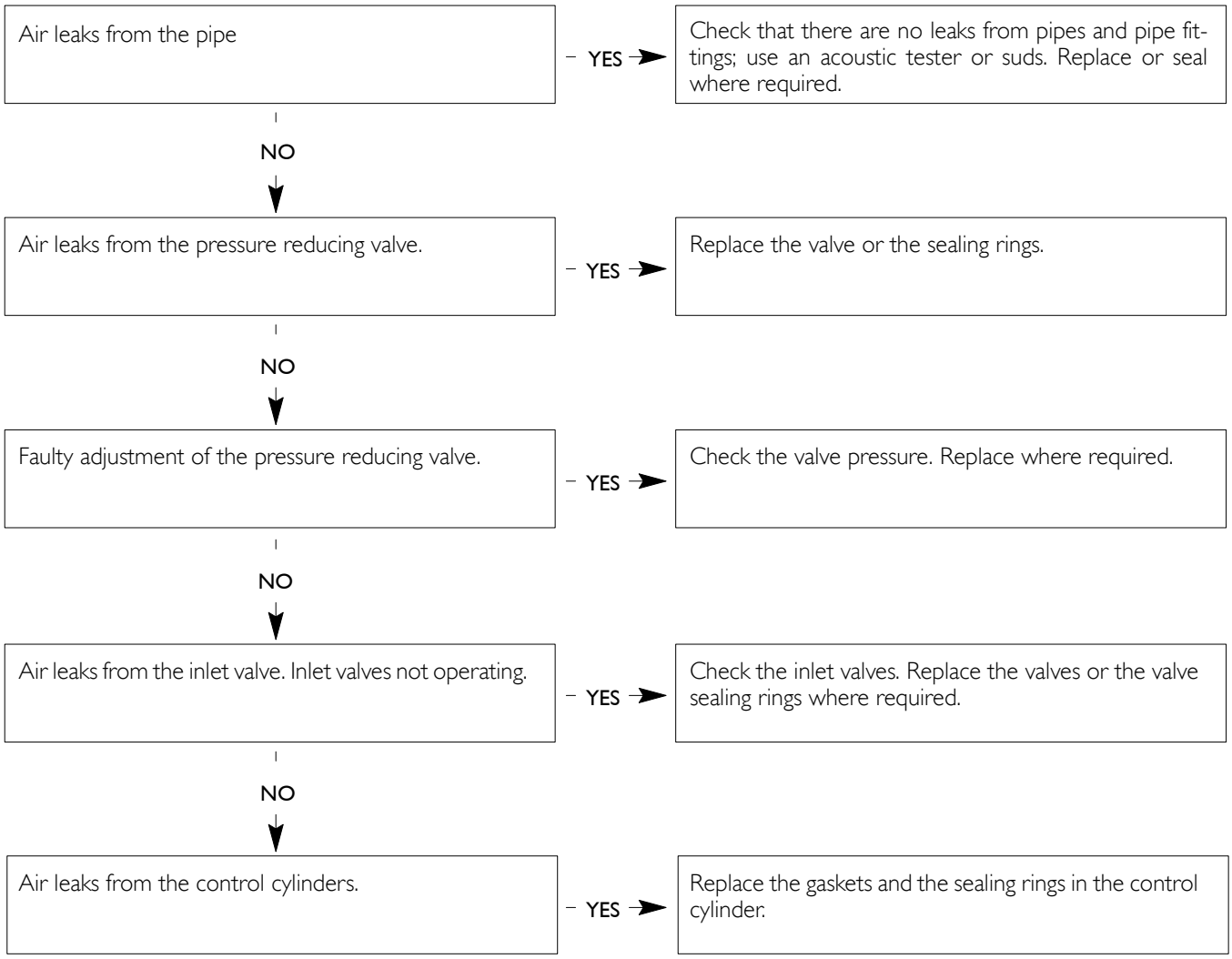
Clutch engagement missing – YES → Adjust or replace the control device

4 PNEUMATIC CONTROL SYSTEM FAULTY OR INEFFICIENT *

Air pipe fittings faulty – YES → Check pipe fittings and replace where required.

NO

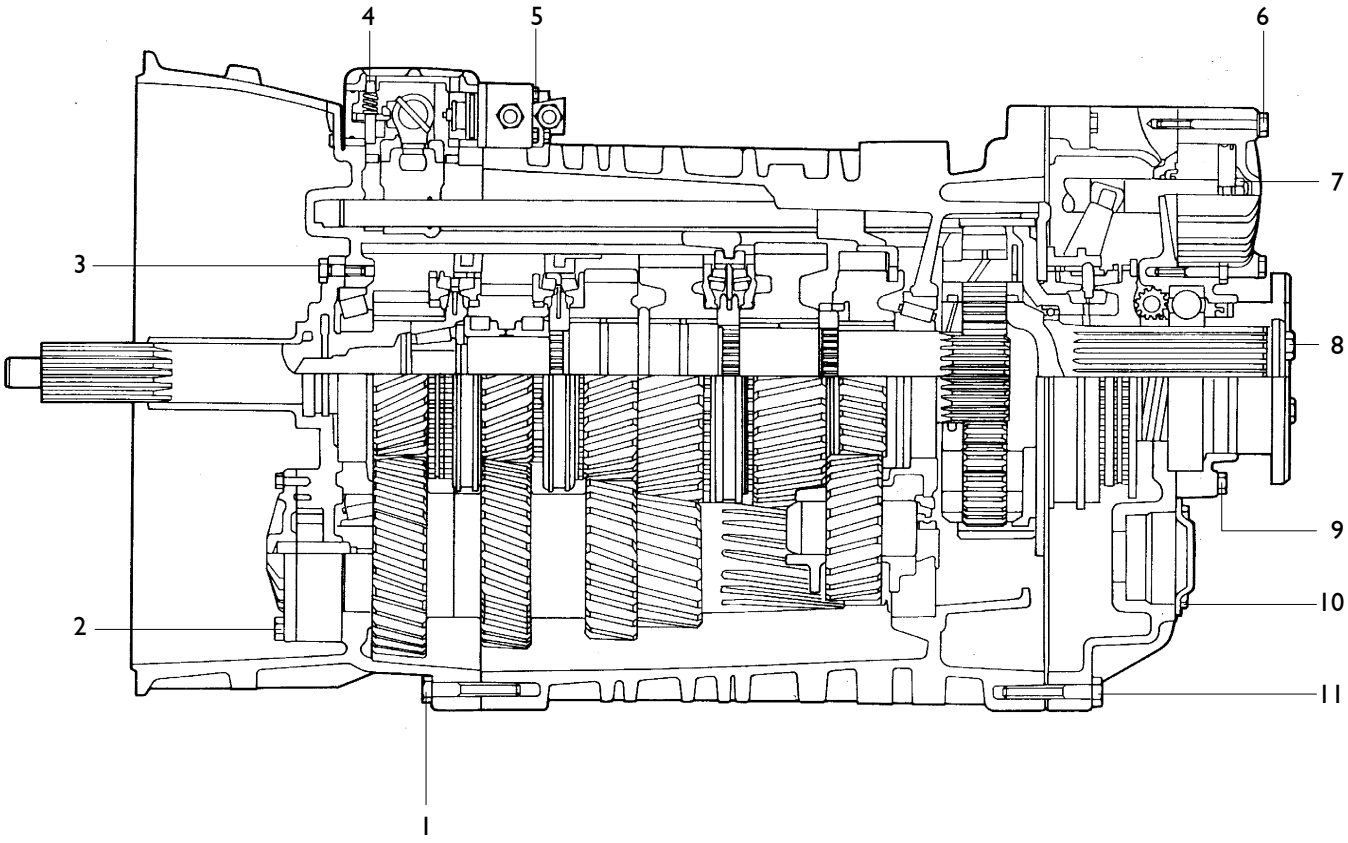
Air pipe bent and/or squeezed. – YES → Replace the pipe.



* Checks are to be carried out with the engine off and air tanks filled up.

TIGHTENING TORQUES

Figure 8



	DESCRIPTION	TORQUE	
		Nm	Kgm
1	Fastening screws for splitter box	49	4.9
2	Fastening screws for oil pump	46	4.6
3	Fastening screws for input shaft cover	46	4.6
4	Fastening screws for the gearbox	43	4.3
5	Fastening screws for the valve to the gearbox	23	2.3
6	Fastening screws for the E.R.U* cylinder case	50	5.0
7	Self-locking nuts to secure splitter control rods and E.R.U* to relevant pistons	150	15.0
8	Fastening screws for ouput flange	120	12.0
9	Fastening screws for rear cover	49	4.9
10	Fastening screws for power takeoff pre-arrangement cover.	79	7.9
11	Fastening screws for E.R.U.* case	49	4.9
	* E.R.U = epicyclic reduction gear unit		
	◆ Apply "Loctite 241"		

	DESCRIPTION	TORQUE	
		Nm	Kgm
	Fastening screws for clutch thrust bearing control fork	150	15.0
	Securing screws: - M 18 x 1.5 - M 22 x 1.5 - M 24 x 1.5	 35 50 60	 3.5 5 6
	Oil vapours vent	10	1
	Rod positioning push rods	50	5
	Screw for reverse gear shaft plate (if applied)	86	8.6
	Screw securing fork on splitter control rod	60	6
	Fastening screws for reverse speed gearbox lower cover	49	4.9
	Fastening screws for gearbox side cover	23	2.3
	Pipe fastening screws	35	3.5
	Oil draining plugs	80	8.0
	Oil draining plugs with magnetic filter	140	14.0
	Pulse sender	50	5.0
	Oil pump screws	46	46
	Switch on the control box	35	3.5
	Fastening screws for splitter control valve	9.5	0.9
	Nut for the screw to secure the lever to the gear selector rod	49	4.9
	Screw pin for the E.R.U* control fork	250◆	25◆
	* E.R.U = epicyclic reduction gear unit		
	◆ Apply "Loctite 241"		

TOOLS

TOOL NO.	DESCRIPTION
99322205	Revolving stand for overhaul of units
99322225	Holder (to use with stand 99322205)
99340205	Percussion puller
99341003	Puller
99341004	Puller
99341012	Pair of brackets
99341015	Clamp
99341019	Tie rods for grips
99341020	Tie rods for grips
99341021	Tie rods for grips
99341022	Grips
99341024	Grips
99341025	Grips
99345058	Thrust block for pullers
99345092	Thrust block for pullers
99347092	Pin to remove the dowels in the front and rear case of the gear box (to use with 99340205).
99360502	Rings to disassemble and re-assemble the reduction gear unit
993605l5	Tool to remove and fit in place main shaft, transmission shaft and fork unit
99370006	Handle for interchangeable drivers.
99370007	Handle for interchangeable drivers
99370113	Driver to fit in place the gasket and/or bushes on the gear selection cover
99370415	Base for test indicator to adjust transmission shaft bearings (to use with 99370006).
99370420	Connecting implement to fit gasket in gearbox front cover (to use with 99370006).
99370449	Main shaft lifting hook.
99370450	Splitter control fork adjusting tool
99370465	Tool to secure safety plates.
99370629	Device to hold thegearbox during fitting into place/removal from the vehicle.
99371050	Brackets to hold the gearbox during overhaul (use with 99322205-99322225)
99374093	Driver to fit in place the outer tracks of bearings (use with 99370007).
99374221	Connecting implement to fit grommet on rear cover.
99374370	Connecting implement to fit in place the oil spreader to direct drive shaft (use with 99370006).
99395604	Gauge (0-10 mm).

GEARBOX REMOVAL - REFIT

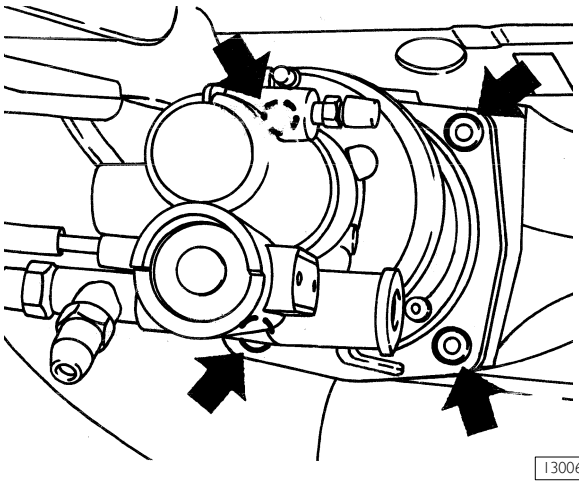
Removal

To remove the unit, proceed as follows:

- ❑ place the vehicle over a pit or on a car lift;
- ❑ open the battery box and disconnect the cables to avoid any risk of short-circuits;
- ❑ tip the cab;
- ❑ disconnect the power take off hydraulic and electrical connections and any relevant user mounted on the gearbox;
- ❑ unscrew the propeller shaft flange securing screws (14) and remove the shaft following the instructions in Section 10;
- ❑ prepare an appropriate container and drain off the power steering circuit following the instructions in Section 15 (only for the 4-axle version);
- ❑ disconnect the power steering oil delivery and return pipes from the auxiliary pump (25) (only for 4-axle version);

The disposal of waste or residual fluid on unauthorised sites or in the public sewer system is prohibited.

Figure 9



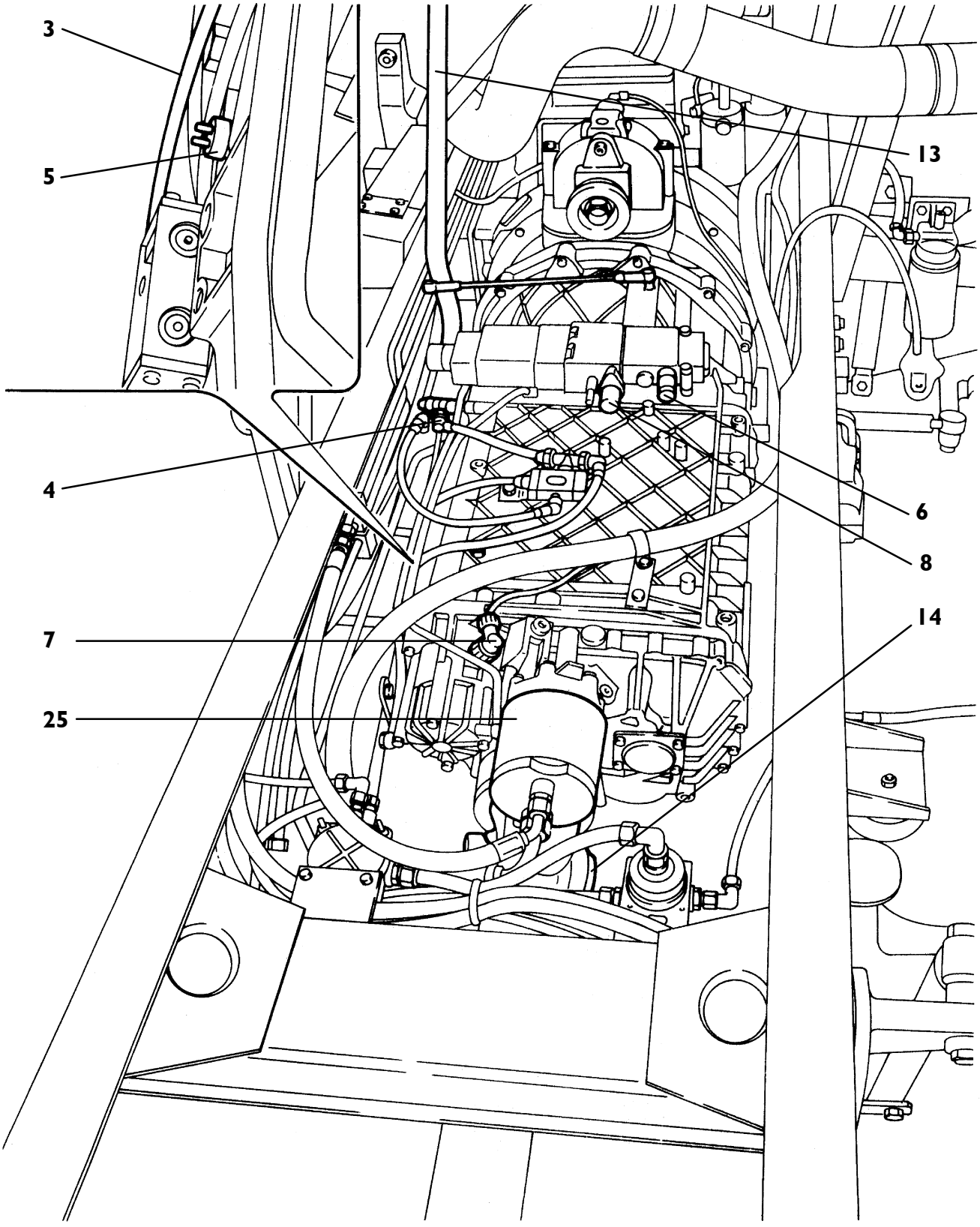
1300601

- ❑ unscrew the servo clutch securing screws (arrow) and remove it from the gearbox, securing it for the moment to the chassis;
- ❑ disconnect the gear selection linkage (13);
- ❑ disconnect the following pneumatic controls:
  splitter control (3);
  range selection control (4);
- ❑ disconnect the following electrical connections:
  splitter ON indicator (5)
  reverse gear switch (6)
  slow gear range ON indicator (7)
  idling position indicator (8);
- ❑ appropriately support the unit, then unscrew the screws securing it to the engine. Move the unit backwards to free the main shaft from the clutch and remove the unit from the bottom.

Refit

Repeat the removal operations in reverse order.

Figure 10

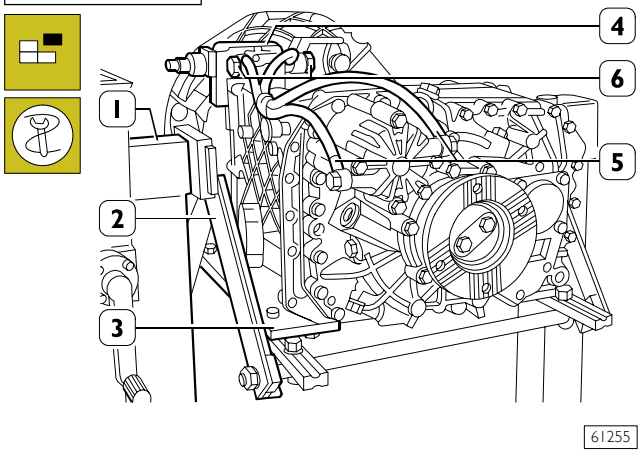


OVERHAULING OPERATIONS

Preliminary operations

The description that follows refers to the overhaul of gearbox ZF 16 S 151. Unless stated otherwise, this is also valid for gearbox ZF 16 S 221.

Figure 11



Thoroughly wash the gearbox externally and drain the oil off into an appropriate container.

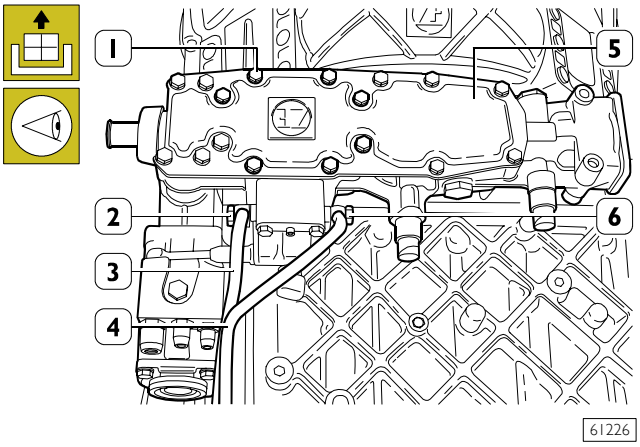
To dispose of the lubricant and detergents attain to the specific standards.

Apply supporting bracket 99371031 (3) to the unit.
Use hooked cables and mobile hoist to place the assembly on revolving stand 99322205 (1) fitted with support 99322225 (2).

Correct tools are to be used for gearbox repair operations.
In order to facilitate re-fitting operations, it is recommended that all parts are put down in disassembling order.

Removal gear command box

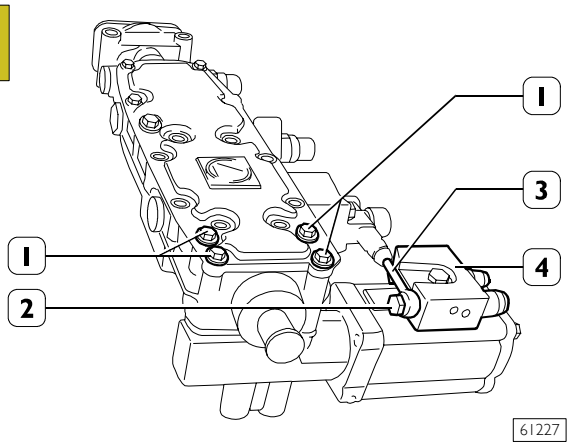
Figure 12



Mark the assembly positions of the pipes (3 and 4) and disconnect them from the gearshift box (5), unscrewing the unions (2 and 6) with the seal washers.
Unscrew the securing screws (1) and remove the gearshift box (5) with the servo shift from the gearbox.

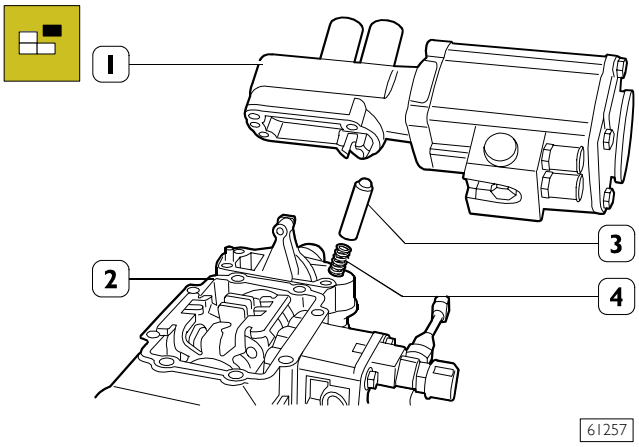
The servo shift device cannot be overhauled. If faults are found, replace it.

Figure 13



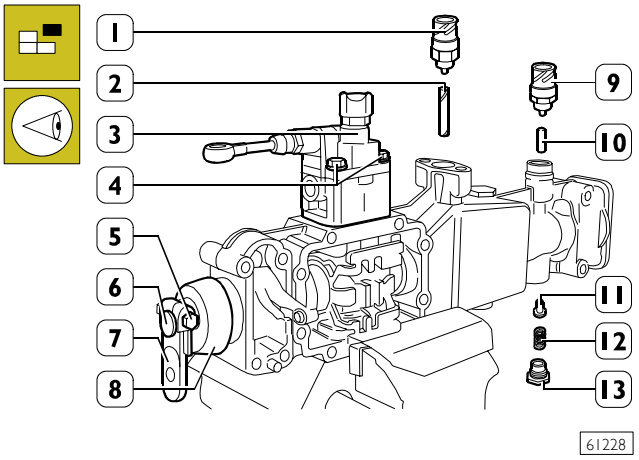
Unscrew the union (2) and disconnect the air hose (3) from the distributor (4).

Figure 14



Undo screws (1, figure 13) and remove the servoshift (1) from the gearshift box(2).
Remove push rod (3) with spring (4).

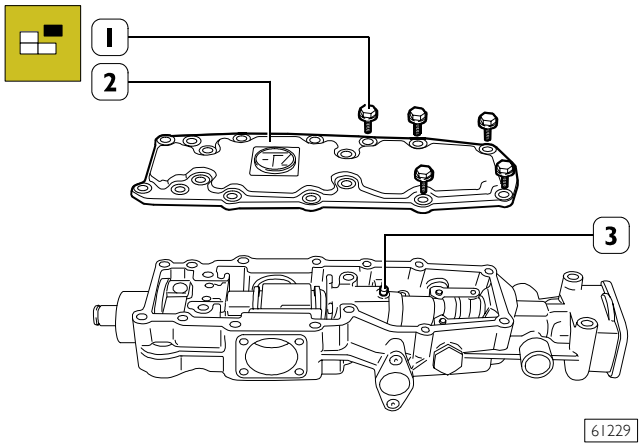
Figure 15



Mark the assembly position of the lever (7) on the rod (6).
Loosen nut (5) and remove lever (7) from the rod (6).
Take out the cap (8).
Remove:

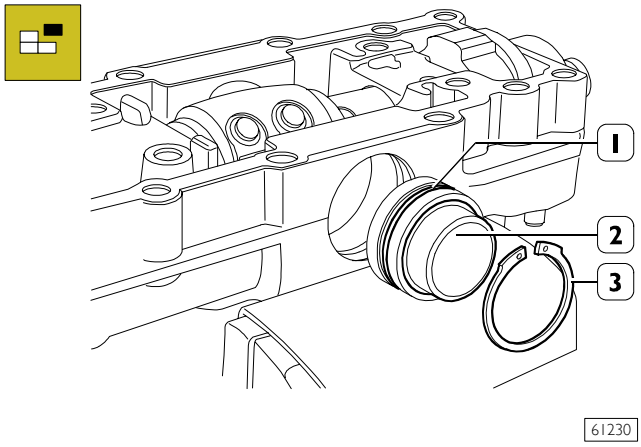
- ❑ valve (3) after removing screws (4);
- ❑ switches (1 and 9) with the washers and push rods (2 and 10);
- ❑ cap (13) with its washer, spring (12) and push rod (11).

Figure 16



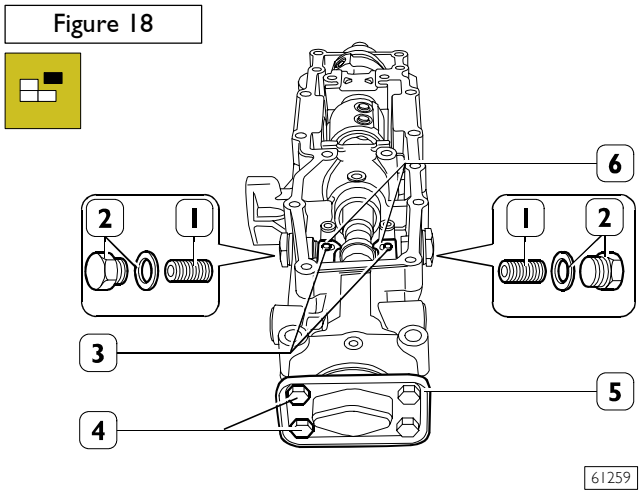
Undo screws (1) and remove the upper cover (2). Take out the pin (3).

Figure 17



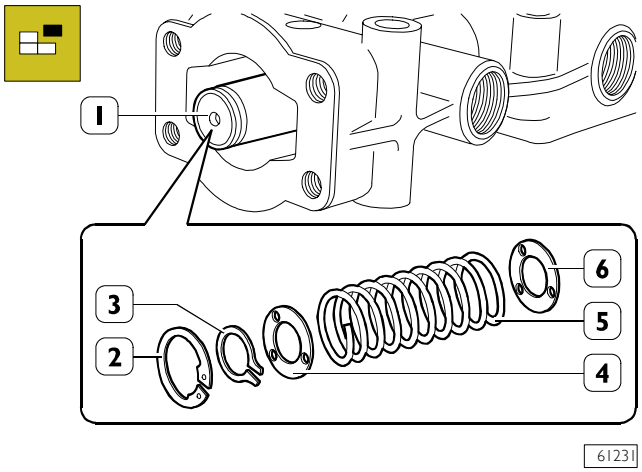
Remove split ring (3) and take out the piston (2) and sealing ring (1).

Figure 18



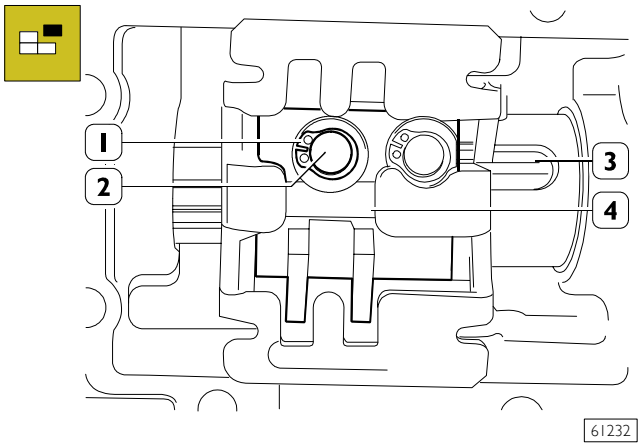
Unscrew the caps (2) with the washers, take out springs (1) and remove the levers (6).
If necessary remove the pins (3).
Undo the screws (4) and take off the cover (5).

Figure 19



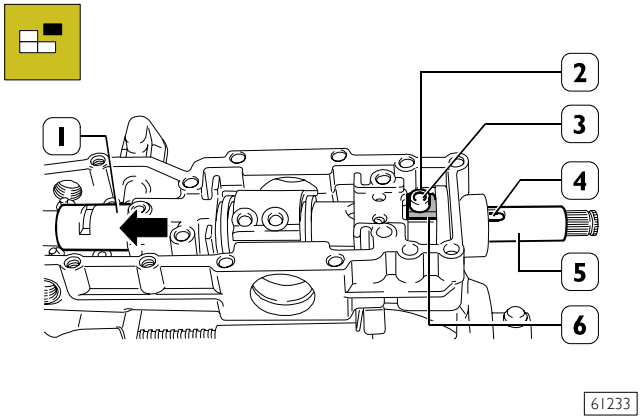
Take the split ring (2) from the rod (1).
Hold the washer (4) to limit the action of the spring (5) and remove the split ring (3). Take out washer (4), spring (5) and washer (6).

Figure 20



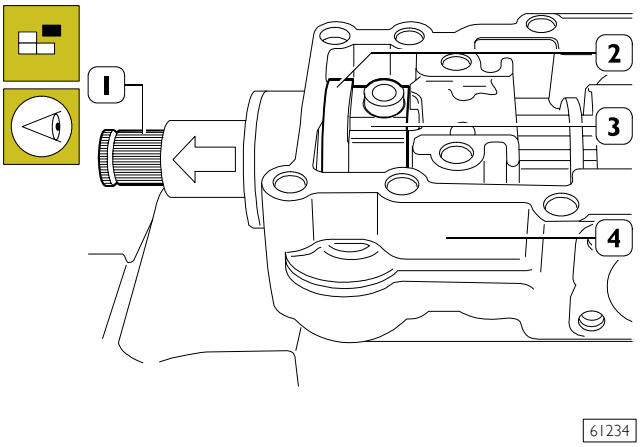
Remove the split rings (1) and take out the pins (2) that secure the actuator (4) to the rod (3).

Figure 21



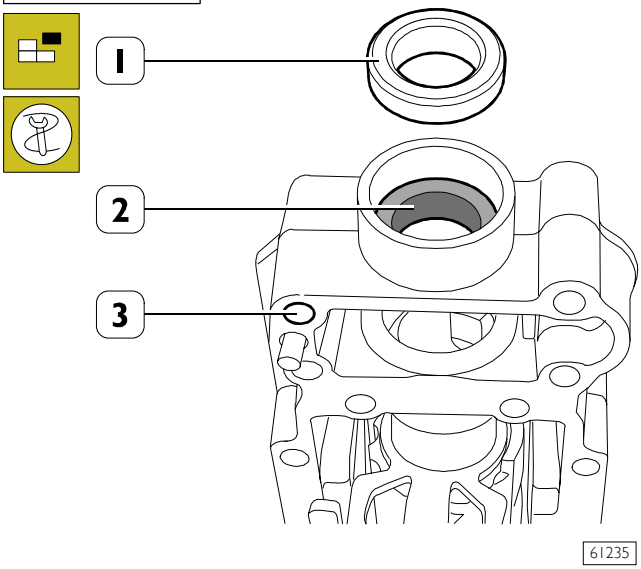
Move the pipe(1) in the direction of the arrow.
Use a punch to knock on the top of the lever (6) to bring out the bearing (3) and pin (2), releasing the latter from the rod groove (5).

Figure 22



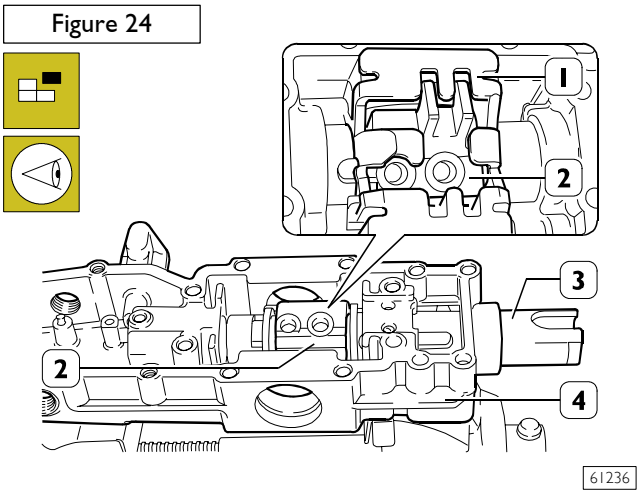
Mark the assembly positions of levers (2 and 3) and remove them from the box (4), taking out rod (1).

Figure 23



Using internal puller 99348004 take out bushing (2) and sealing ring (1) from the box (3).

Figure 24

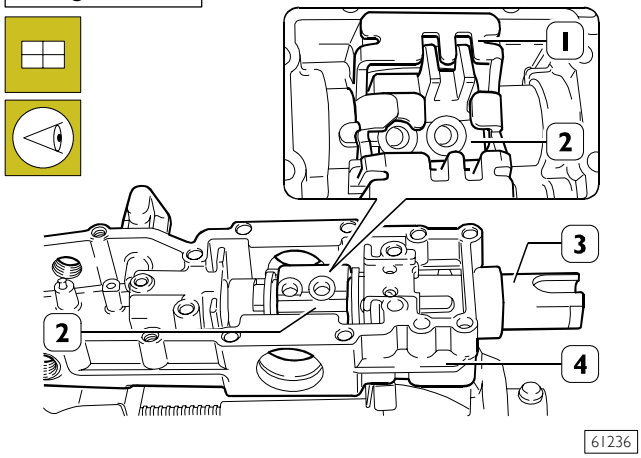


Mark the position of the locking element (1) and the actuator (2) then remove them from the box (4) after removing the pipe (3).

Refitting gear command box

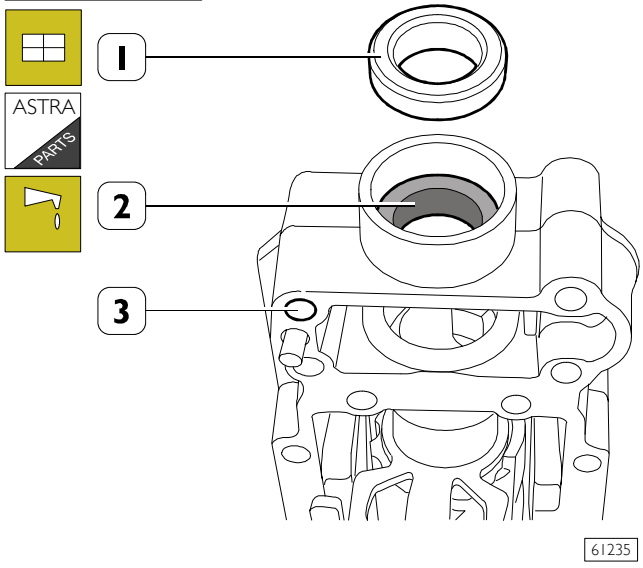
When assembling, always replace sealing elements with new ones, i.e.: rings, copper washers, flat gaskets, spring pins and needle bearings with their pins. Check that the springs are not damaged or worn.

Figure 25



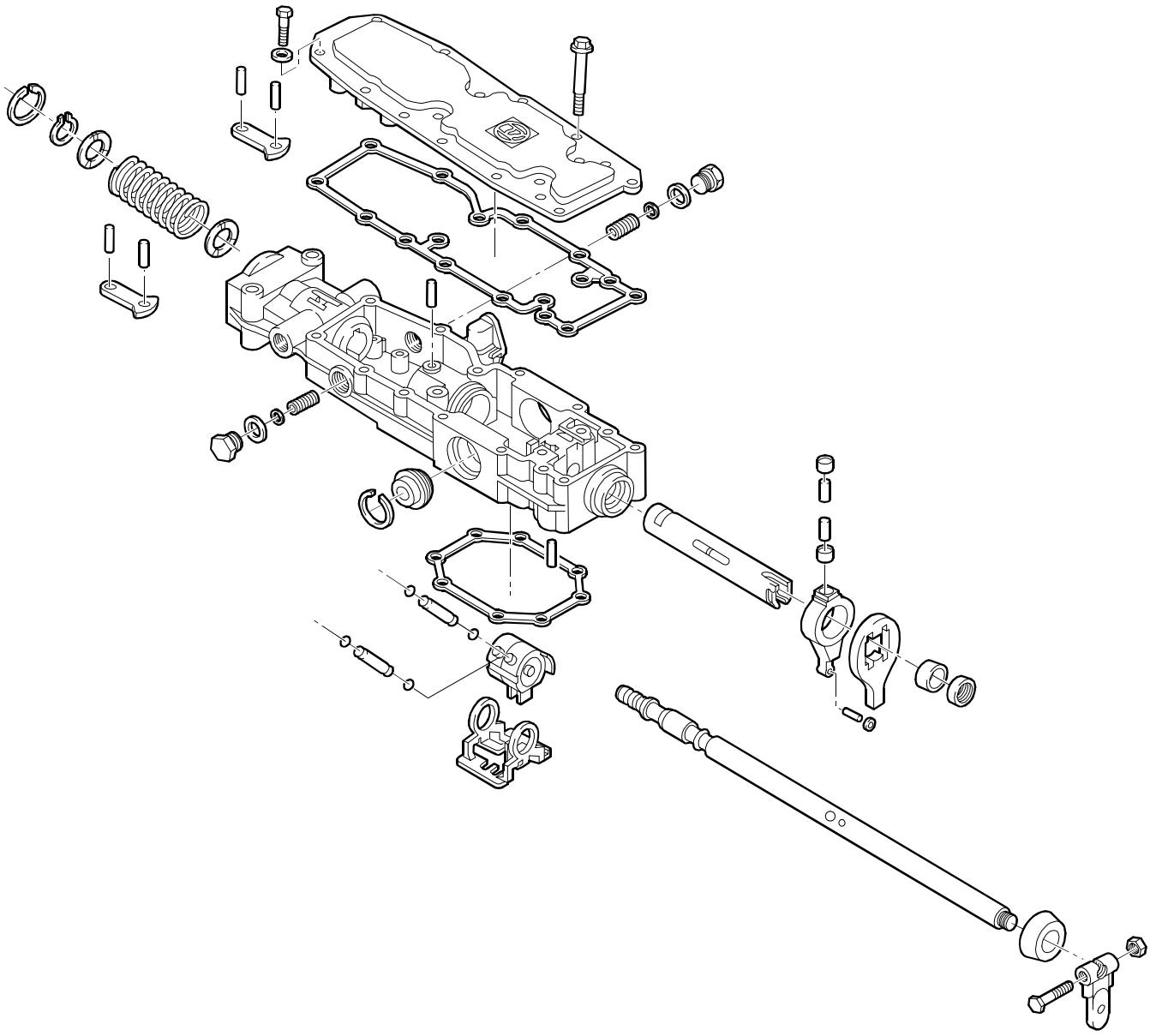
Fit the locking element (1) and actuator (2) in the box (4) as they were marked at disassembly and insert the pipe (3) into them.

Figure 26



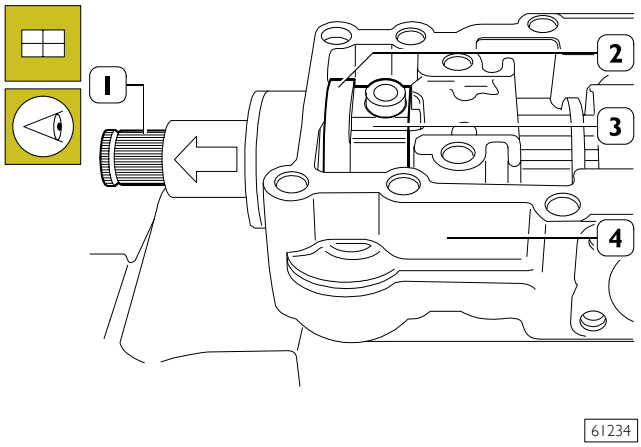
With a appropriate driver fit the bushing (2) in the box (3). Use the suitable tool to fir the sealing ring (1) into the box (3). Grease the inner part of the sealing ring (1).

Figure 27



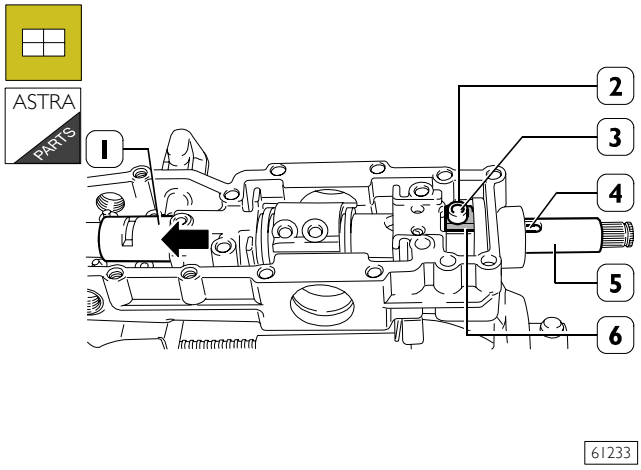
GEARSHIFT

Figure 28



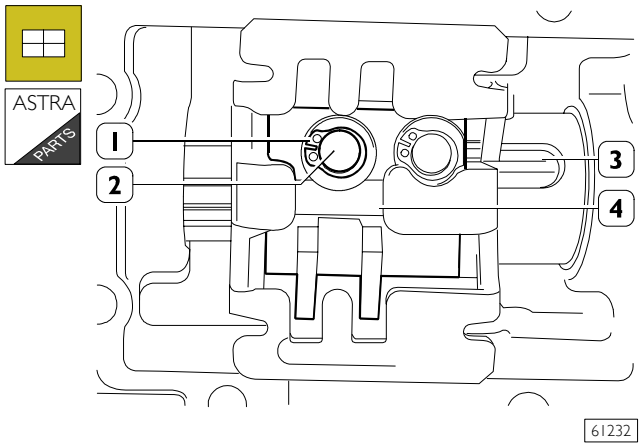
Fit the levers (2 and 3) in the box as marked at disassembly then insert the rod (1).

Figure 29



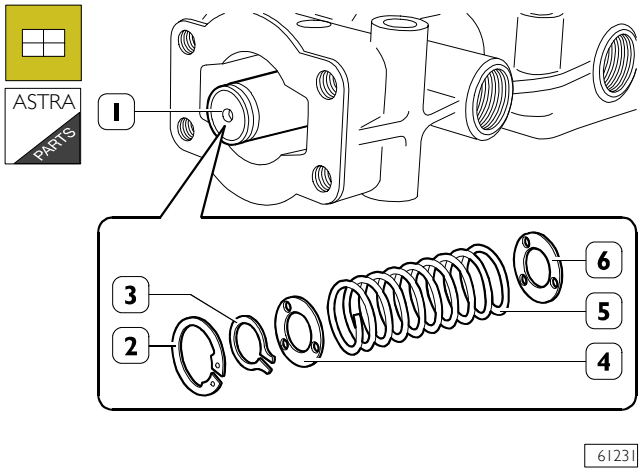
Move the pipe(1) in the direction of the arrow.
Fit a new needle bearing (3) and pin (2) on the lever (6). Position the rod (5) so that the groove (4) corresponds to the needle (3) and pin (2).
Resting the lever (6) on a flat surface, gently knock the bearing (3) and pin (2) so they are flush with the top of the lever (6) and are correctly inserted in the groove (4) of the rod (5).

Figure 30



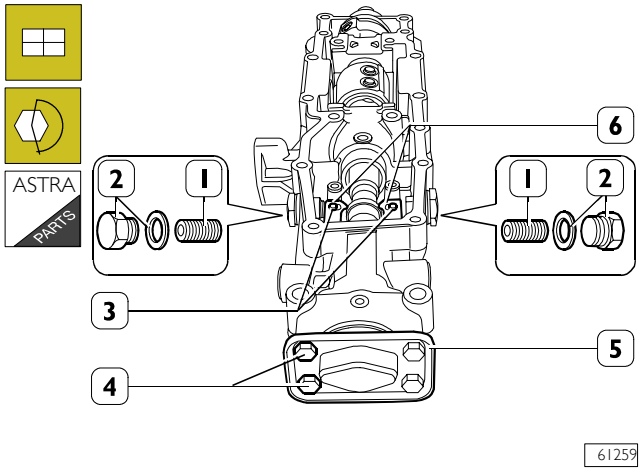
Secure the actuator (4) to the rod (3) inserting the pins (3). Insert new split rings (1) on the pins.

Figure 31



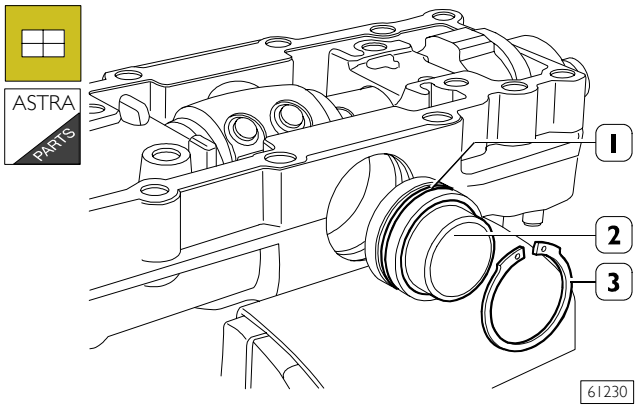
Fit the washer (6), spring (5) and washer (4) on the rod (1) and fit a new split ring (3)
Fit a new split ring (2).

Figure 32



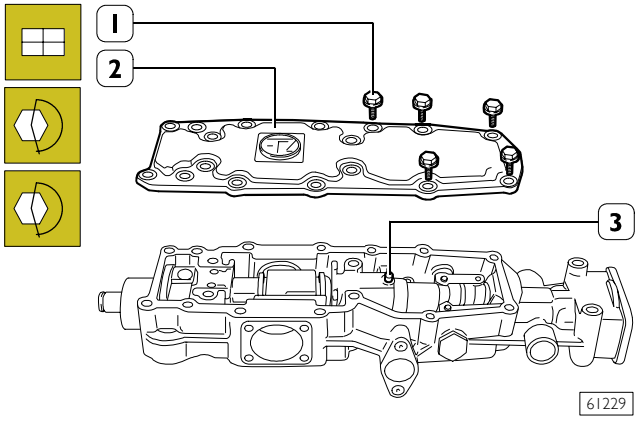
Assemble the cover (5) with a new gasket, insert the screws (4) and tighten to the specified torque.
Fit the levers (6) on the pins (3). Screw the caps (2) with new washers and the springs (1). Tighten to the specified torque.

Figure 33



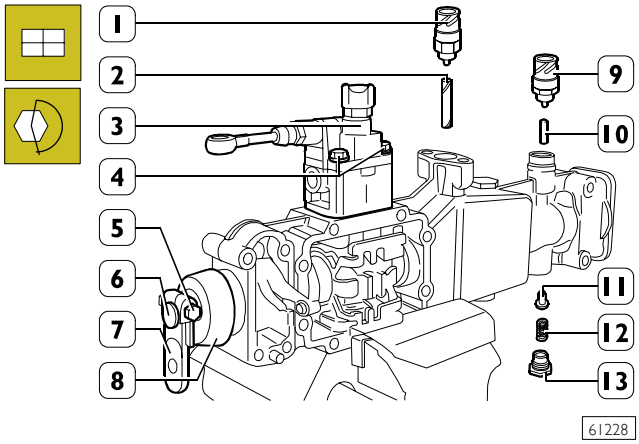
Fit a new sealing ring (1) on the piston (2). Fit the piston in the box and secure it with the split ring (3).

Figure 34



Insert the pin in the box (3).
Assemble the upper cover (2) with a new gasket.
Insert screws (1) and tighten to the specified torque.

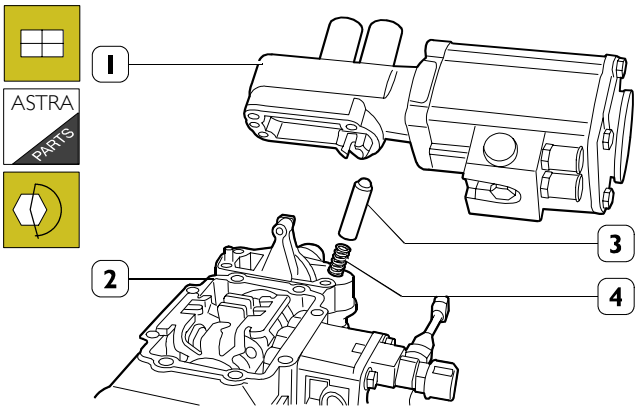
Figure 35



Complete the assembly of the gearshift refitting:

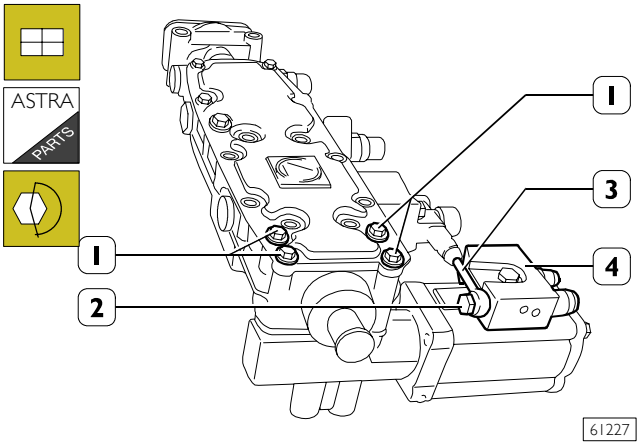
- ❑ push rod (11), spring (12), cap (13) with a new gasket;
- ❑ push rods (2 and 10), switches (1 and 9) with new washers;
- ❑ cap (8), lever (7) on rod (6) in the position marked at disassembly. Tighten nut (5) to the specified torque.

Figure 36



Fit the push rod (3) with the spring (4) in the box.
Refit the servoshift (1) with a new gasket.
Insert the screws (1, Figure 37) and tighten to the specified torque.

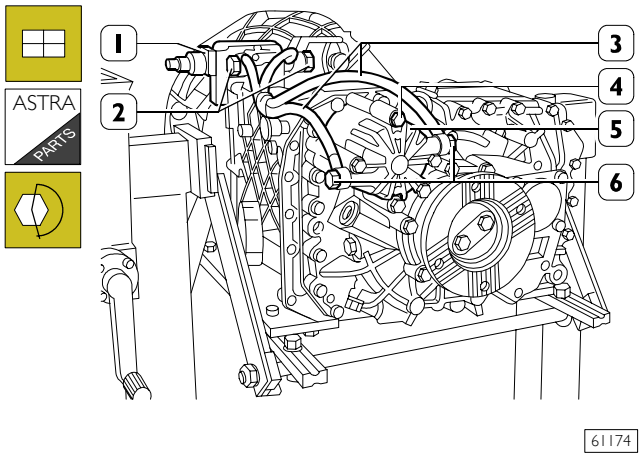
Figure 37



Connect the air hose (3) to the distributor (4) tightening the union (2) with new copper washers and tightening to the specified torque.

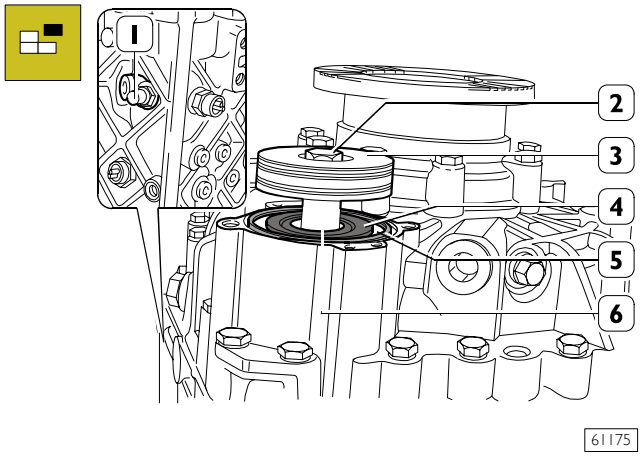
Epicyclic reduction unit (E.R.U.) removal

Figure 38



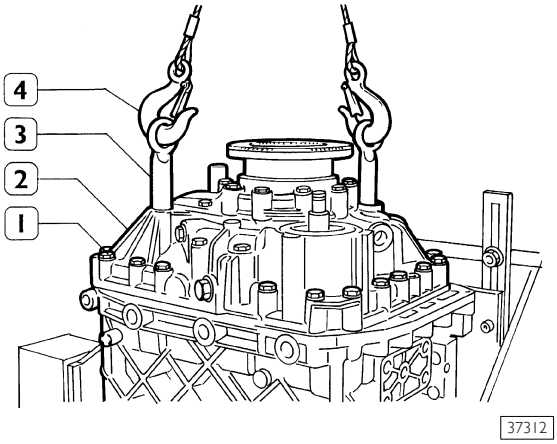
Remove the gearshift (1) as described in the relevant section. Mark the assembly position of the pipes (3) on the E.R.U. control cylinder (5) then disconnect them unscrewing the unions (6) with their washers.

Figure 39



Unscrew the nut (2) remove the piston (3) with the two sealing rings and anti-vibration ring from the E.R.U. control rod (6) Remove the sealing ring (5). Use a screwdriver to remove the gasket (4) from the rod (6).
Unscrew the rod positioning push rod (1).

Figure 40

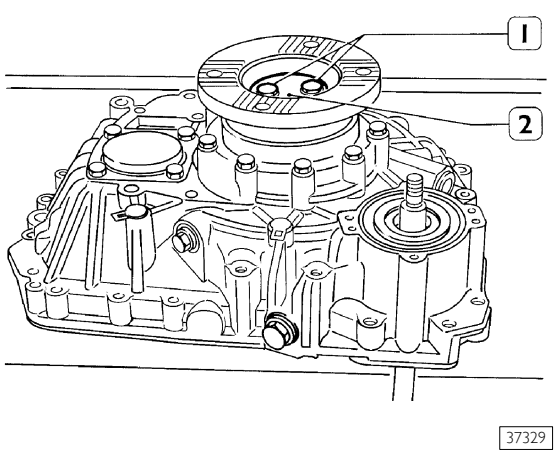


Undo the screws (1). Screw the eye bolts (3) onto the E.R.U. box. With hooks and a mobile hoist remove the E.R.U. (2) from the gearbox.

Disassembling the epicyclic reduction unit (E.R.U.)

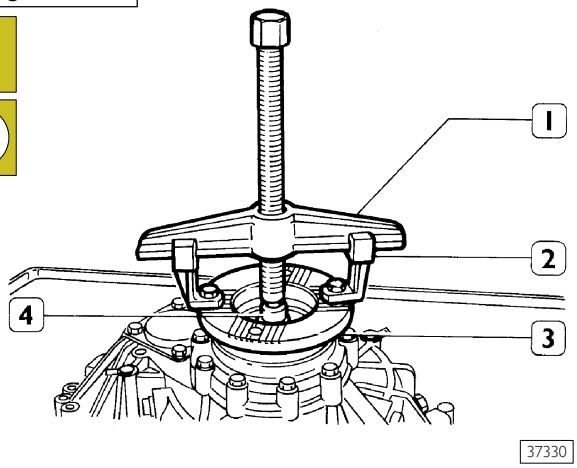
The operations described and illustrated below refer to the disassembly for the straight tooth epicyclic reduction unit. Unless indicated otherwise, is also valid for the helical tooth type.

Figure 41



Remove the safety plate, undo the two screws (1), remove the pressure disk (2) and the sealing ring underneath.

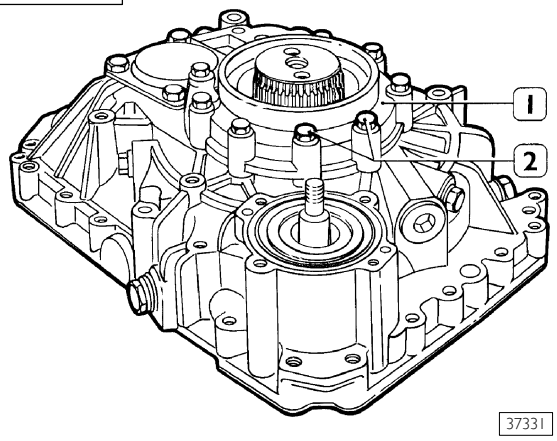
Figure 42



With a puller consisting of:

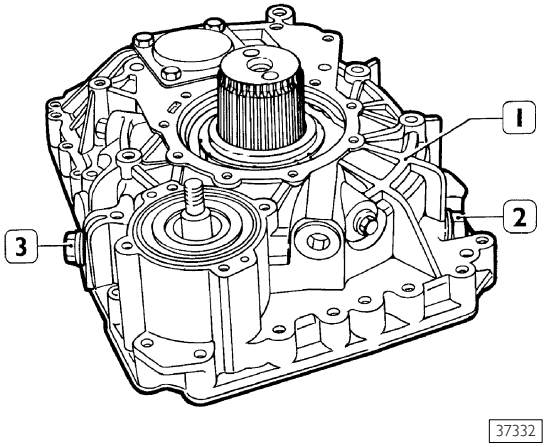
- ❑ tie-rods (2);
- ❑ puller (1);
- ❑ thrust block 99345058 (4) pull out the output flange (3);

Figure 43



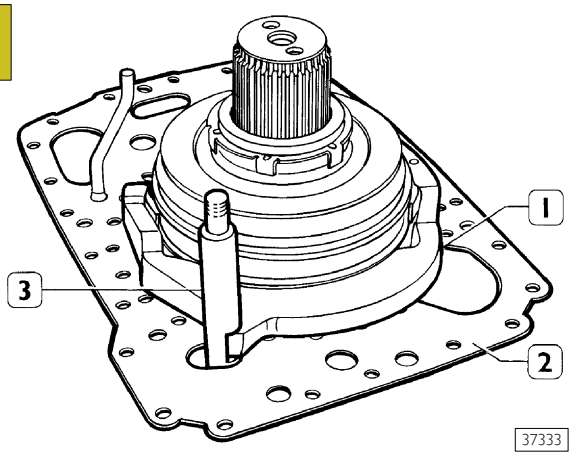
Undo screws (2) take off cover (1) and remove the support bearing, adjusting ring and sealing ring from it.

Figure 44



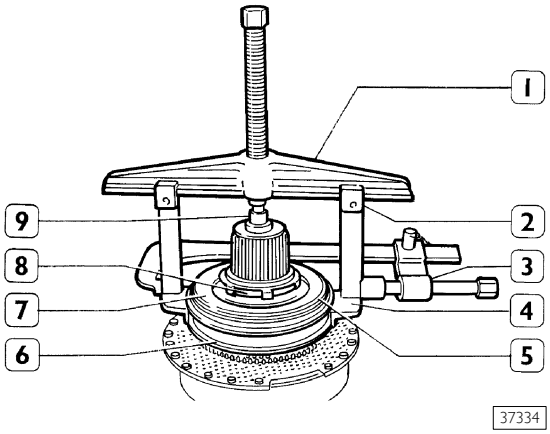
Undo the screw pins (2 and 3) and remove the box (1) from the E.R.U.

Figure 45



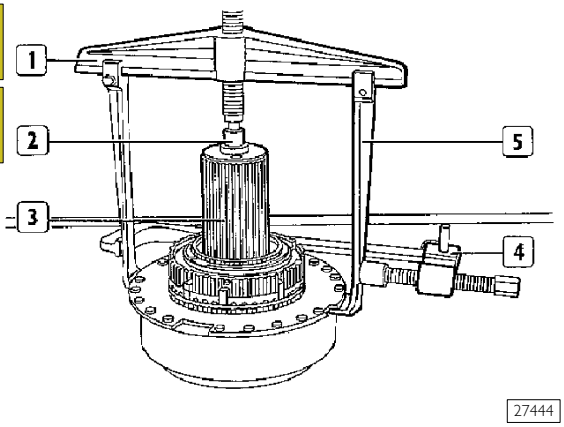
Take out the rod (3), the fork (1) with the E.R.U. control shoes. Disassemble the intermediate plate (2).

Figure 46



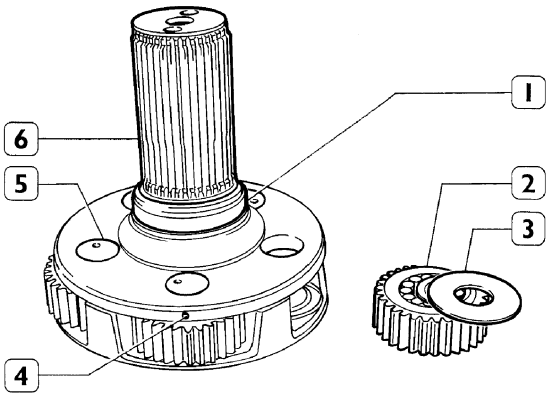
Take out the phonic wheel (8), the sliding sleeve (6) with the springs and synchronising ring thrusts (5).
Remove also the coupling vase (7) using a puller composed of: grips (4), tie-rods (2), puller (1) and thrust block 99345058 (9).

Figure 47



Take out the spider shaft (3) using a puller composed of: grips (5), puller (1) thrust blocks 99345058 (2) and clamp (4).

Figure 48

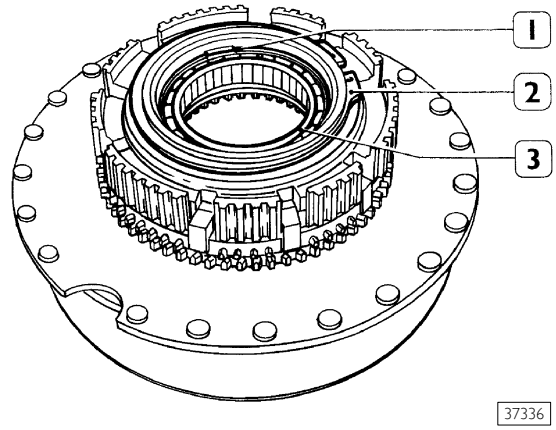


37335

Take out the spacer (1) push the spring pins (4) into the pins (5) and with an appropriate driver knock out the pins (5) from the spider shaft (6).
Take out the spider shaft (6), the planetary gear (2) with shim rings (3) and roller bearings.

The shim ring (3) is not installed on the helical tooth version.

Figure 49

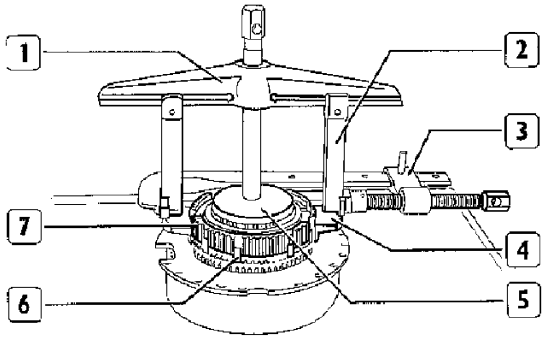


37336

Remove the split ring (2) that restrains the fixed sleeve.
Only for straight tooth version:
Remove the split ring (1) and take out the ball bearings (3).

The helical teeth version has a thrust bearing (see Figure 53).

Figure 50

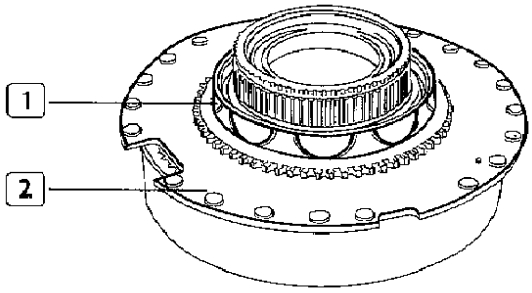


15889

Remove the synchronising ring (6) and the fixed sleeve (7) using a puller consisting of:

- ❑ grips (4);
- ❑ tie rods (2);
- ❑ puller (1);
- ❑ thrust block 99345092 (5);
- ❑ clamp (3).

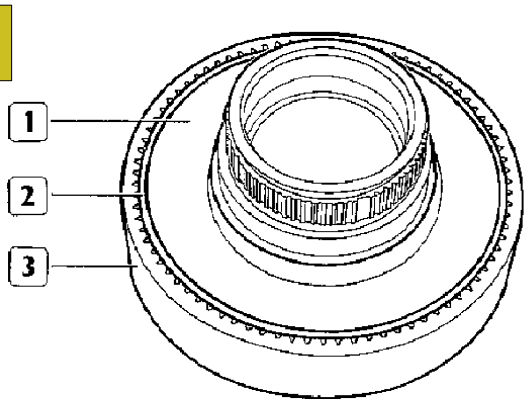
Figure 51



15900

Take out the coupling element (1) with the plate (2).

Figure 52



19527

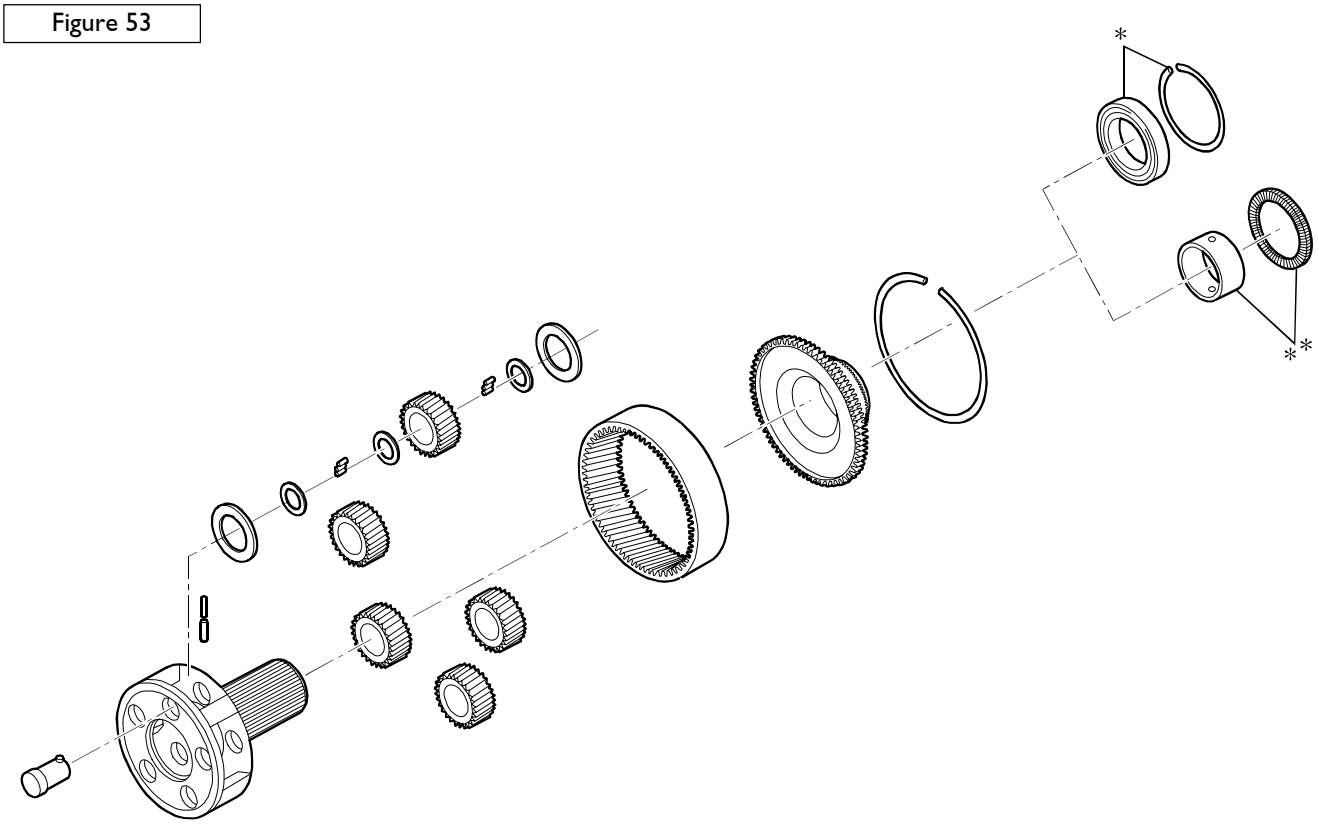
Remove the split ring (2) and separate the crown wheel (3) from the support (1).

Assembling the epicyclic reduction unit (E.R.U.)

To assemble the epicyclic reduction unit follow the disassembly operations in reverse order.

The operations and assembly steps that require special tools, clearance checks, adjustments or special specifications are described below.
The tightening torques are given in the relevant table.

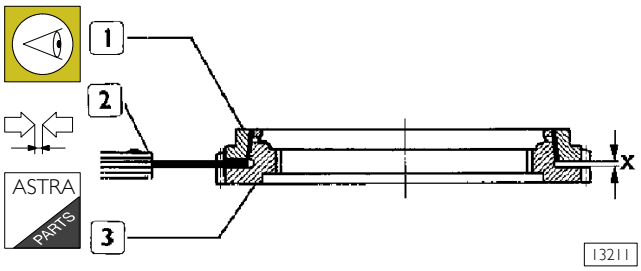
Figure 53



BREAK-DOWN DRAWING OF EPICYCLIC REDUCTION UNIT COMPONENTS

* only straight tooth version
** only helical tooth version

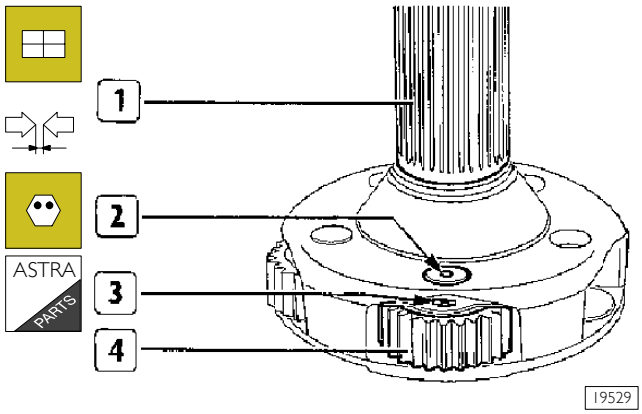
Figure 54



Before reassembling the synchronisers, check the wear on the synchronising rings (1) and the coupling elements (3); use a thickness gauge (2) to measure the distance between the synchronising ring (1) and the coupling element (3) in two opposite points. If the distance (X) found is less than 1.2 mm replace the synchronising ring (1) or the coupling element (3). Do not confuse the checked parts (it is better to mark them).

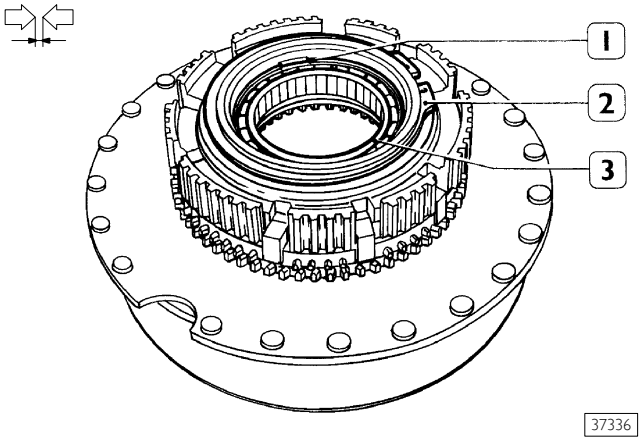
Heat the bearings inner ring and the sliding sleeve hub to about 100°C for roughly 15 minutes before assembly.

Figure 55



Check that the end float between the spider (1) and the planetary gear (4) is between 0.40 and 1.30 mm.
After checking the end float fit the bearing pins (2) in the spider (1)matching the "0" reference stamped on the pins with the holes (3) for the spring pins.
Fit the spring pins in the holes (3) and calk them.

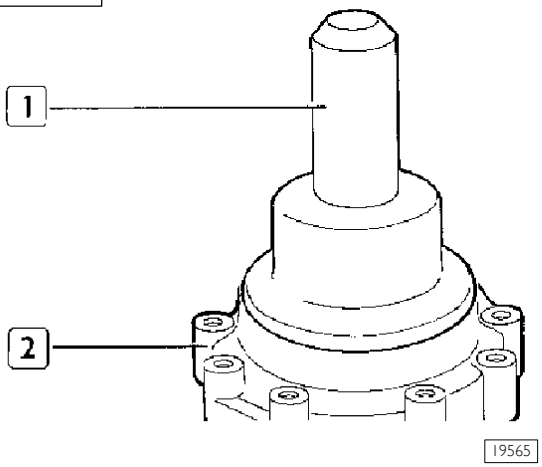
Figure 56



With a thickness gauge check the clearance between split ring (1) and bearing outer ring (3). The clearance should be between 0.0 to 0.1 mm.
Check also the clearance between split ring (2) and its seat. The clearance should be between 0.0 to 0.1 mm.

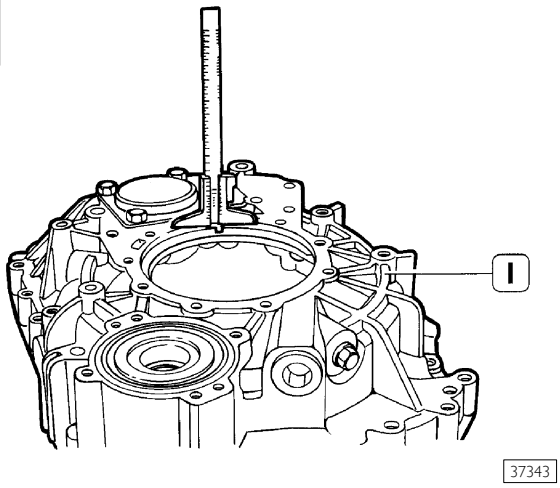
Split rings (1) and (2) are supplied as spares in different thicknesses.

Figure 57



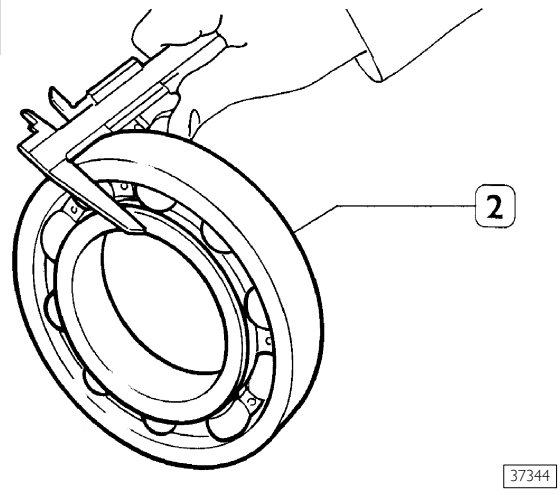
Using coupling device 99374221 (1) fit the sealing ring in the output flange cover (2).

Figure 58



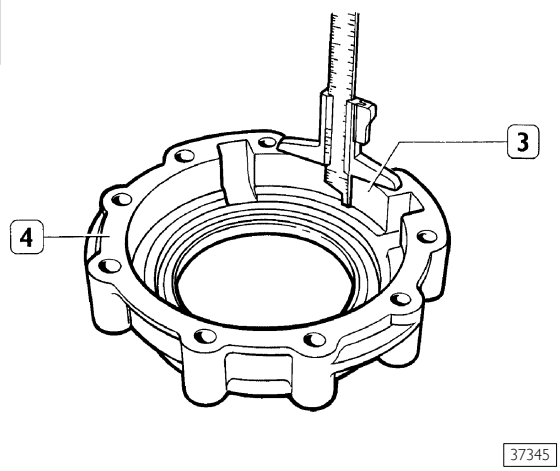
Measure the depth of the bearing seat in the E.R.U. box (1).

Figure 59



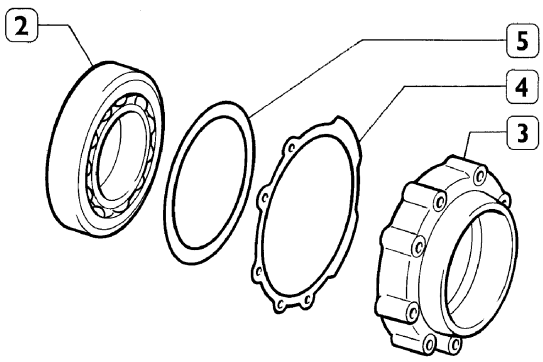
Measure the thickness of the bearing (2).

Figure 60



Measure the depth of the bearing seat in the cover (3) with the gasket (4).

Figure 61



37346

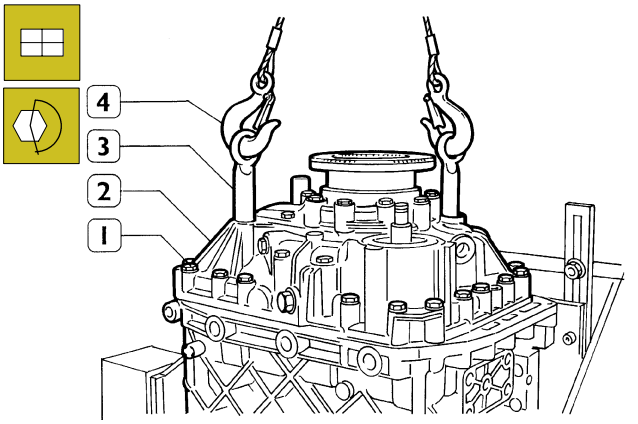
Determine the thickness of the adjusting ring (5) so that between the bearing (2) and the E.R.U. box (1) there is a clearance of 0.0 to 0.1 mm.

EXAMPLE	mm
❑ Depth of bearing seat in the box (1)	7.40 +
❑ Depth of bearing seat in the cover (3) with gasket (4)	23.00 =
❑ Total	30.40 -
❑ Bedding of the gasket (4)	0.05 =
❑ Total	30.35 -
❑ End float (0.0 to 0.1 mm) average value	0.05 =
❑ Total	30.30 -
❑ Bearing thickness	30.00 =
❑ Total	0.30
The thickness of the adjusting ring (5) shall be 0.30 mm.	

Refitting the epicyclic reduction unit (E.R.U.)

To refit the epicyclic reduction unit box, follow the removal instructions in reverse order.
Assembly operations that require special tools, clearance checks, adjustments or special specifications are described below.
The tightening torques are given in the relevant table.

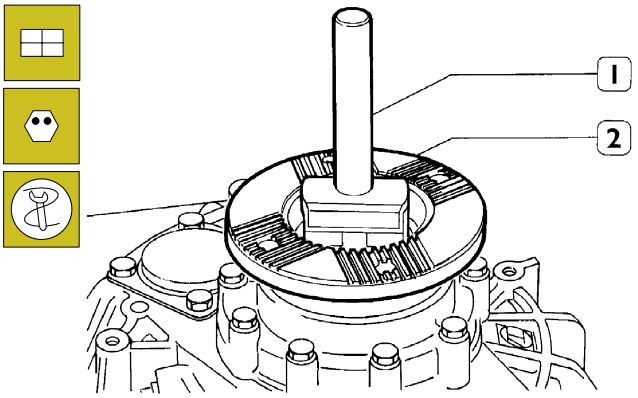
Figure 62



37312

Screw the eye bolts (3) onto the E.R.U. box (2). fit the cables with hooks (4) and with a mobile hoist assemble the E.R.U. on the gearbox.
Tighten the screws (1) to the specified torque.

Figure 63

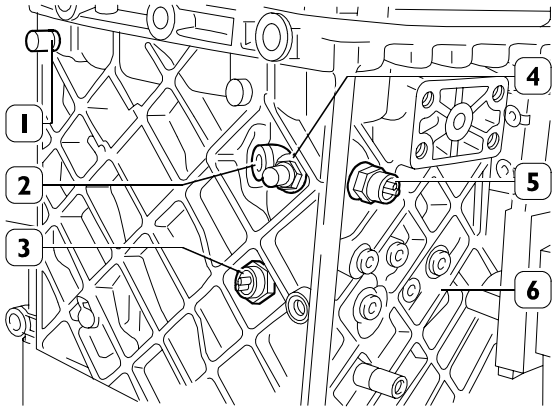


37359

After tightening the two output flange securing screws to the required torque, fit on the safety plate and secure it with tool 99370465 (1).
Remove the gearbox from the rotating stand and top up the oil level.

Disassembling the gearbox

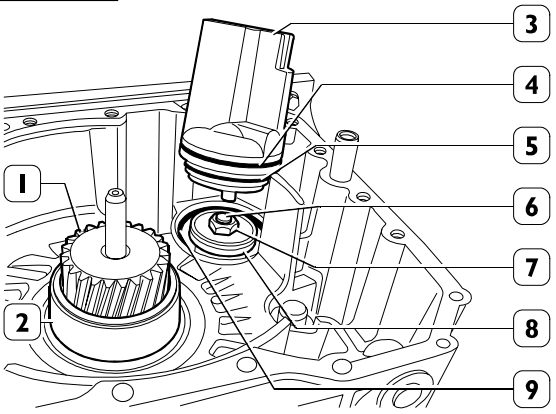
Figure 64



61207

Mark the assembly position of the switches (3), type 235N; (5), type 145N and remove them from the gearbox (6). Take off the oil vapours breather (1) and the cap (2).

Figure 65



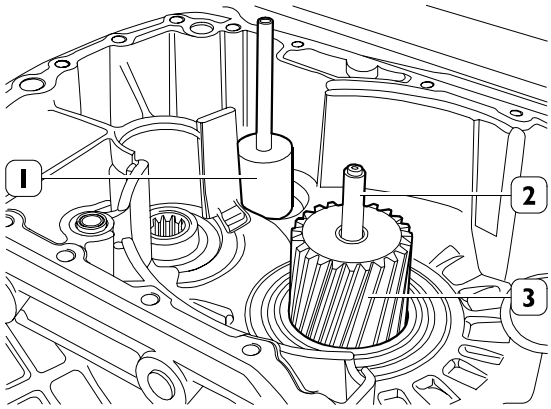
61177

Disassemble the splitter control cylinder (3) with the sealing rings (4-5).

The cylinder (3) may have 3 sealing rings.

Remove the split ring (9). Unscrew nut (7) and remove the piston (8) from the rod (6).

Figure 66



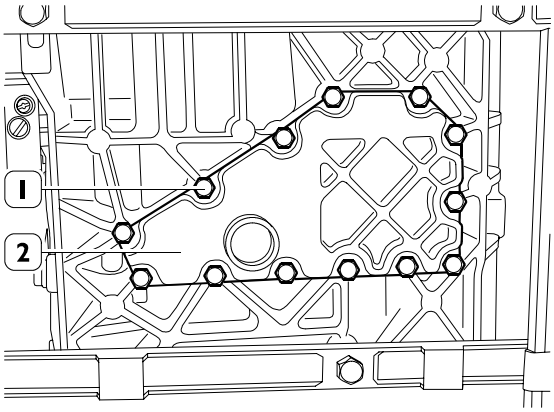
61178

Take out the reverse gear shaft (1).

On certain gearboxes it is necessary to remove the screw securing the retaining plate to the gearbox to be able to remove the shaft.

Remove the pipe (2) from the main shaft (3).

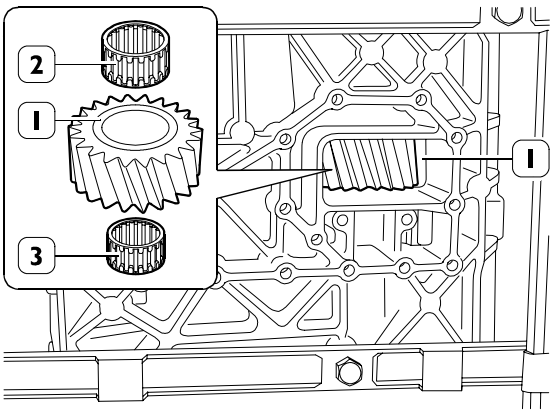
Figure 67



61179

Undo the screws (1) and take off the cover (2).

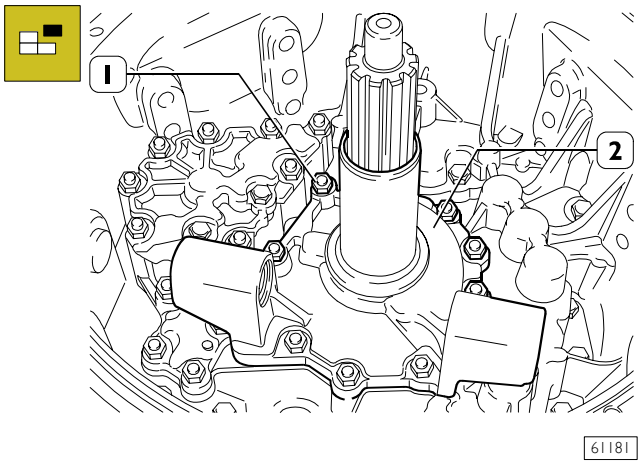
Figure 68



61180

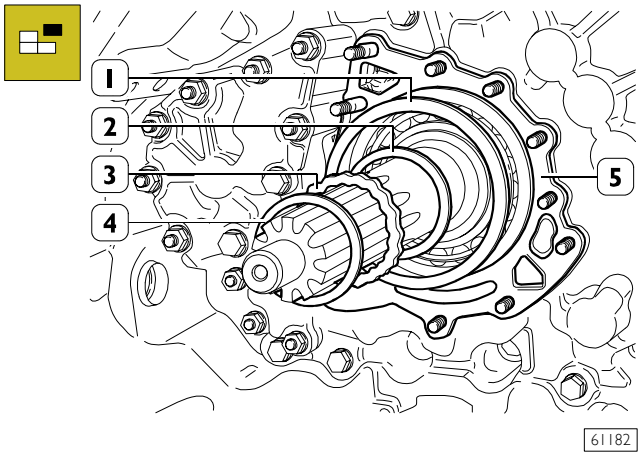
Remove the reverse transmission gear (1) with the needle bearings (2 and 3).

Figure 69



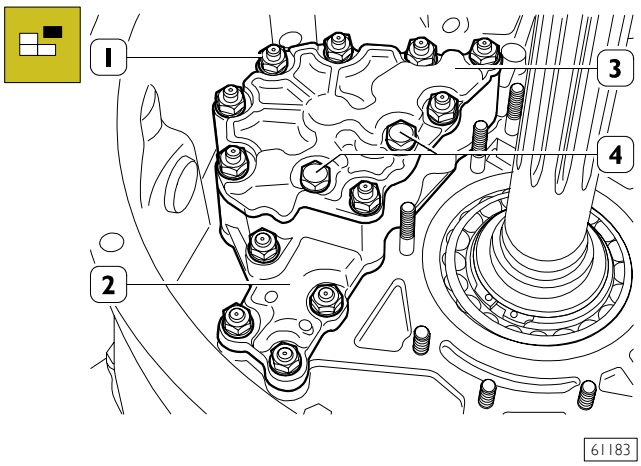
Unscrew the nuts (1) and remove the oil pump (2).

Figure 70



Remove thrust ring (4), spring (3) thrust ring (2), adjusting ring (1) and gasket (5).

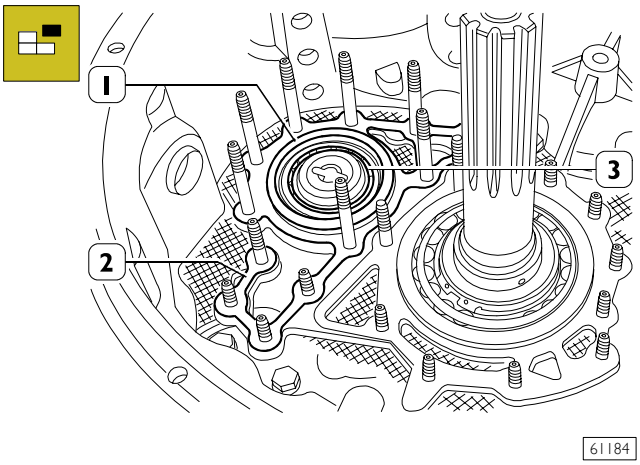
Figure 71



Unscrew nuts (1) and remove the input cover (2).

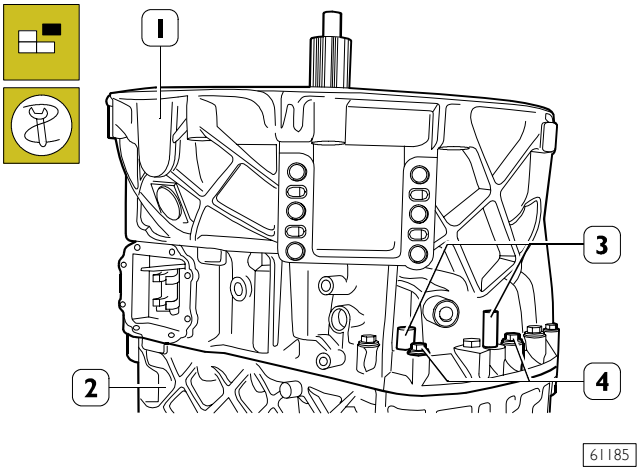
When removing the oil pump (2), do not undo screws (4). These screws secure the cover (3) to the pump casing and are to be unscrewed after the part has been removed, only for the oil pump overhaul.

Figure 72



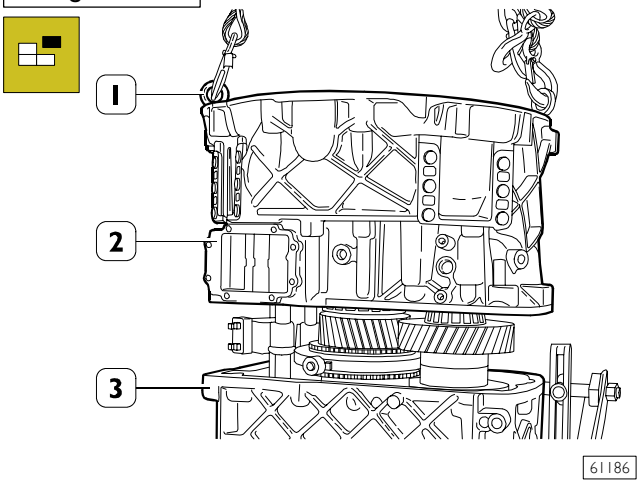
Remove the adjusting rings (1) from the taper roller bearing (3). Remove the gasket (2).

Figure 73



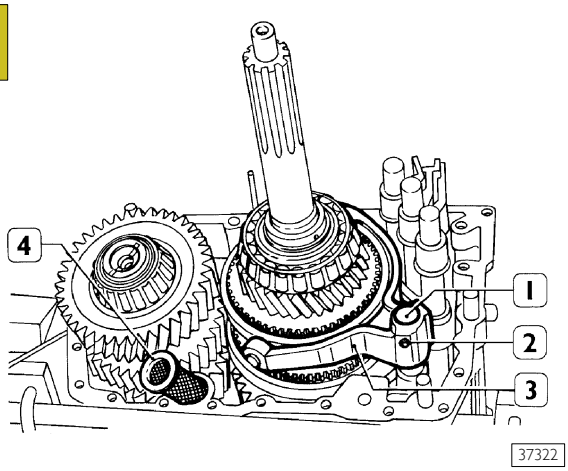
Using puller 99340205, take out the front cover (1) gearbox (2) centring pins (3).
Undo screws (4) and nuts securing the front cover (1) to the gearbox (2).

Figure 74



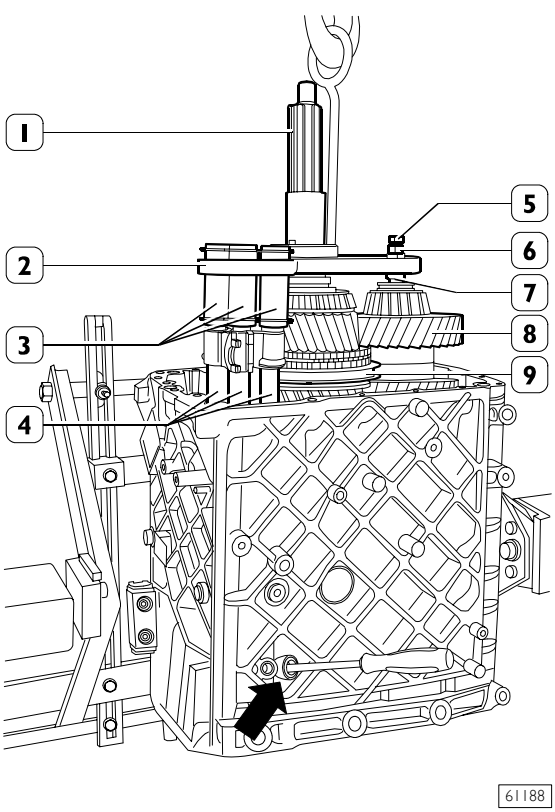
Apply appropriate hooks (1) to the front cover (2); with cables and hoist remove this from the gearbox (3).

Figure 75



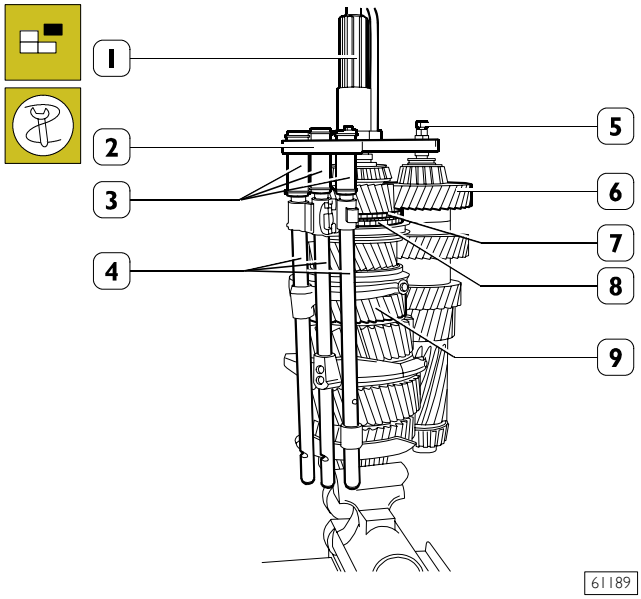
Remove the oil filter (4) from the gearbox. Unscrew the two hex. head cap screws (2), take out the splitter control rod (1) and remove the relevant fork (3) with shoes from the sliding sleeve.

Figure 76



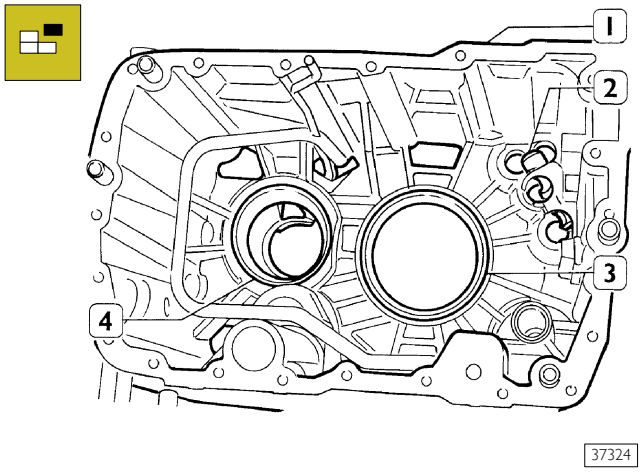
Fit tool 993605 15 (2) on the input shaft (1). Fit the sleeves (3) of the latter on the rods (4).
Tighten screw (5) of tool 993605 15 (2) into the transmission shaft (8), adjust nut (6) and threaded bushing (7) so that the transmission shaft (8) remains aligned to the main shaft (9) when withdrawn later.
Hook tool 993605 15 (2) to the hoist.
With a screwdriver inserted in the gearbox hole (→). push the bolt (2, Figure 78) to free the control rods (4) and at the same time withdraw the shafts-rods group from the gearbox.

Figure 77



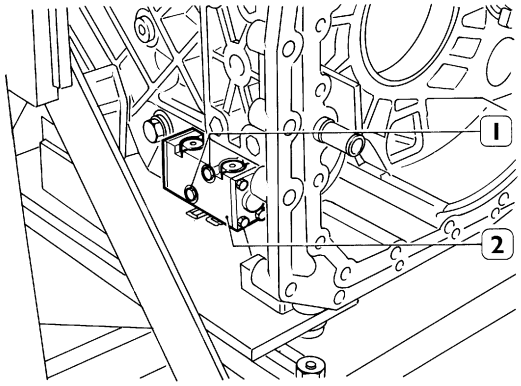
Lock the main shaft (7) in a clamp.
Undo screw (5) and remove the transmission shaft (6).
Raise the sleeves (3) from the rods (4) and remove the latter from the sliding sleeves.
Disassemble the input shaft (1) from the main shaft (9).
Disassemble the synchronising ring (8) and the coupling element (7).

Figure 78



Remove the gear bolt (2) with the spring from the gearbox. With an appropriate driver remove the two outer rings (3) and (4) of the support bearings on the E.R.U. side of the transmission and main shafts. Clean the lubricating oil delivery ducts with a jet of compressed air.

Figure 79



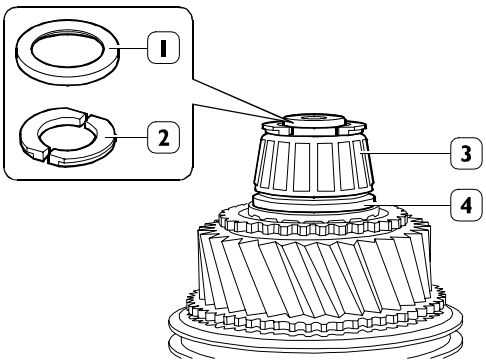
37325

Undo the two screws (1) and remove the splitter control valve (2).

Do not disassemble the splitter control valve (2). If it is faulty, replace it.

Disassembling the main shaft

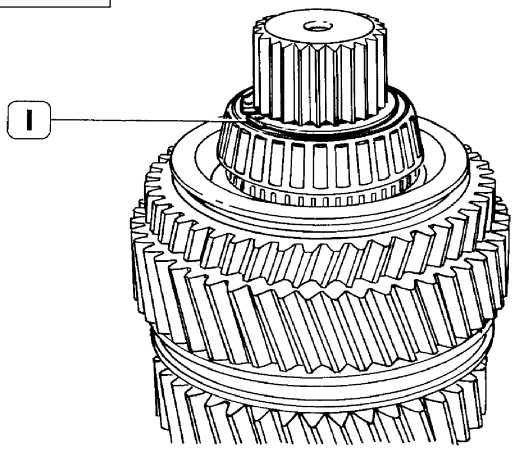
Figure 80



61190

Raise the dent on the retaining ring (1) and remove the half-rings (2). With an appropriate puller, remove the taper roller bearing inner ring (3). Take out the thrust ring (4).

Figure 81

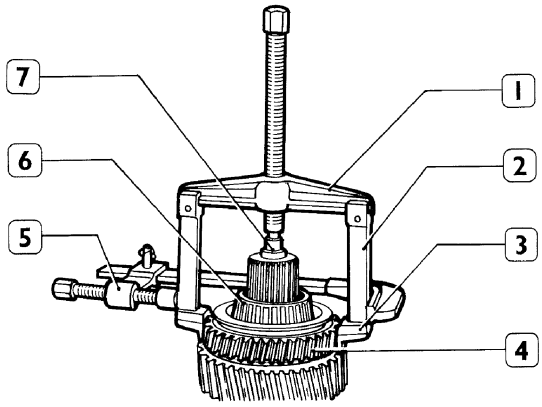


37327

Turn over the main shaft in a clamp and remove the split ring (1).

The figure shows the main shaft in the version with straight tooth end.

Figure 82



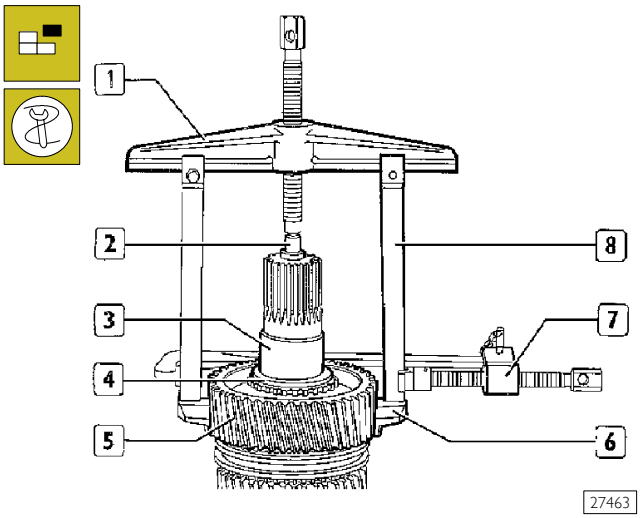
37328

Remove the reverse gear (4) and inner ring (6) of support bearing E.R.U. side using a puller consisting of:

- ❑ grips (3);
- ❑ tie-rods (2);
- ❑ puller (1);
- ❑ thrust block 99345058 (7);
- ❑ clamp (5).

Take the needle bearing of the reverse gear (4) from the main shaft.

Figure 83

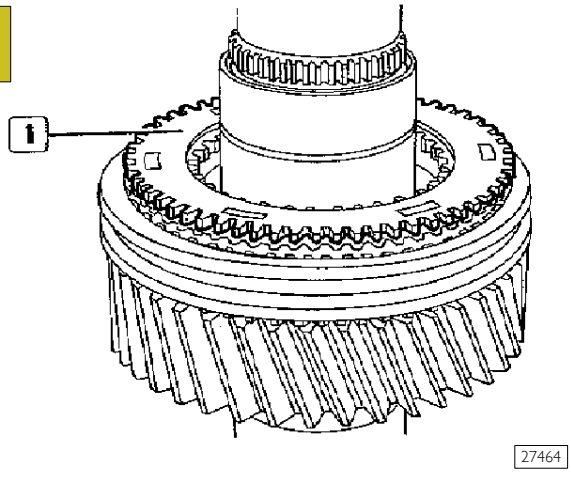


Remove the 1st speed gear (5), the coupling element (4) and the inner ring (3) of the reverse gear bearing using a puller consisting of:

- ❑ grips (6);
- ❑ tie-rods (8);
- ❑ puller (1);
- ❑ thrust block 99345058 (2);
- ❑ clamp (7).

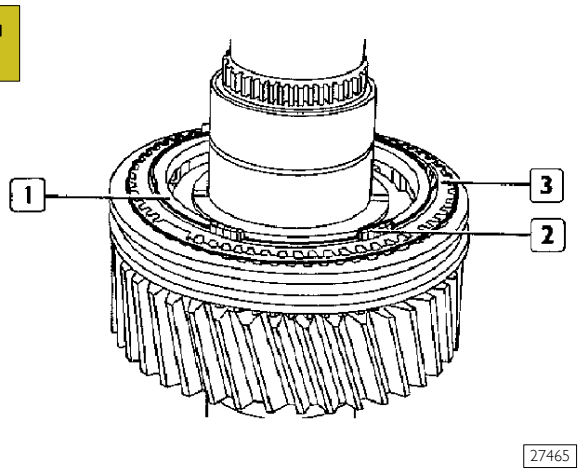
Remove the needle bearing of the 1st speed gear from the shaft.

Figure 84



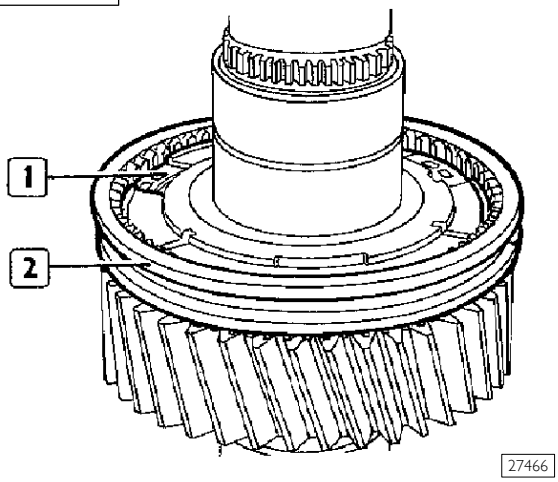
Take off the coupling element (1).

Figure 85



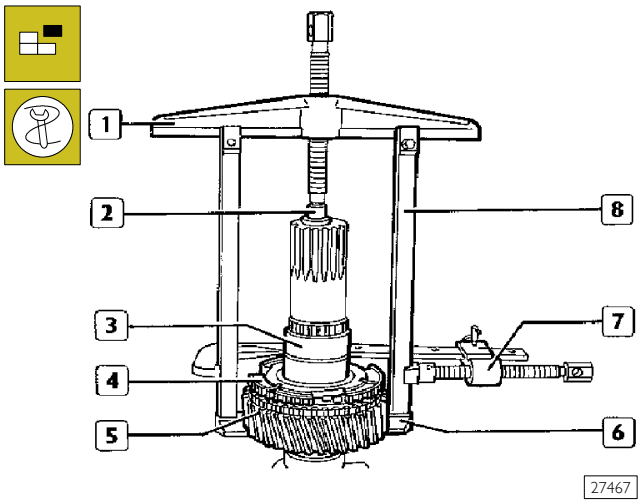
Remove the synchroniser ring from the main shaft (3).

Figure 86



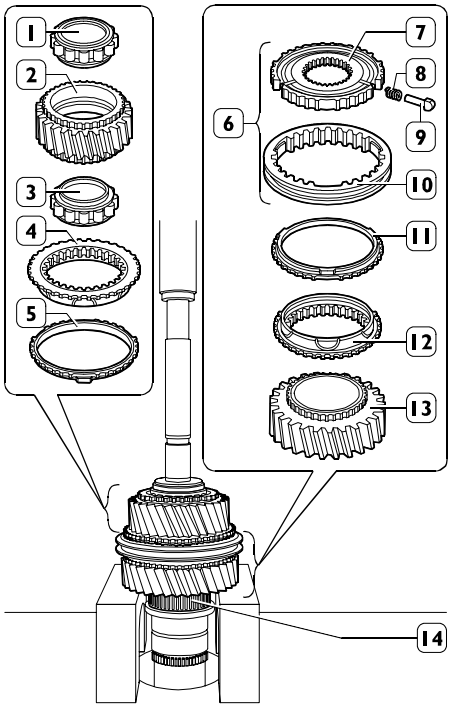
Take off the sliding sleeve (2) with springs and thrust elements and remove the three connecting blocks (1).

Figure 87



Extract the 2nd gear cog (5), the coupling body, friction ring, synchroniser ring , fixed connecting (4) sleeve and coupling (3) with a compound extractor.

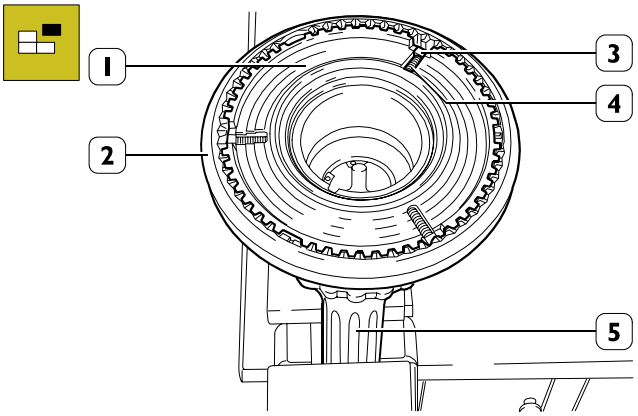
Figure 88



With a hydraulic press remove the 3rd speed gear (13), the coupling element (12), the synchronising ring (11), the synchronising unit (6), the synchronising ring (5), the coupling element (4), the roller bearing (3), the 4th speed gear (2) and the roller bearing (1) from the main shaft and withdraw the roller bearing (14).
Disassemble the synchronising unit (6). Remove the sliding sleeve (10) from the hub (7) taking care to recover the pins (9) and the springs (8). Lay these aside.

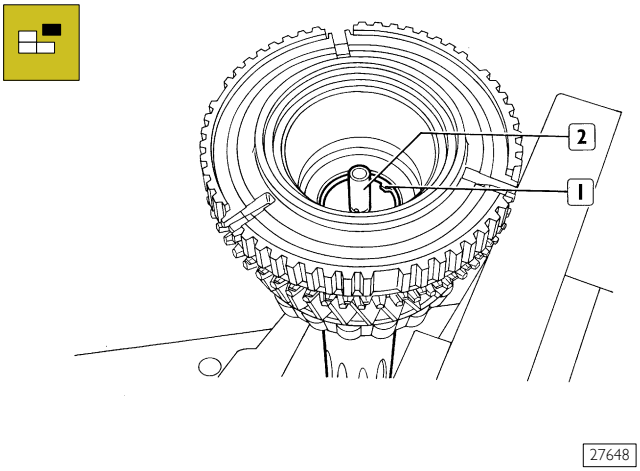
Disassembling the input shaft

Figure 89



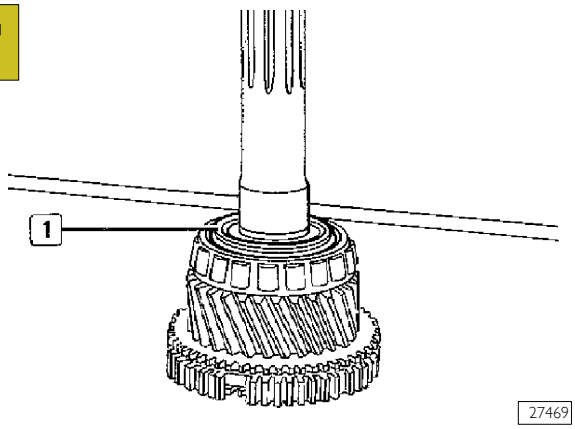
Lock the input shaft (5) in a clamp. Remove the sliding sleeve (2) from the hub (1), taking care to recover the pins (3) and springs (4). Lay these aside.

Figure 90



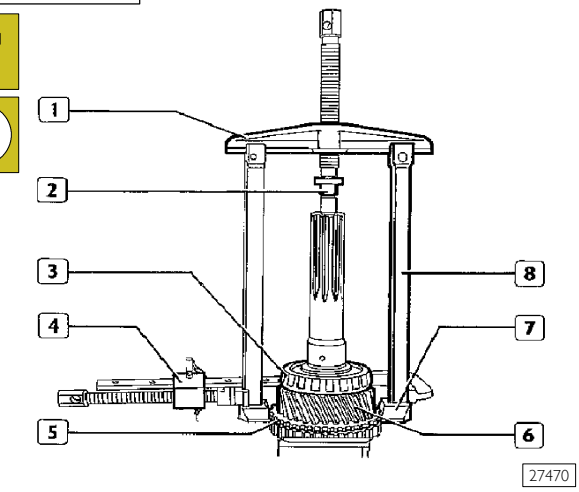
Remove the split ring (1) and remove the tube (2).

Figure 91



Remove the retaining ring (1) and the splined ring underneath.

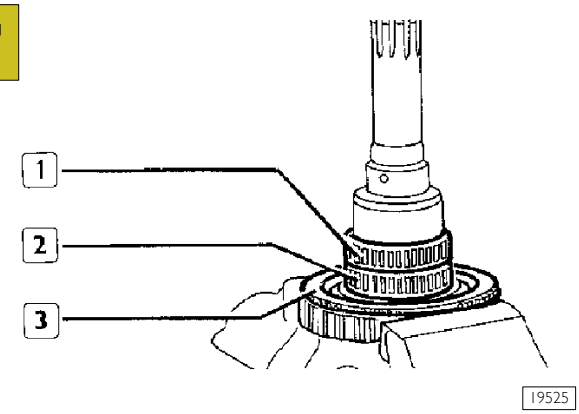
Figure 92



Remove the coupling element (5), gear (6) and inner ring (3) of the input shaft bearing using a puller consisting of:

- ❑ grips (7);
- ❑ tie-rods (8);
- ❑ puller (1);
- ❑ thrust block 99345058 (2);
- ❑ clamp (4).

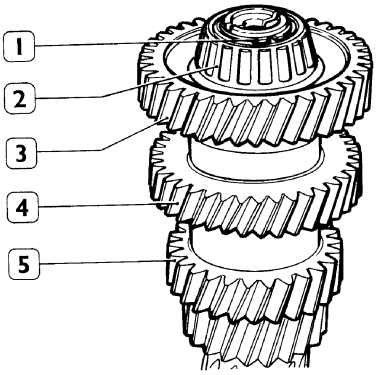
Figure 93



Remove the bearings (1 and 2) and the synchronising ring (3).

Disassembling the transmission shaft

Figure 94



Remove the split ring (1) and with an appropriate puller remove the inner ring (2) of the bearing on the splitter side. In the same way, after turning over the transmission shaft, remove the inner ring of the bearing on the E.R.U. side.

The two roller bearings of the transmission shaft are not interchangeable. Mark them and lay them aside separately to avoid confusing them when reassembling.

With a hydraulic press remove the gears (3rd, 4th and 5th) from the transmission shaft.

CHECKS

Gearbox

There should be no signs of cracks on the gearbox and its covers.
The contact surface between the gearbox and the covers should not be in any way damaged or warped. Remove any residual sealant from these surfaces.
The seats of the bearings, shafts and the gear control levers should not be damaged or badly worn.
Check that the holes, tubes and lubrication grooves are not obstructed by grease or foreign matter.

Hubs - sliding sleeves - forks

The grooves on the hubs and sliding sleeves are to be free of damage. The sliding sleeve is to slide freely on the hub. The sliding sleeve positioning blocks or pins are not to be damaged or worn. The sliding sleeve meshing teeth are to be undamaged. The forks are to be intact and the end float in the sleeve radial groove shall not be more than 0.6 to 1.2 mm.

Bearings

The roller bearings or the roller cages are to be in perfect condition with no signs of wear or overheating.

Shafts - gears

Bearing seats on the shafts are not to show signs of damage or wear. The gear teeth are not to show signs of damage or wear.

Synchronisers

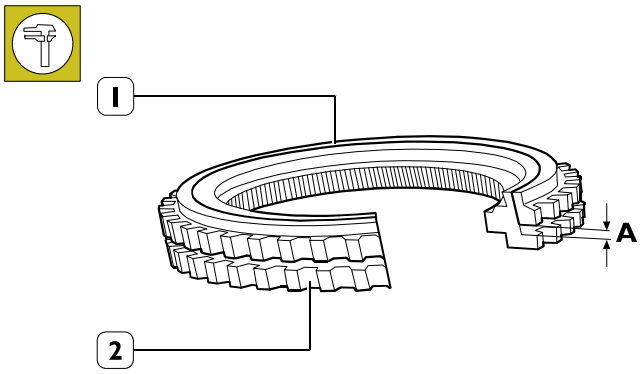
To check the wear on the synchronising rings, proceed as follows:

After checking, mark the synchronisers on their gears to avoid changing their position when reassembling.

❑ Visually check that the friction surface is not rippled.

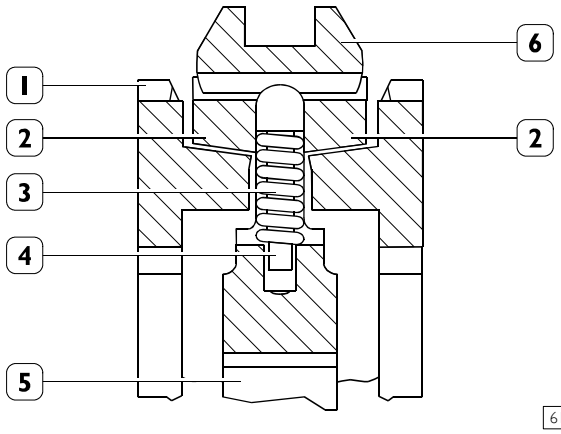
Single cone synchronisers type BK

Figure 95



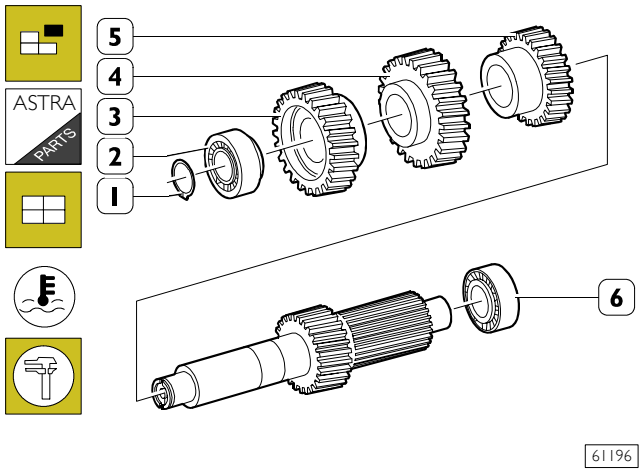
Place the synchronising ring (1) on the coupling element (2).
Turn the synchronising ring (1) so that it fits properly on the coupling element (2).
With a thickness gauge check distance A on two diametrically opposite points.
This is not to be less than 0.8 for the gears and splitter ;
- 1.2 for the epicyclic reduction unit.

Figure 96



1 - Coupling element; 2 - Synchronising ring;
3 - Compression spring; 4 - Pin; 5 - Synchroniser hub;
6 - Sliding sleeve.

Figure 97



Heat the gears (5th, 4th and 3rd) to 150° - 180°C for about 15 minutes and with a press drive them onto the shaft.

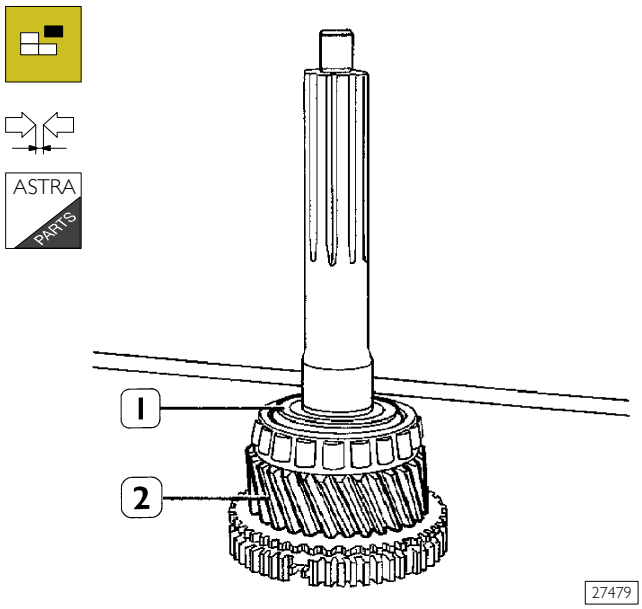
When assembling, the inner rings of the taper roller bearings are to be heated beforehand at a temperature of 100°C for about 15 minutes.

Assemble the inner ring of the bearing (2) splitter side and split ring (1): Check with a thickness gauge that the clearance between the split ring (1) and its seat is within 0.0 to 0.1 mm.

Assembling the input shaft

To assemble the input shaft, follow the instructions given for disassembly in reverse order.
Operations and assembly steps that require special tools, clearance checks, adjustments or special specifications are described below.

Figure 98

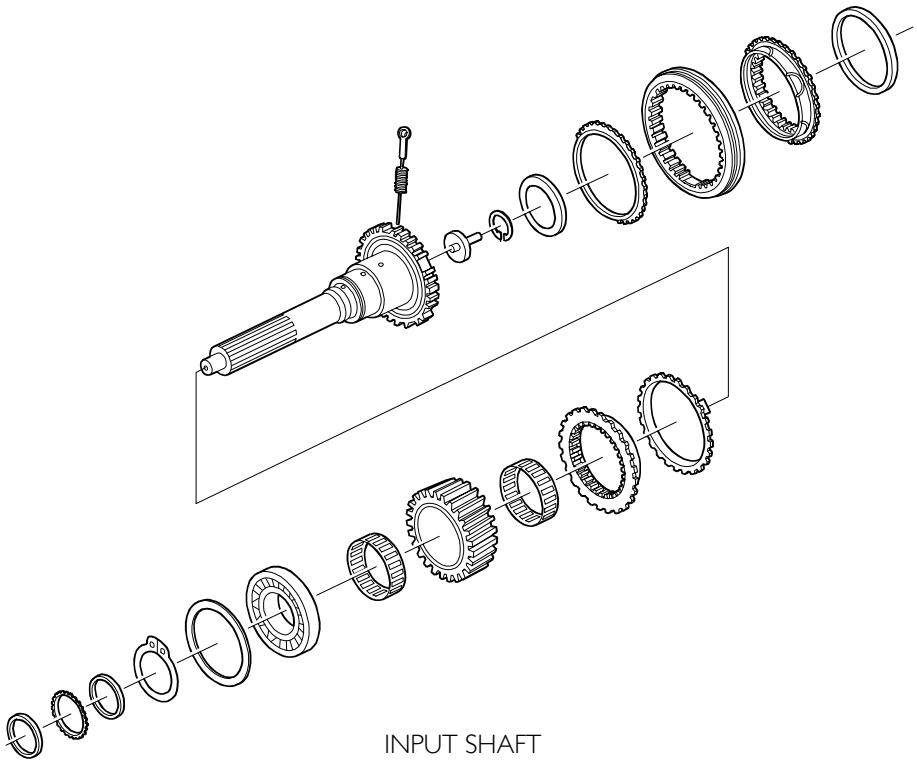


Use a thickness gauge to check the backlash on the input shaft (2): minimum backlash 0.2 mm.
Check the tolerance between the splined ring (1) and its seat. This should be between - 0.05 to + 0.05 mm

The splined ring (1) is supplied as a spare part in different thicknesses.

After mounting the splined ring (1) fit the retaining ring onto it and dent in two points, diametrically opposite each other.

Figure 99



INPUT SHAFT

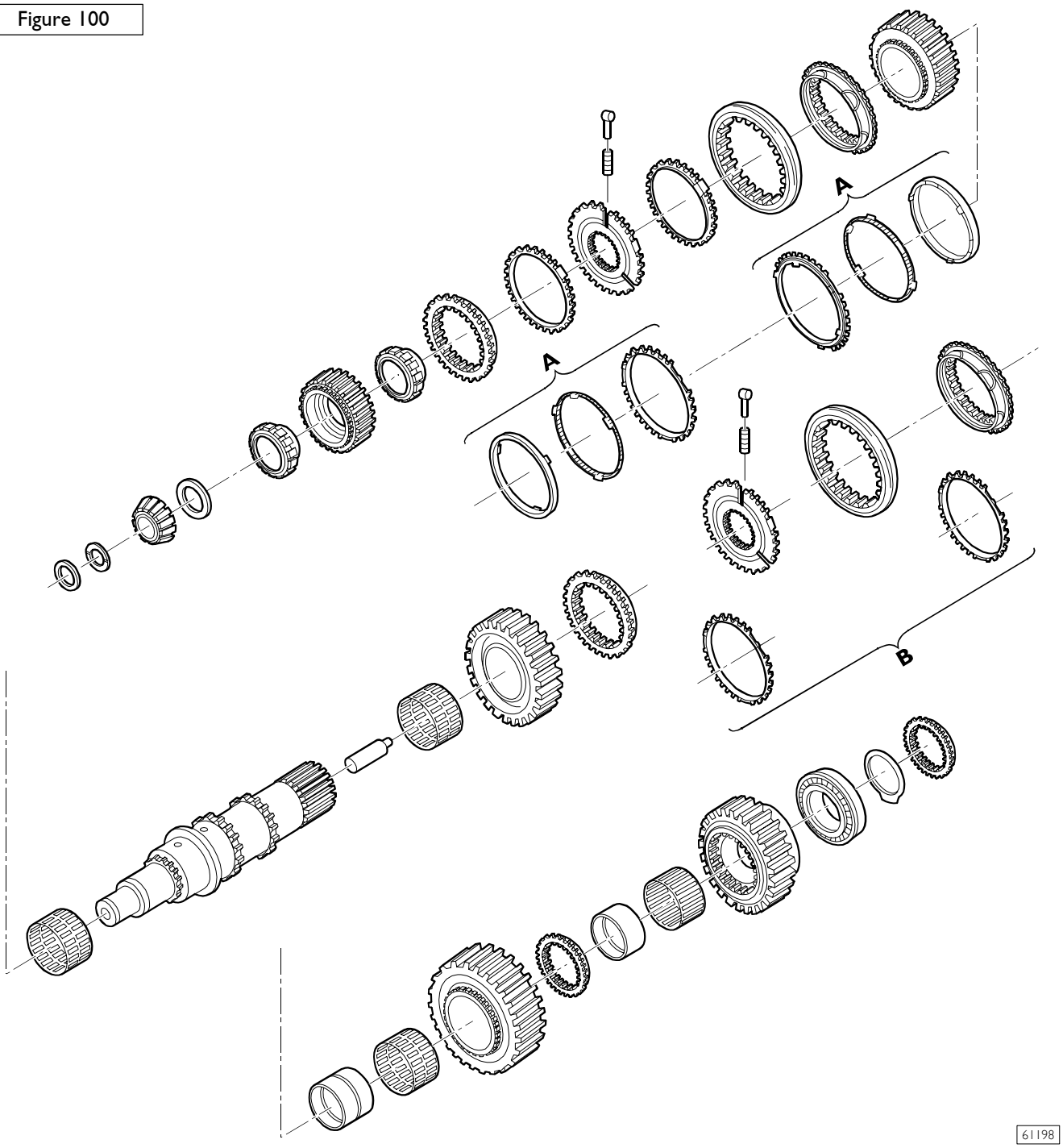
61197

Assembling the main shaft

To assemble the main shaft follow the instructions given for disassembly in reverse order.

Operations and assembly steps that require special tools, clearance checks, adjustments or special specifications are described below.

Figure 100



MAIN SHAFT

The main shaft is shown in the straight tooth version.

Before assembly heat:

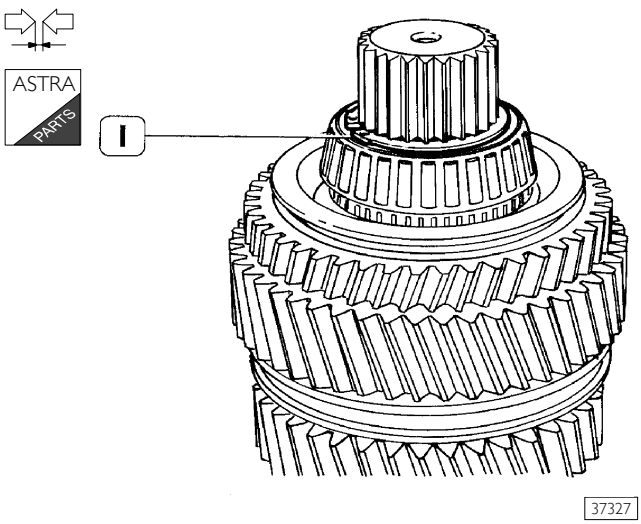
- ❑ inner rings of bearings at approx. 100 °C;
- ❑ bushings, hubs for sliding sleeves and toothed ring to engage reverse gear at 120 °C;
- ❑ bearing seats on the box and cover A approx. 60°C.

At assembly lubricate gear needle bearings.

After gears have been assembled check the backlash which should be:

- ❑ 1st - 2nd gears : 0.2 mm;
- ❑ 4th gear : 0.05 mm;
- ❑ reverse gear : 0.4 - 1.15 mm.

Figure 101



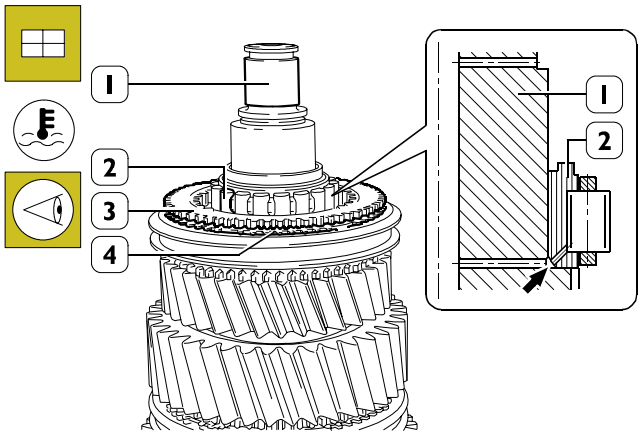
37327

The main shaft is shown in the straight tooth version.

Use a thickness gauge to check the clearance between the split ring (1) and its seat. The clearance should be between 0.0 and 0.1 mm.

The split ring (1) is supplied as a spare part in difference thicknesses.

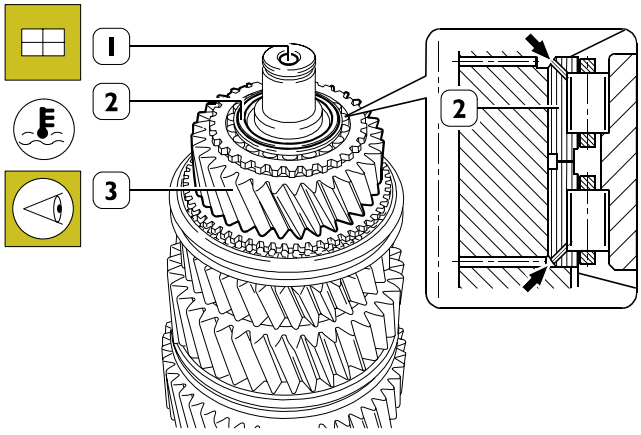
Figure 102



61199

Assemble the 4th gear as follows:
Heat the roller bearing (2) to 100 °C. Fit it on the main shaft (1) with the lubrication holes (→) positioned as shown in the figure. Leave to cool.
Assemble the synchronising ring (4) and the coupling element (3).

Figure 103

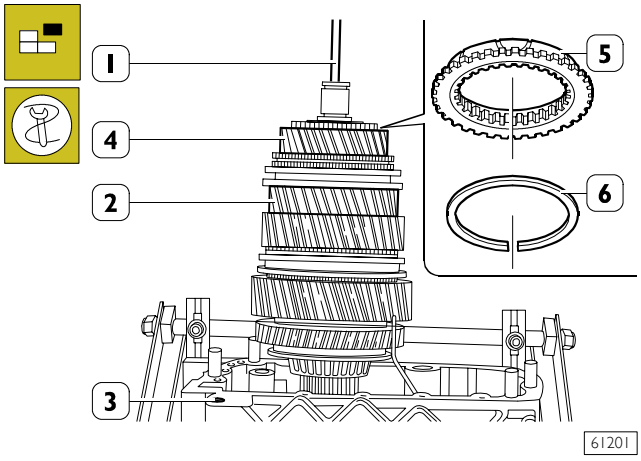


61200

Place the roller bearing (2), with the lubrication holes (→) as indicated in the figure, onto the 4th speed gear (3) then heat them to 100 °C and fit them assembled like this onto the main shaft (1).

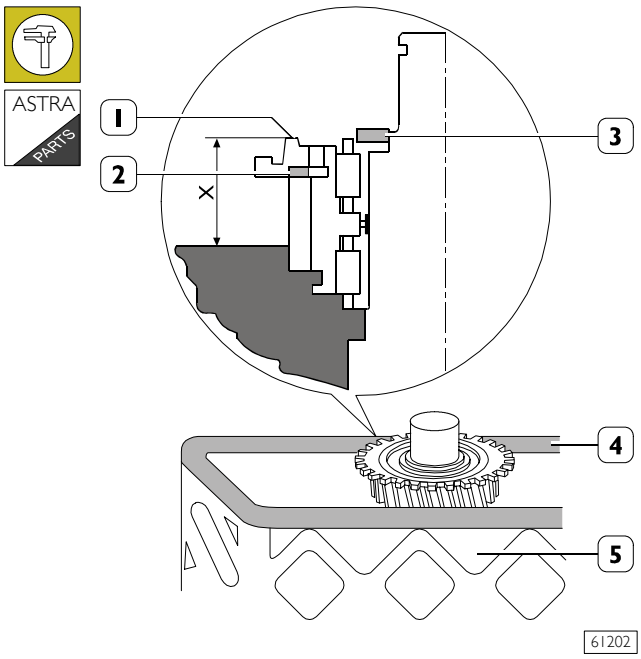
Adjusting the main shaft - version with straight tooth epicyclic reduction unit

Figure 104



Determine the thickness of the adjusting ring (6) of the coupling element (5) for the 4th gear (4) proceeding as follows:
Apply hook 99370449 (1) to the main shaft and with a mobile hoist mount the main shaft (2) in the gearbox (3).
Place the coupling element (5) with adjusting ring (6) on the 4th gear.

Figure 105



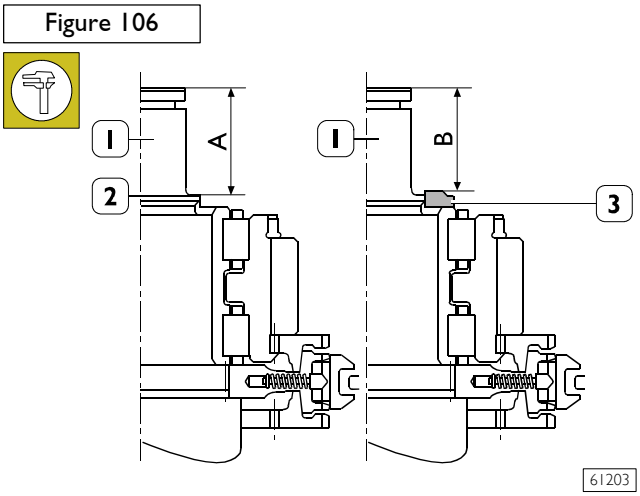
Place the gasket (4) on the gearbox (5). Measure distance X between the top of the coupling element (1) and the gasket (4) in several diametrically opposite points.
The average value of distance X should be:

- ❑ 32.2 $^{+02}$ mm for gearbox 16 S 151;
- ❑ 19.2 $^{-05}$ mm for gearbox 16 S 221.

If a different value is found replace the adjusting ring (2) with another of appropriate thickness.

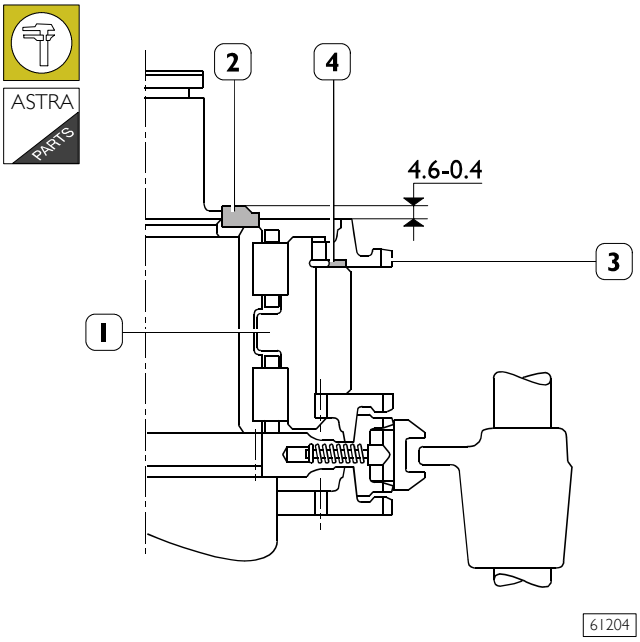
Adjusting the main shaft - version with helical tooth epicyclic reduction unit

Figure 106



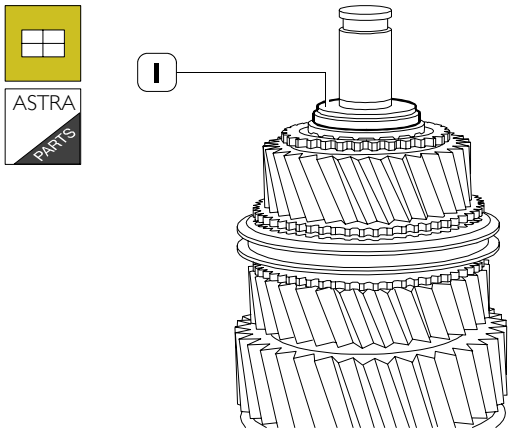
Determine the thickness of the adjusting ring (4, Figure 107) of the coupling element (3, Figure 107) for the 4th gear (4) proceeding as follows:
Measure distance **A** between the end of the shaft (1) and the taper roller bearing seat (2).
Fit the thrust ring (3) and measure distance B between this and the end of the main shaft (1).
The difference **A - B** is to be between +0.07 and -0.08 mm.

Figure 107



Place the coupling element (3) with adjusting ring (4) on the 4th speed gear.
Measure the distance between the top of the coupling element (3) and the thrust ring (2).
This should be 4.6 -0.4 mm.
If a different value is found replace the adjusting ring (4) with another of appropriate thickness.

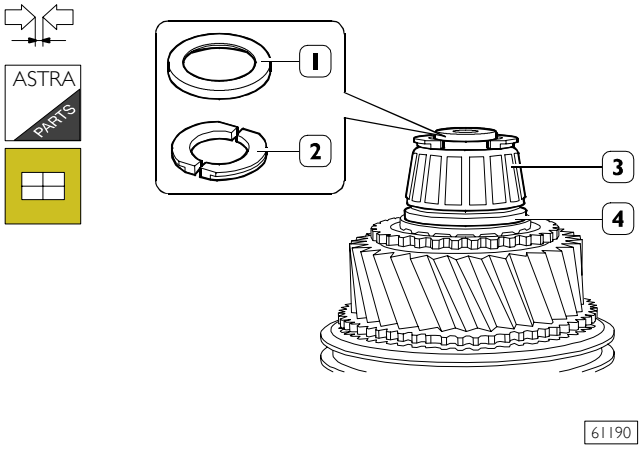
Figure 108



Fit the thrust ring (1); the thickness is to be chosen according to the thickness of the adjusting ring (2, Figure 105 or 4, Figure 107) as indicated in the table below:

Adjusting ring (2, Figure 105 or 4, Figure 107)	Thrust washer (1, Figure 108)
3.2	7.5
3.4	7.7
3.6	7.9
3.8	8.1
4.0	8.3
4.2	8.5
4.4	8.7
4.6	-
4.8	-
5.0	-

Figure 109



Fit the bearing (3) that was previously heated to 100 °C.
Fit the splined ring (2): its thickness is to obtain an end float in its seat of -0.05 to +0.05 mm.
Fit the retaining ring (1) and secure it on several equidistant points under the splined ring (2).

Assembling the gearbox

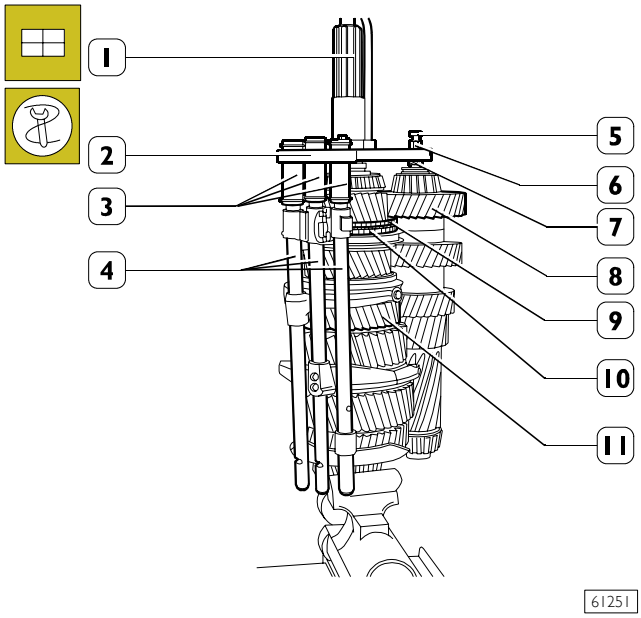
To assemble the gearbox follow the instructions given for disassembly in reverse order.
Operations and assembly steps that require special tools, clearance checks, adjustments or special specifications are described below.
The tightening torques are indicated in the specific table.

Rings, gaskets, ring nuts, split rings, safety plates, self locking screws which are found worn and all parts that are not perfectly efficient, are scored, indented or warped are to be replaced when assembling.

Flat gaskets are to be fitted in place dry, without sealing agent or grease.

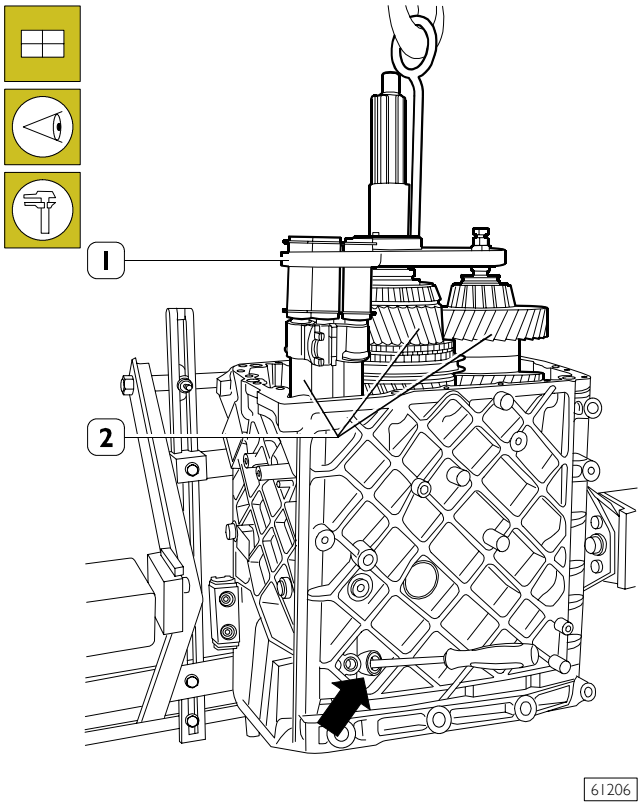
Before fitting the two-lip sealing rings fill the gap between the two lips with TUTELA MR3.

Figure 110



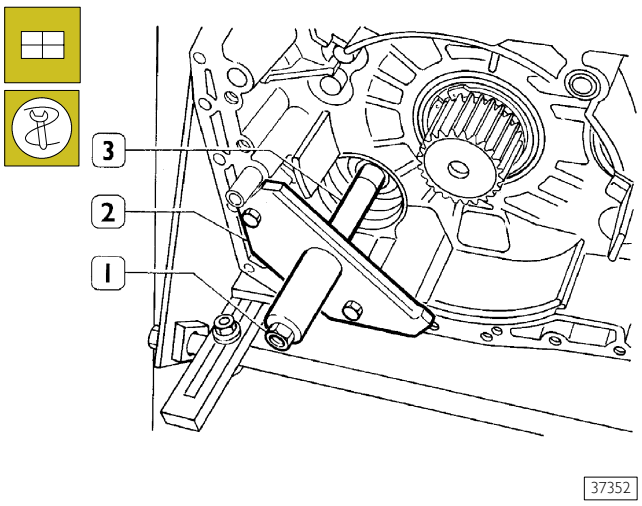
Lock the main shaft (1) in a clamp and fit onto it the coupling element (10) with adjusting ring and synchronising ring (9).
Assemble the input shaft (1).
Fit tool 993605 15 (2) onto the input shaft (1).Couple the transmission shaft (8) to the main shaft (11). Tighten screw (5) of tool 993605 15 (2) into the transmission shaft.
Adjust the nut (6) and threaded bushing (7) so that the transmission shaft (8) remains aligned with the main shaft (11).
Fit the forks with the blocks, rods (4) onto the sliding sleeves.
Place the sleeves (3) of tool 993605 15 (2) onto the rods (4).

Figure 111



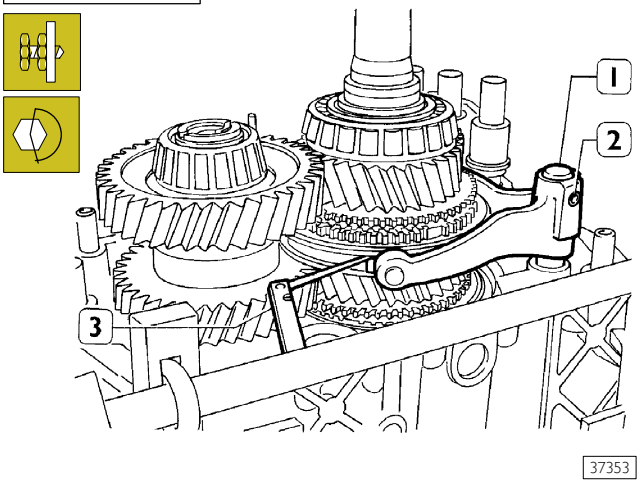
Hook the hoist to tool 993605 15 (1), lift the shafts-rods group (2) as it has been already assembled,
and insert it in the gearbox. With a screwdriver inserted in the gearbox hole, push the gear bolt so that the rods can enter their respective housings.
Remove tool 993605 15 (1).

Figure 112



Fit tool 99370450 (2) with spacer (3) onto the gearbox and insert the splitter fork control lever, locking it with nut (1).

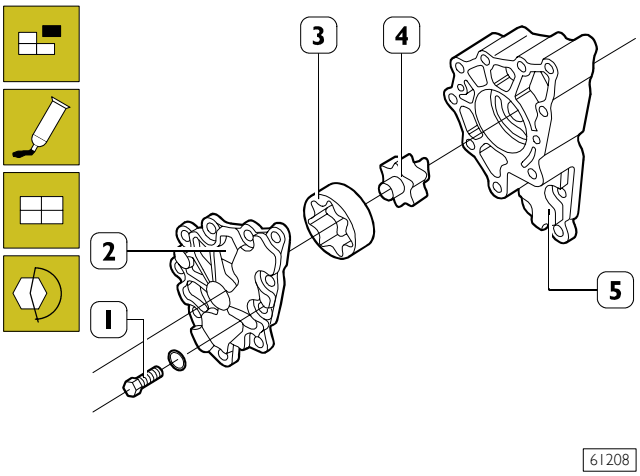
Figure 113



Operating on the two hex head cap screws (2) position the splitter control fork (1) so that the two shoes (4) are centred in the groove of the sliding sleeve. Use a thickness gauge (3) to ensure centring.
After adjustment tighten the two screws (2) to the specified torque.
Insert the splitter control stop screw onto the gearbox and tighten to the specified torque.
Remove the adjusting tool 99370450 (2, Figure 112) and the spacer (3) from the gearbox after loosening the nut (1).

Oil pump

Figure 114



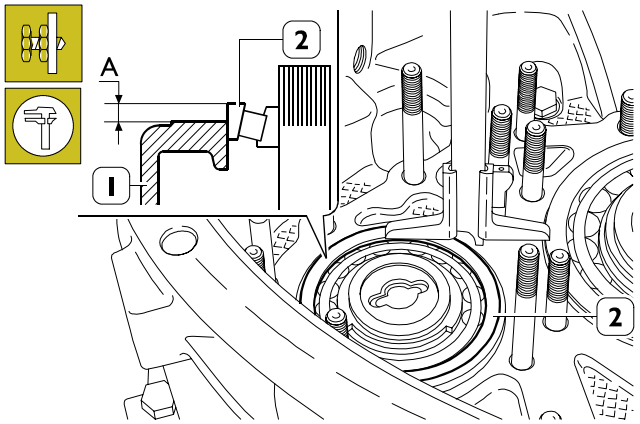
To strip down the oil pump: undo the screws (1), remove the cover (2) from the pump casing (5) and take out the external rotor (3) and the internal rotor (4).
To reassemble, follow the steps in reverse order.

On the cover mounting surface (2) apply a thin film of LOCTITE 547.

Tighten the screws (1) to the specified torque.

Adjusting the transmission shaft end float

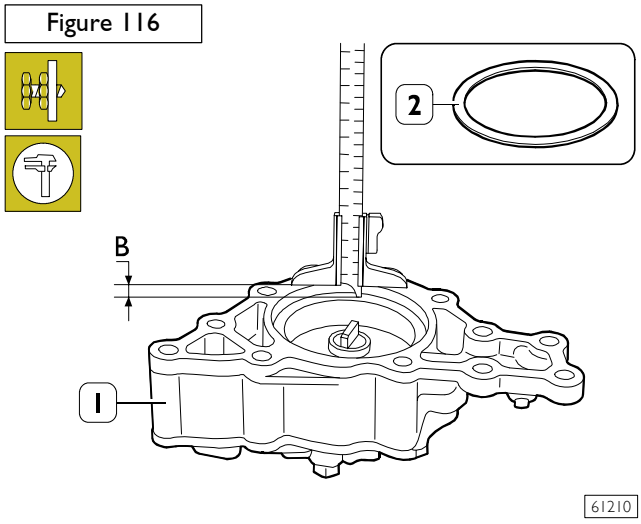
Figure 115



To determine thickness **S** of adjusting rings (2, Figure 116) for the bearing (2) end float on the transmission shaft, proceed as follows:

- ❑ rotate the shafts and check that the bearing outer ring (2) rests without clearance on the bearing rollers;
- ❑ on two diametrically opposite points measure the distance between the front box surface (1) and the outer ring (2) value **A**.

Figure 116



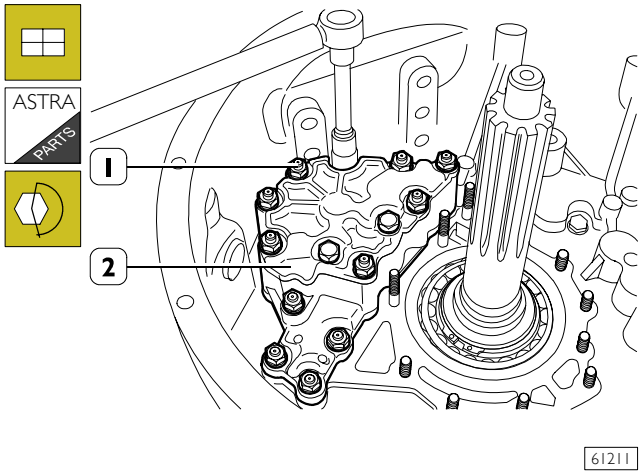
Measure the depth of the bearing seat (2, Figure 115) on the pump casing (1), value **B**.
Thickness **S** of the adjusting ring (2) is determined by the following equation:

$$S = [\,B - (A - C)\,] - D$$

Where:

- ❑ **A – B**, measurements found;
- ❑ **C**, thickness of gasket;
- ❑ **D**, end float of 0 to 0.1 mm.

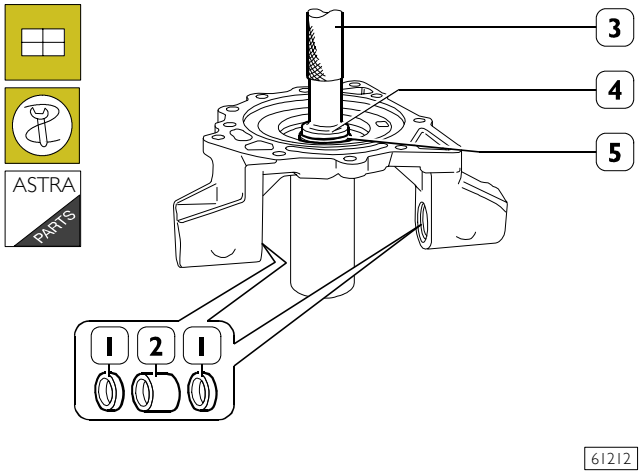
Figure 117



Fit a new gasket on the front cover, fit the oil pump (2) with the adjusting ring (2, Figure 116).
Tighten the nuts (1) and tighten to the specified torque.

Input shaft cover

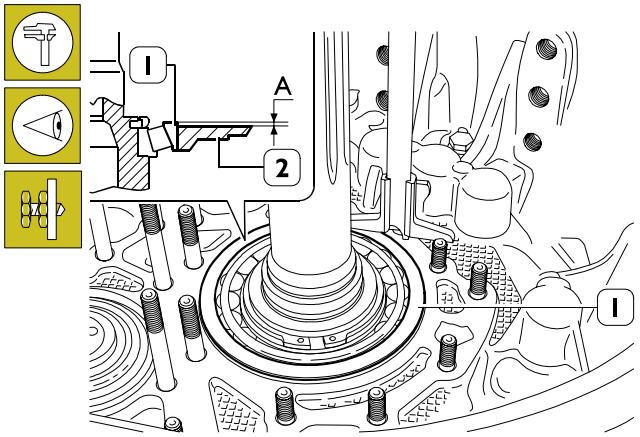
Figure 118



To replace the sealing rings (1) and bushings (2), use standard tools for the removal-refitting.
For sealing ring (5) use connecting tool 99370420 (4) and handle 99370006 (3).

Adjusting the input shaft end float

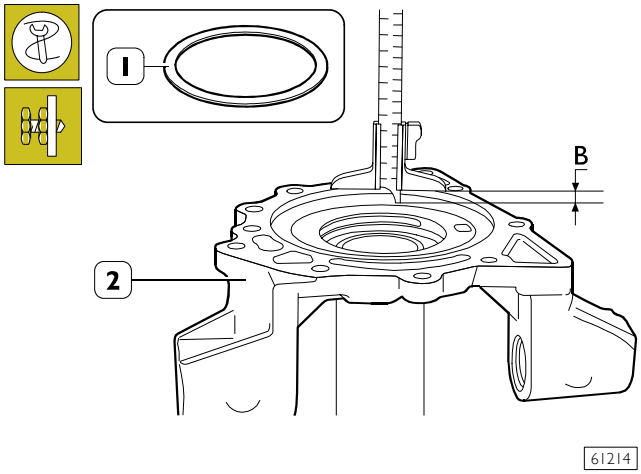
Figure 119



Determine thickness **S** of the input shaft bearing adjusting ring as follows:

- ❑ Rotate the input shaft and check that the outer ring (1) rests without backlash or pre-load on the bearing inner ring;
- ❑ measure the bearing (1) overhang from the front cover surface (2), value **A**;

Figure 120



- ❑ measure the depth of the bearing seat (1, Figure 119) on the cover (2), value **B**.

Thickness **S** of the adjusting ring (1) is determined by the following equation:

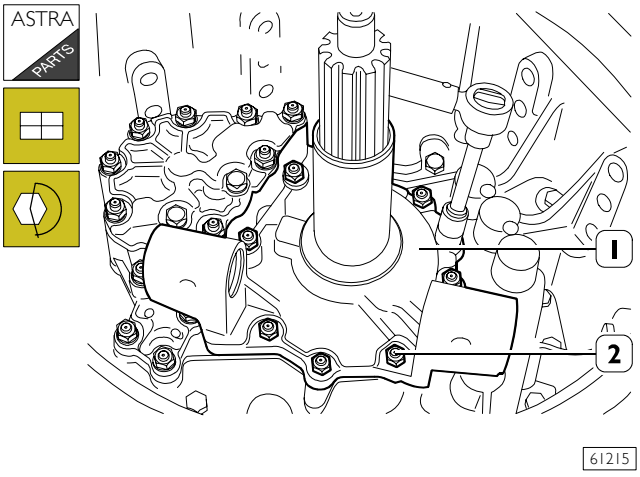
$$S= [B – (A – C)] - D$$

Where:

- ❑ **A – B**, measurements found;
- ❑ **C**, thickness of gasket;
- ❑ **D**, end float of 0 to 0.1 mm.

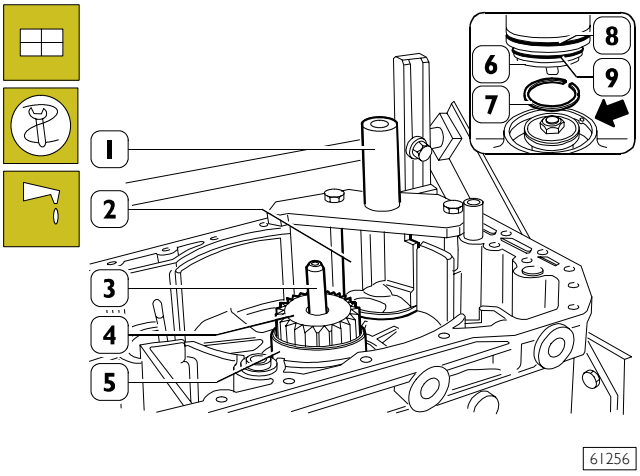
Completion

Figure 121



Place a new gasket on the front cover (1), assemble the cover (1) with the adjusting ring (1, Figure 120).
Fit the nuts (2) and tighten to the specified torque.

Figure 122



Turn over the gearbox.
Fit the tube (3) in the main shaft.
Fit the spacer (5) on the main shaft (4) place the split ring (6) in the splitter control cylinder.

Position the ring split (7) to correspond to the hole (→).

Fit the sealing rings (8 and 9) onto the cylinder (6) and lubricate them.
Fit the cylinder (6) in the gearbox.
Fit tool 99370450 (1) onto the gearbox to keep the cylinder (6) in place. Feed the splitter control valve with compressed air (max. 6.8 bar) and listen to hear that the internal piston is operating and that there are no air leaks.
Remove tool 99370450 (1).
Refit the epicyclic reduction unit as described in the relevant section.
Fill the gearbox with the required quality and quantity of lubricating oil.

VERSIONS FITTED WITH INTARDER

This paragraph describes the differences in operation resulting from intarder application.

Refer to the basic configuration for whatever matter not explicitly specified.

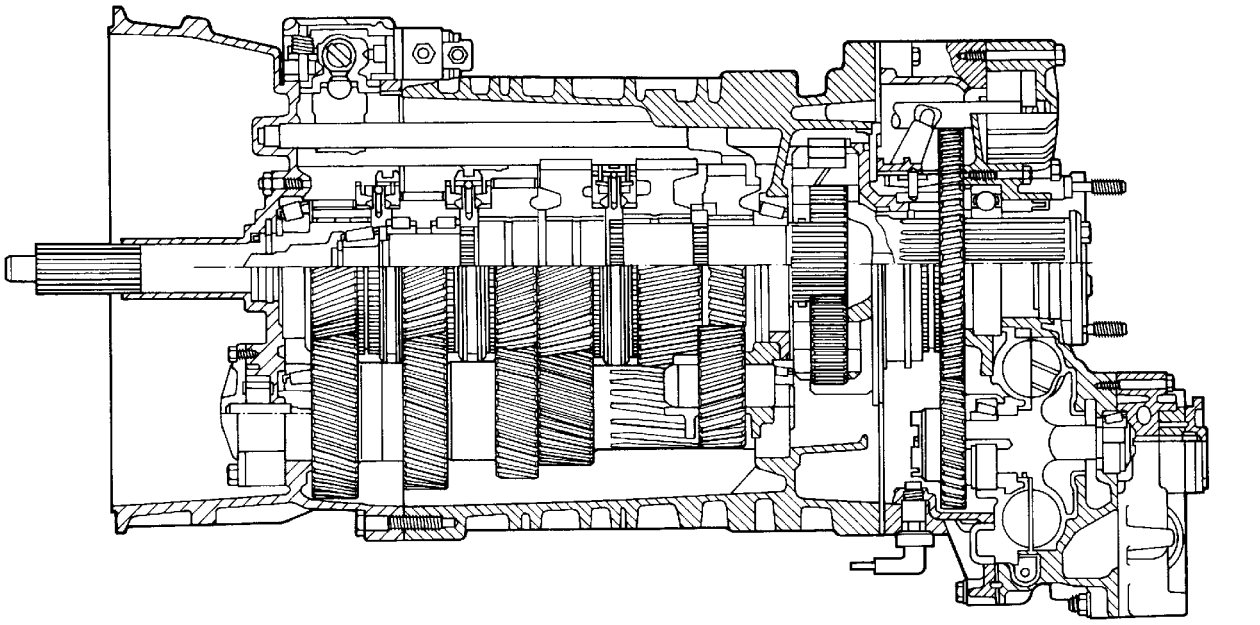
DESCRIPTION

Intarder ZF is a hydrodynamic brake mounted on the gearshift output.

The braking effect is given by the oil contained in the retarder.

The rotor increases the speed of the oil coming into the retarder, which, when meeting the stator, is slowed down. This provokes an increase in oil temperature.
Oil is cooled down through a oil/water heat-exchanger connected to the cooling system of the vehicle. The braking torque deriving from this activity acts on the cinematic chain of the vehicle and slows it down.
Intarder is integrated to the ZF gearshifts.

Figure 123



LONGITUDINAL SECTION OF THE GEARSHIFT IN THE INTARDER

GENERAL CHARACTERISTICS

		Gear ZF 16 S 151	Gear ZF 16 S 221
	REFUELING *		
	Quantity (after revision, gear and retarder completely empty) l	17	20.5
	kg	15.3	18.5

* See Section 2 - LUBRICANT AND HYDRAULIC FLUID TABLE for the required type of fluid.

TIGHTENING TORQUES

PIECE	TORQUE	
	Nm	Kgm
Assembling nuts of the heat-exchangers in the rear half-box*	62	6.2
Securing screw of the heat-exchanger in the rear half-box (M8)*	23	2.3

* Versions with built-in heat exchanger

TOOLS

TOOL NUMBER	NAME
99340030	Extractor to work hydraulically to dismount the gear to control the Intarder (use with 99341033 - 99341034 - 99345058).
99341009	Brackets pair.
99341018	Brackets pair with hole.
99341033	Hydraulic unit with 17.5 tons for extractor.
99341034	Hydraulic pump with 50 tons.
99342143	Punch to extract the grub in the rear and front gear boxes (use with 99340205).
99370047	Tool for the pre-loading of the bearings to check consistence on the rotor shaft.
99370048	Centring plate of the rotor shaft on the Intarder box.
99370465	Tool to flatten the safety plates.
99370629	Bench for connecting and disconnecting the gearshift.
99389819	Spanner (0 to 10 Nm) with 1/4" connection.

STRIPPING DOWN - REFITTING GEARBOX

Versions with separate exchanger

Removal

- ❑ To remove the unit proceed as described for standard versions up to servo-clutch draining out;
- ❑ Then drain out engine coolant circuit as described in Section 3;

The disposal of waste or residual fluid in unauthorised sites or in the public sewer system is prohibited.

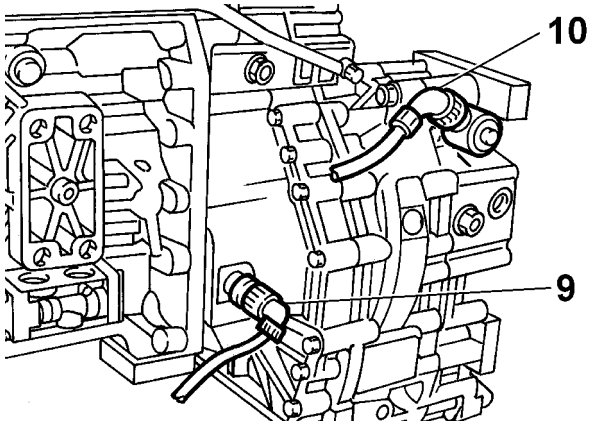
- ❑ Disconnect coolant delivery (23) and return (24) pipes;

During these operations, coolant leak from pipes can take place.

- ❑ Prepare a suitable container, open gearbox oil drain plug and drain out the gearbox;
- ❑ Disconnect intarder oil delivery (21) and return (22) pipes from oil-water exchanger;

During these operations, oil leak from exchanger or pipes can take place.

Figure 124

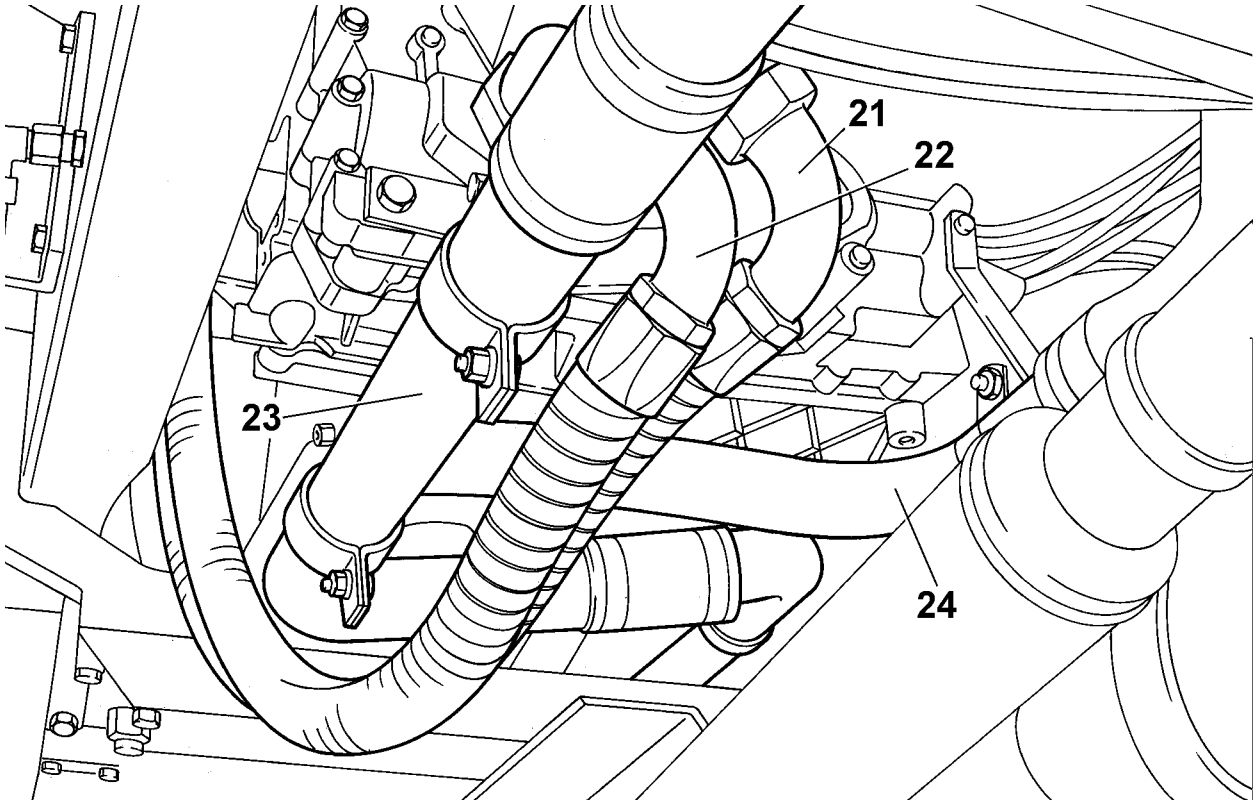


- ❑ Disconnect electrical connections (9) and (10) from intarder housing and then proceed as described for standard versions.

Refitting

To refit, follow the removal operations in reverse order.

Figure 125



Versions with built-in exchanger

Removal

- ❑ To remove the unit proceed as described for standard versions up to servo-clutch draining out;
- ❑ Then drain out engine coolant circuit as described in Section 3;

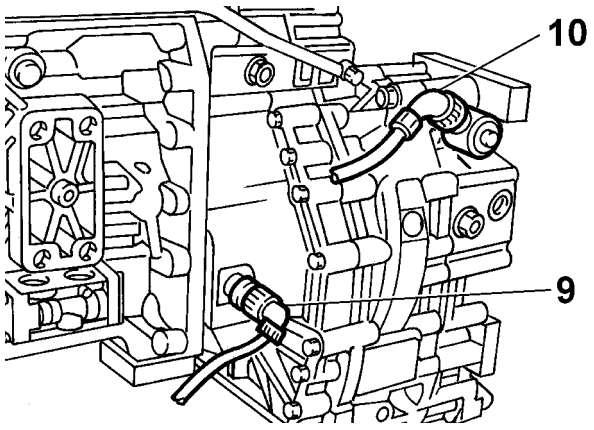
The disposal of waste or residual fluid in unauthorised sites or in the public sewer system is prohibited.

- ❑ Disconnect coolant delivery (23) and return (24) pipes;

During these operations, oil leak from exchanger or pipes can take place.

- ❑ Disconnect pneumatic (17) and electric (18) connection from exchanger (26);

Figure 126

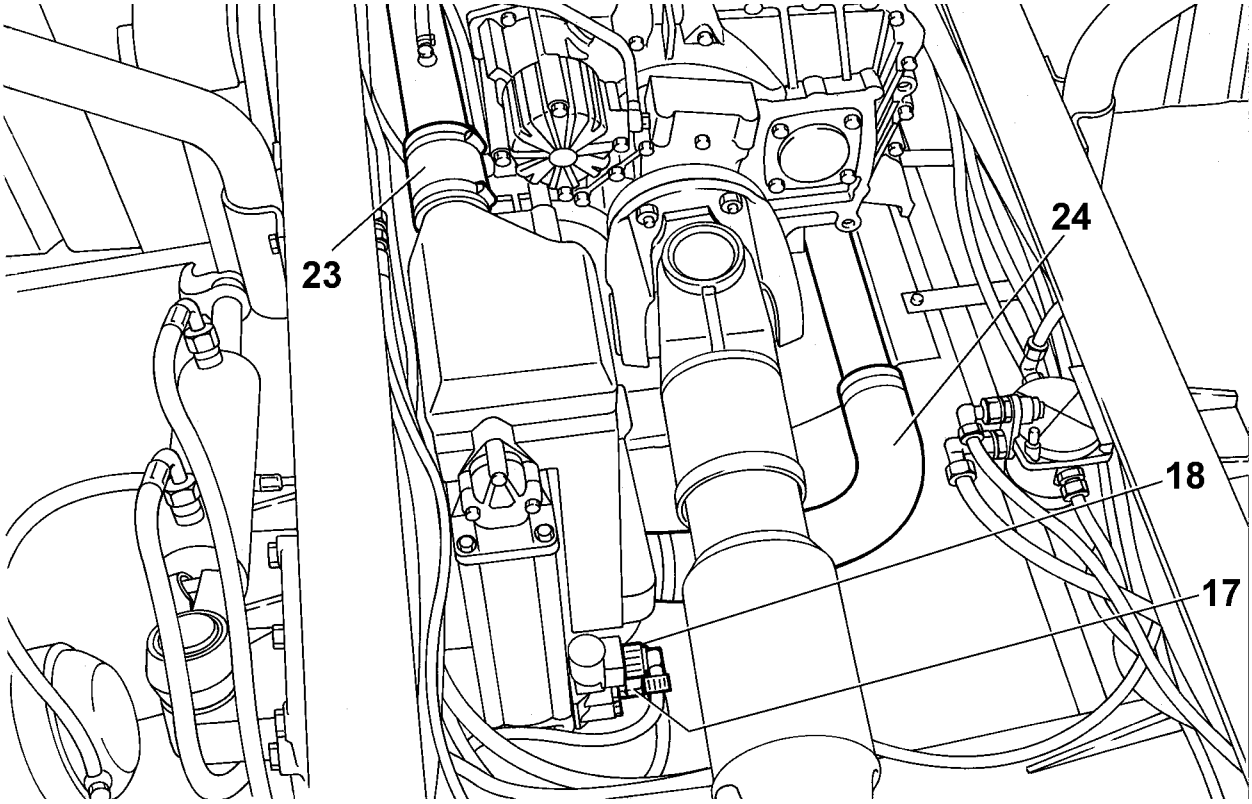


- ❑ Disconnect electrical connections (9) and (10) from intarder housing and then proceed as described for standard versions.

Refitting

To refit, follow the removal operations in reverse order.

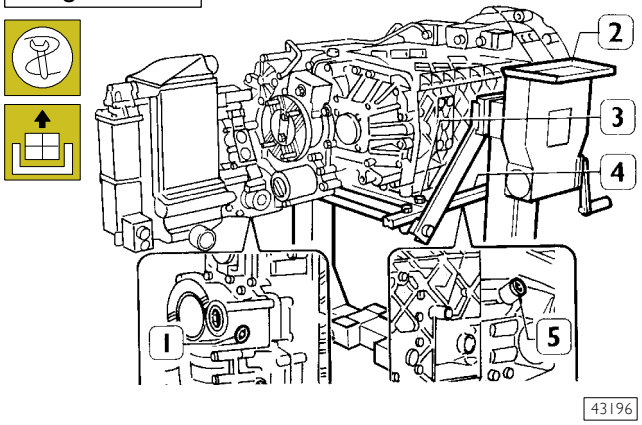
Figure 127



REPAIR OPERATIONS

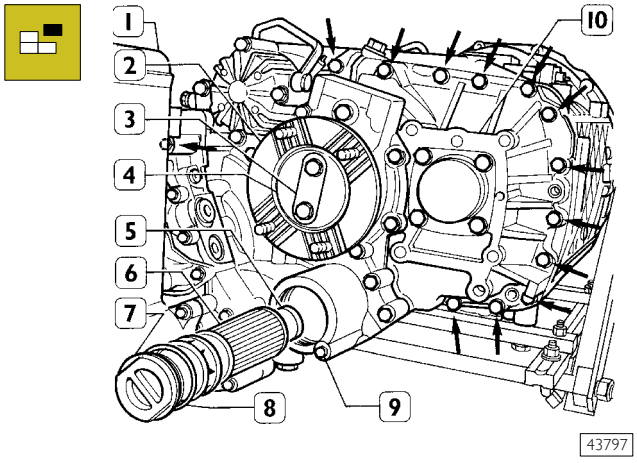
Removing the hydraulic retarder

Figure 128



Apply supporting brackets 99371050 (3) to the group.
Using cables with hooks and mobile hoist, place the assembly on the revolving stand 99322205 (2) with its support 99322225 (4).
Remove the cap (5) and drain off the lubrication oil from the gearshift.
Remove the cap (1) and drain the lubricating oil from the hydraulic retarder.

Figure 129

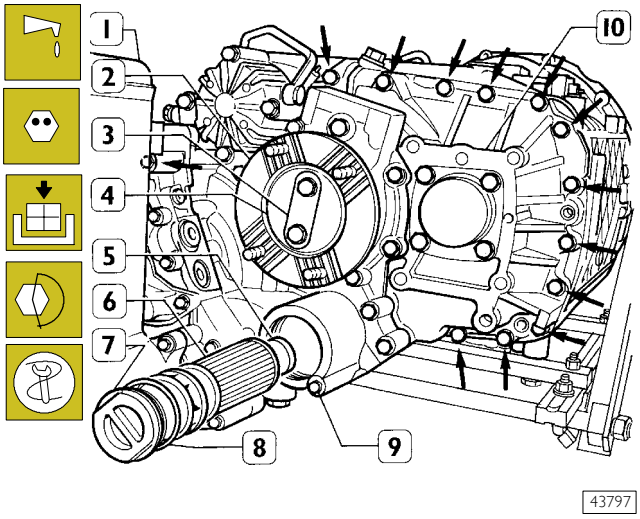


Raise the first covering of the safety plate (3) and then remove the plate.
Remove the securing screws of the output flange (2), the plate (4) and the sealing ring underneath.
Remove screw (9) and take out: cap (7) with sealing ring (8), oil filter (6) and magnet (5).
Place the gearshift vertical.
Remove the screws (→) securing the hydraulic retarder (1) to the epicyclic reduction unit (10). Harness the heat exchanger with ropes and with a hydraulic hoist remove the hydraulic retarder (1) from the epicyclic reduction unit (10).

Recover the adjusting rings from the stator and from the bearing seat of the epicyclic group shaft.

Refitting the hydraulic retarder

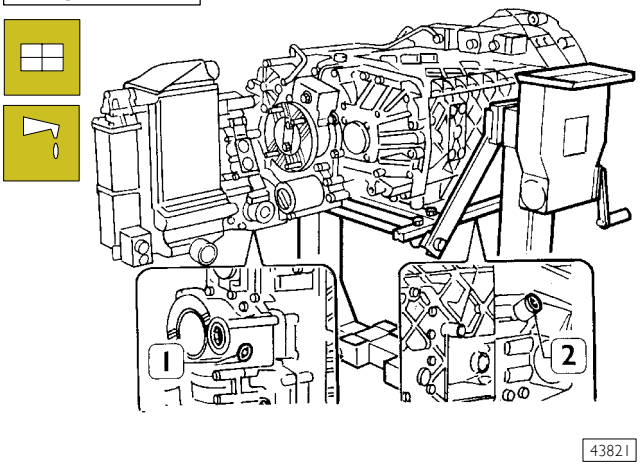
Figure 130



Fit the adjusting rings on the E.R.U. support bearings and the hydraulic retarder.
Refit the hydraulic retarder (1) on the E.R.U. box (10), tightening the screws (→) to the specified torque.
Mount the magnet (5), the oil filter (6), the cap (7) with the sealing ring (8) and tighten the screws (9) to the specified torque.
Fit the flange (2) on the E.R.U. shaft
Lubricate the sealing ring and mount it.
Fit in place the retaining plate (4) and tighten the screws to the specified torque.
Insert the screws in the safety plate (3) and secure with tool 99370465.

ASTRA PARTS Replace sealing elements with new ones.

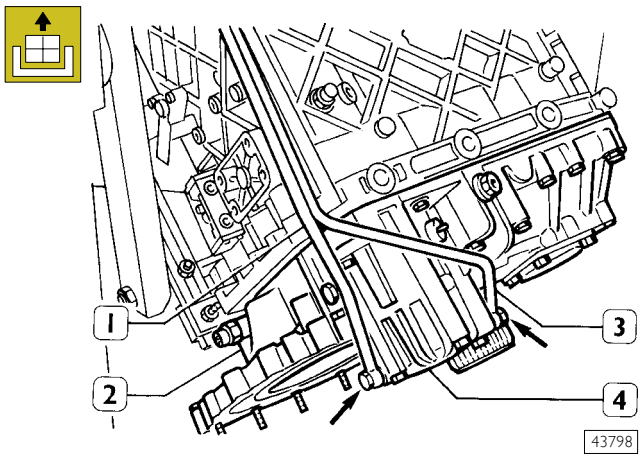
Figure 131



Mount the outlet cap (1) of the retarder and the oil drain cap of the gearshift.
Fill the unit with the quantity and quality of oil specified.

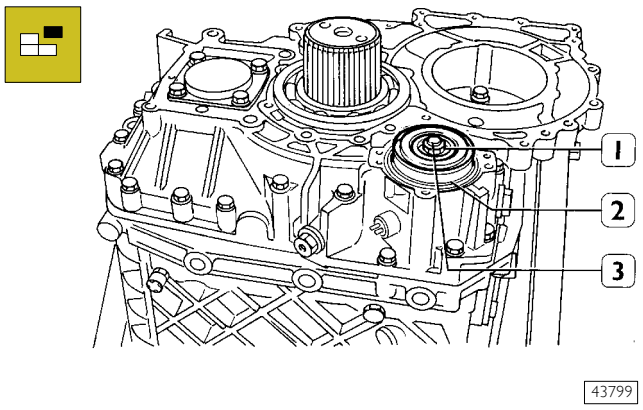
Removing the epicyclic reduction unit (E.R.U.)

Figure 132



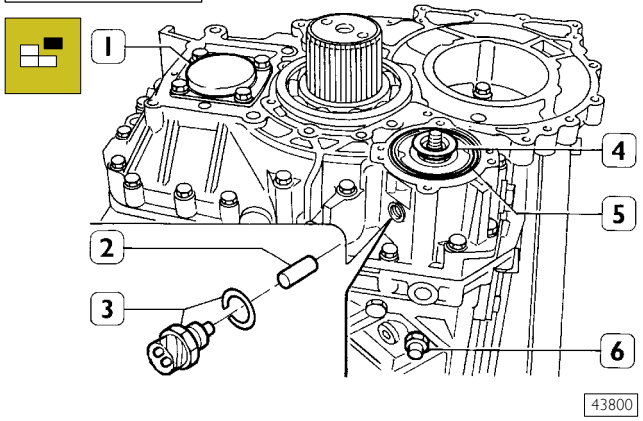
Remove the hydraulic retarder as described in the relevant section.
Remove the unions (→) and disconnect the pipes (1 and 3) from the cylinder (4). Remove the cylinder (4) from the E.R.U. box (2).

Figure 133



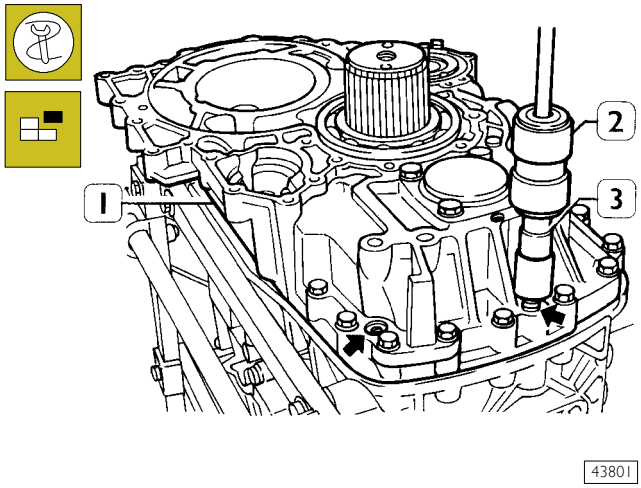
Remove the nut (1) and withdraw the piston (2) from the rod (3).

Figure 134



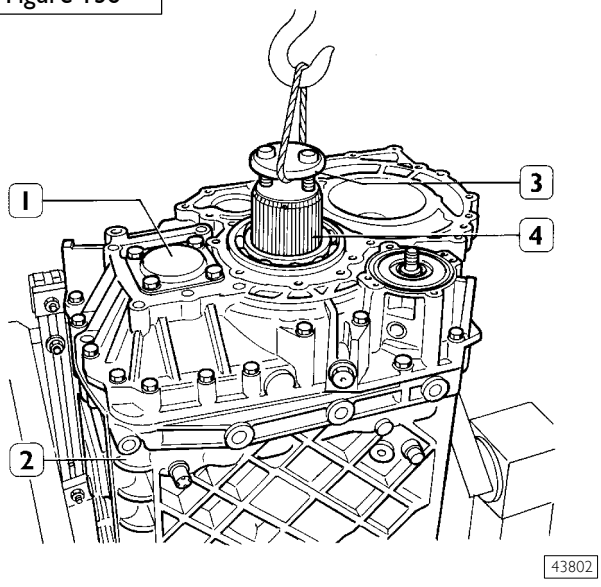
Remove from the E.R.U. box (1): sealing ring (5), gasket (4), switch (3), push rod (2) and blocking pin (6).

Figure 135



Use percussion puller 99340205 (2) and part 99342143 (2) to remove two of the three centring pins from the E.R.U. box (1).
The arrows indicate the external pins to remove, there is a third pin inside.

Figure 136

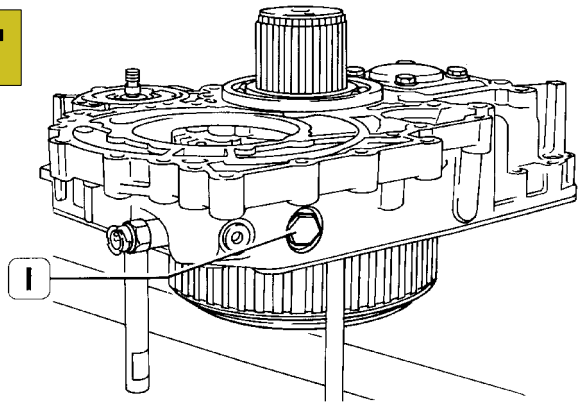


Remove the screws securing the E.R.U. box (1) to the gearbox (2). With two screws fasten the retaining plate (3) to the shaft (4). With a rope and hydraulic lifter remove the E.R.U. box (1) from the gear box (2).

Disassembling the epicyclic reduction unit (E.R.U.)

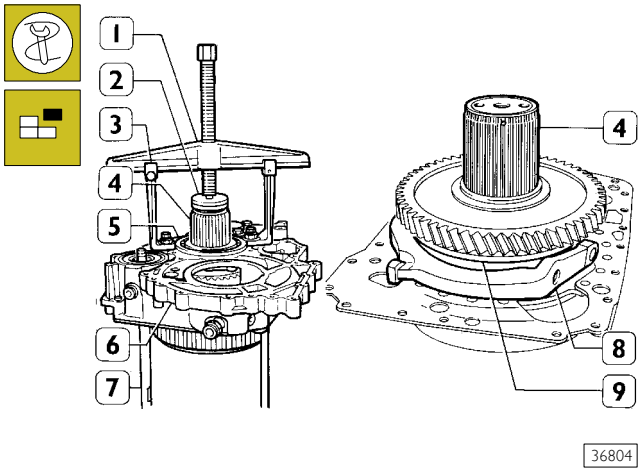
The following procedures refer to the disassembly and assembly operations of the helical tooth epicyclic reduction unit (E.R.U.) that differ from those described for gearshifts without retarder.

Figure 137



Place the epicyclic reduction unit (2) on the workbench and remove the pins (1) of the fork joints (8, Figure 138).

Figure 138

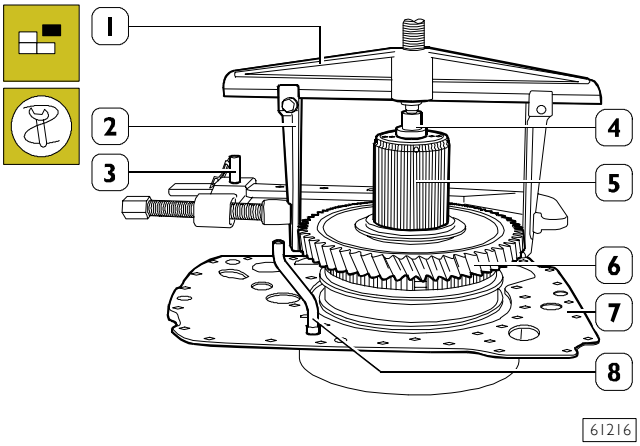


Apply a puller consisting of : puller (1), tie-rods (3) and block (2) to the E.R.U. box as shown in the figure and take out the bearing (5) and the box (6) from the E.R.U. shaft (4).

During this operation, hold the rod (7) tight and withdraw it from the box (6) after the rod is free of the fork (8).

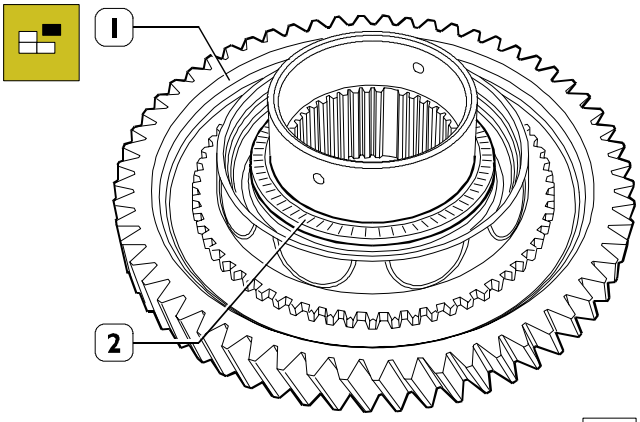
Remove the fork (8) with the blocks from the sliding sleeve (9).

Figure 139



With a puller consisting of: puller (1), brackets (2), element (4) and clamp (3) remove the gear (6) from the E.R.U. shaft (5). Remove the plate (7) with the lubrication tube (8).

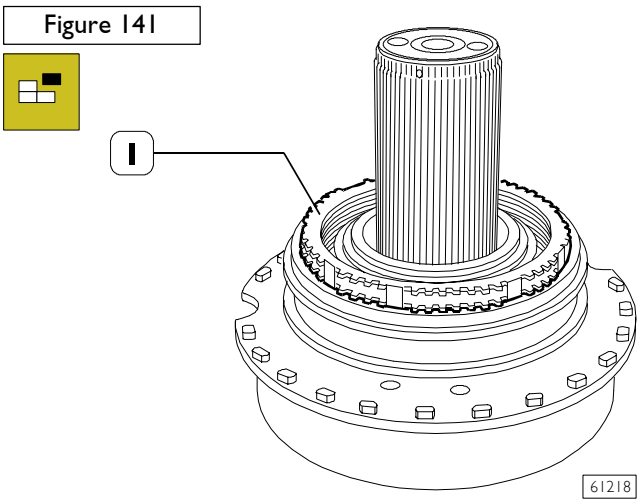
Figure 140



Only for helical tooth version.

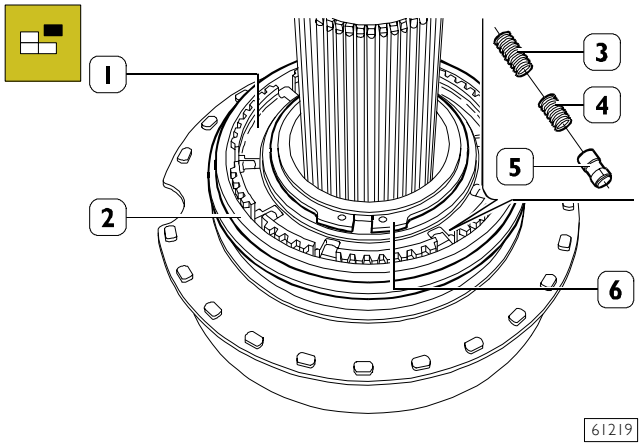
Remove the bearing (2) from the gear (1).

Figure 141



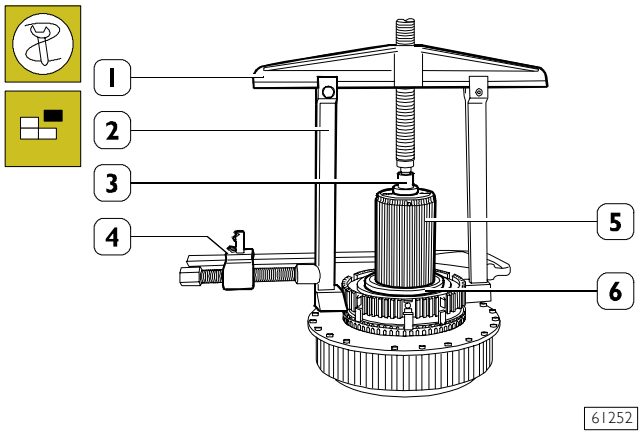
Remove the synchronising ring (1) from the sliding sleeve hub.

Figure 142



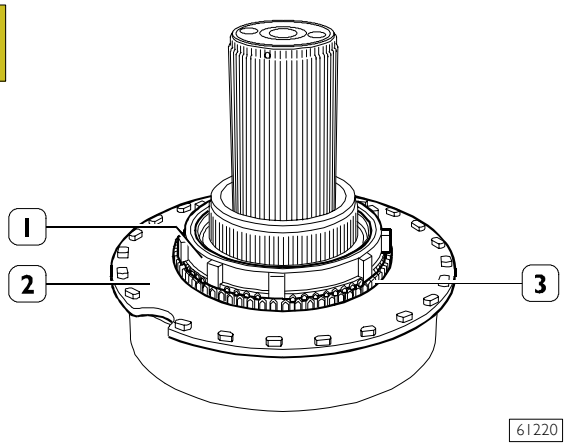
Taking care that the blocks (5) and springs (3 and 4) do not come out of the hub (1), remove the sliding sleeve (1) from the latter, remove the split ring (6).

Figure 143



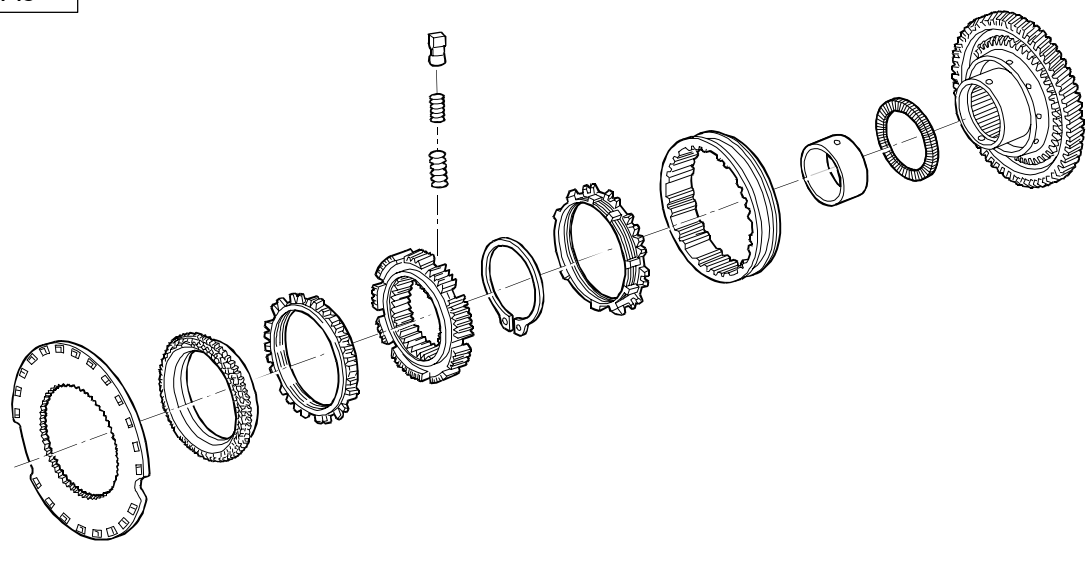
With a puller consisting of : puller (1), brackets (2)thrusting element (3) and clamp (4) remove the sliding sleeve hub (6) from the E.R.U. shaft (5).

Figure 144



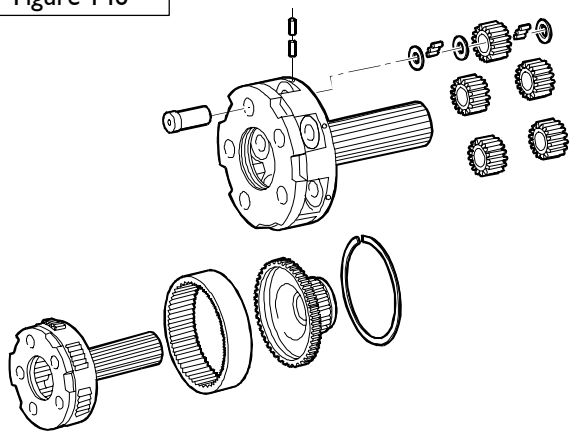
Remove the synchronising ring (1) and the coupling element (3) with the plate (2).
Levering under the coupling element (3) take this out from the plate (2).

Figure 145



EPICYCLIC REDUCTION UNIT SYNCHRONISER COMPONENTS
* ONLY HELICAL TOOTH VERSION

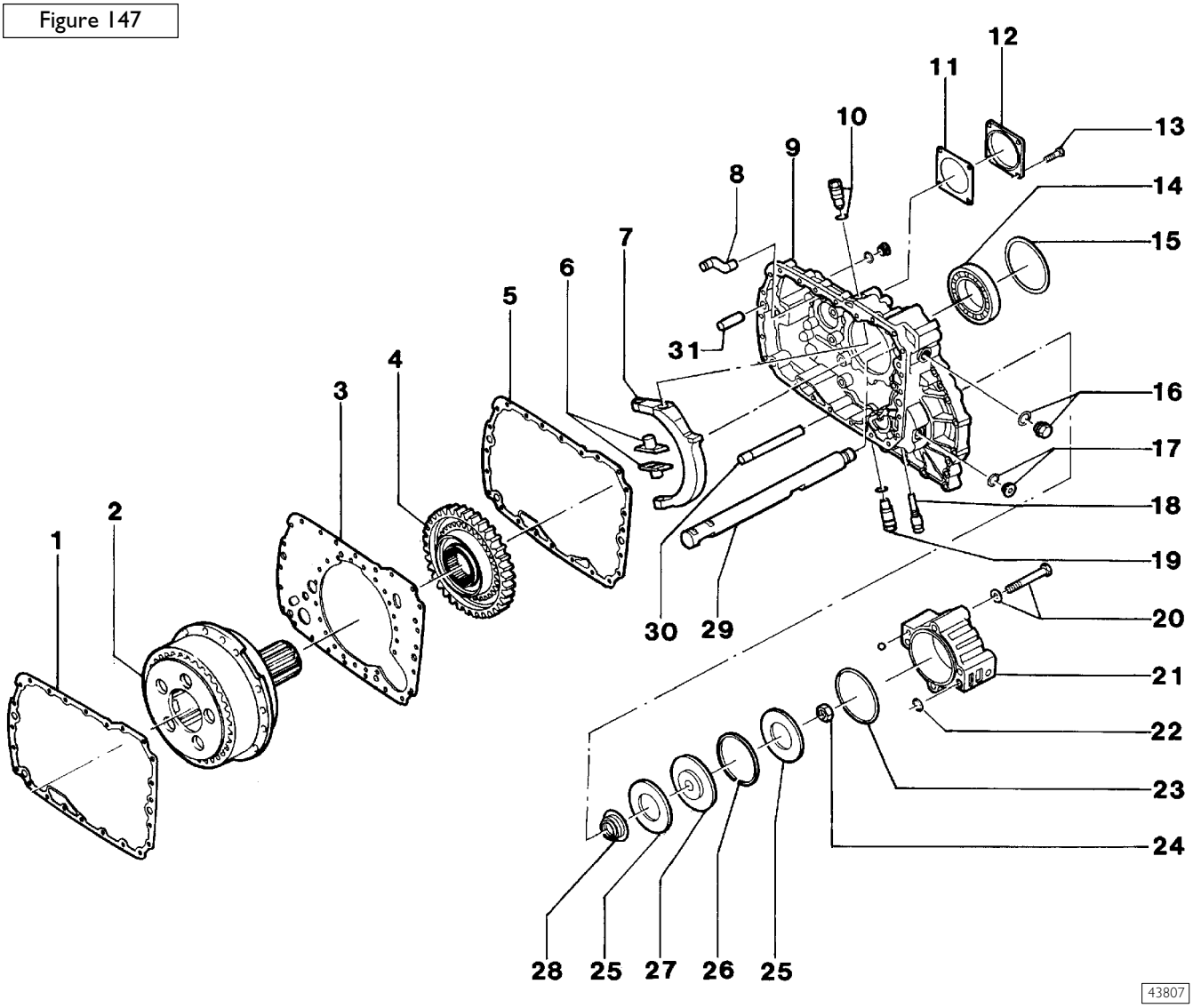
Figure 146



Epicyclic reduction unit components

Strip down the epicyclic reduction unit as described for gearshift without retarder.

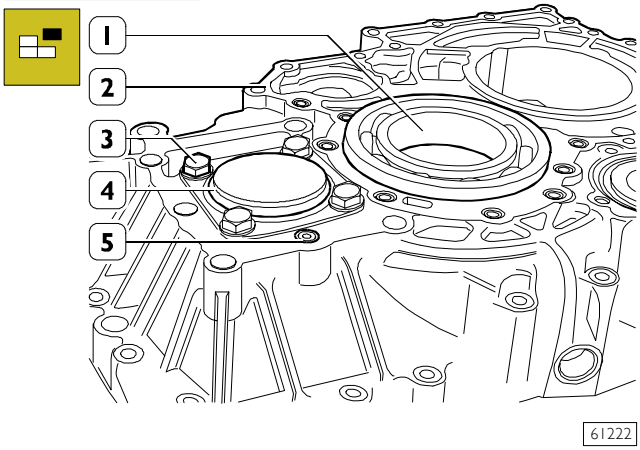
Figure 147



E.R.U. CONTROL AND BOX COMPONENTS

1. Gasket - 2. E.R.U. - 3. Plate - 4. Gear - 5. Gasket - 6. Shoes - 7. Fork - 8. Spraying pipe - 9. E.R.U. box - 10.- 11. Gasket - 12. Cover - 13. Screw - 14. Ball bearing - 15. Adjusting ring - 16. Cap with gasket - 17. Cap with gasket - 18. Sensor - 19. Fork joint screw with washer - 20. Screw with washer - 21, Cylinder - 22. Sealing ring - 23. Sealing ring - 24. Nut - 25. Sealing ring - 26. Spacer ring - 27. Piston - 28. Sealing ring - 29. Rod - 30, Pipe - 31 Pin.

Figure 148

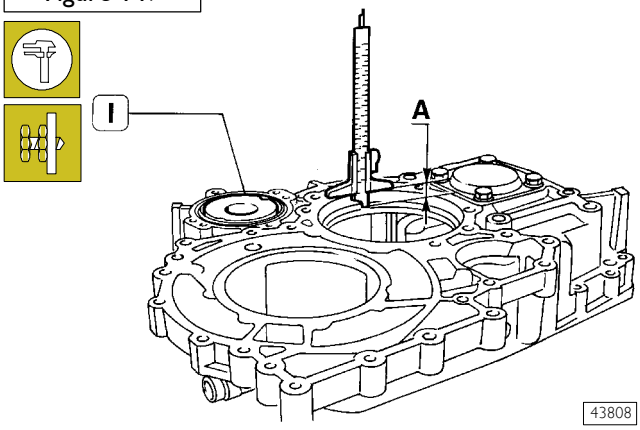


Remove the ball bearing (1) from the E.R.U. box (2).
Undo screws (3) and remove the cover (4)
Undo the screw (5).

Assembling the epicyclic reduction unit (E.R.U.)

To assemble the epicyclic reduction unit follow the disassembly operations in reverse order.
Operations and assembly steps that require special tools, clearance checks, adjustments or special specifications are described below.

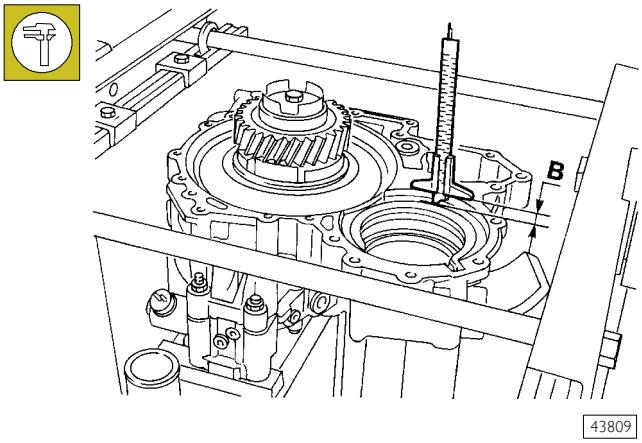
Figure 149



To determine thickness S of the end float adjusting ring on the E.R.U. ball bearing, proceed as follows:

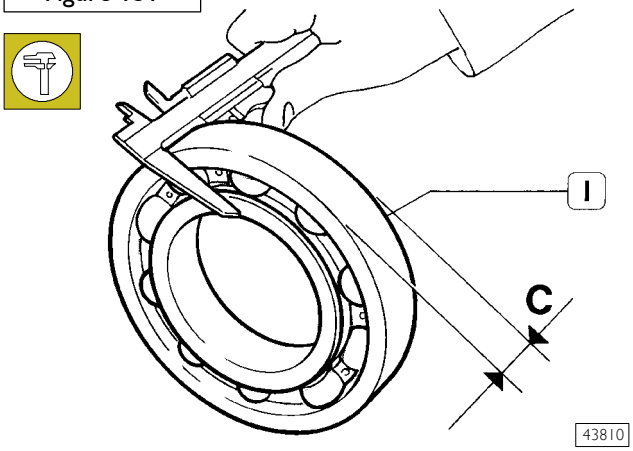
- ❑ measure the depth of the bearing seat in the E.R.U. box (1): value **A**.

Figure 150



Measure the depth of the bearing seat in the retarder: value **B**.

Figure 151



- ❑ measure the thickness of the bearing (1): value **C**;
- ❑ measure the thickness of the gasket between retarder and E.R.U. box: value **D**.

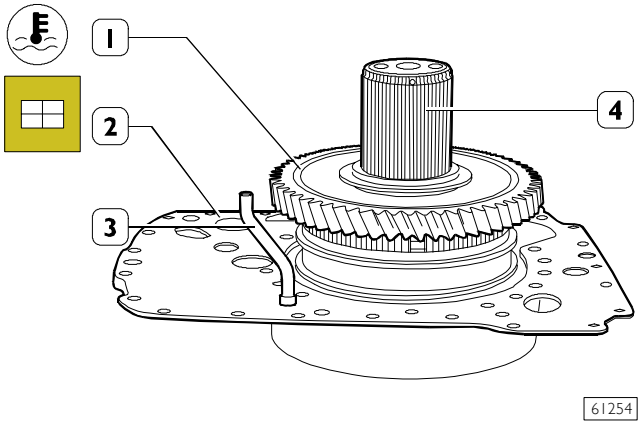
Thickness **S** of the adjusting ring to be fitted between the ball bearing and the retarder is obtained from this equation:

$$S = [(A + B + D) - C] - Y$$

where:

- ❑ **A - B - C - D** = values found in the previous measurements;
- ❑ **Y** = 0.1 mm end float of ball bearing (0.00 to 0.10 mm)

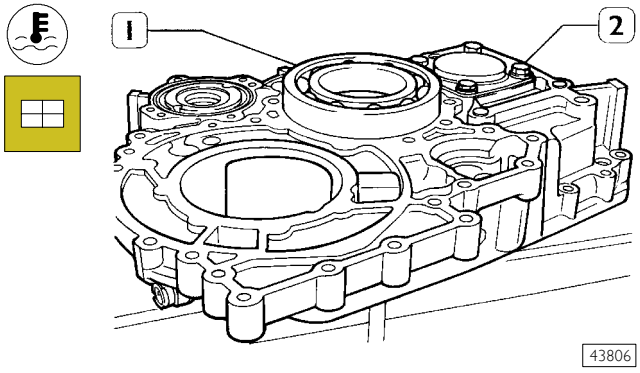
Figure 152



Place the plate (2) with pipe (3) on the E.R.U (3).

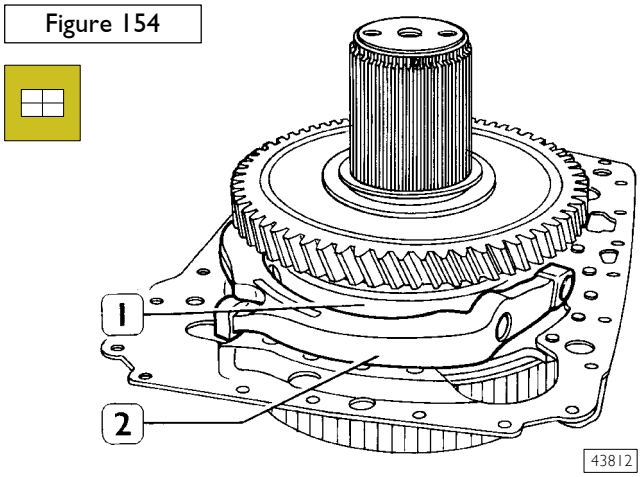
Warm the gear (1) to a temperature of 160 °C for not more than 10 seconds.
Fit the gear (1) on the E.R.U shaft (3).

Figure 153



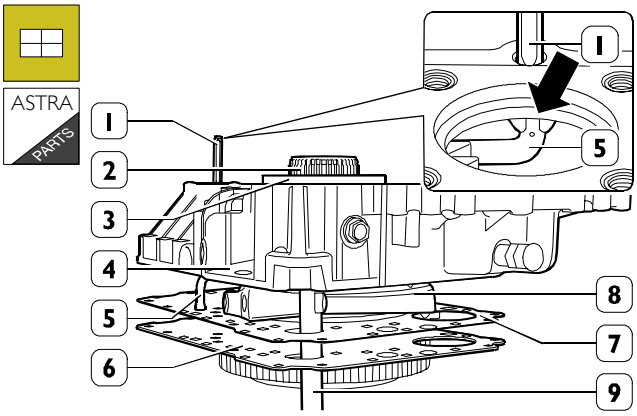
Warm the ball bearing seat (1) on the E.R.U. box (2) to ~60°C and mount the ball bearing (1).

Figure 154



Arrange the fork (2) with its blocks on the sliding sleeve (1).

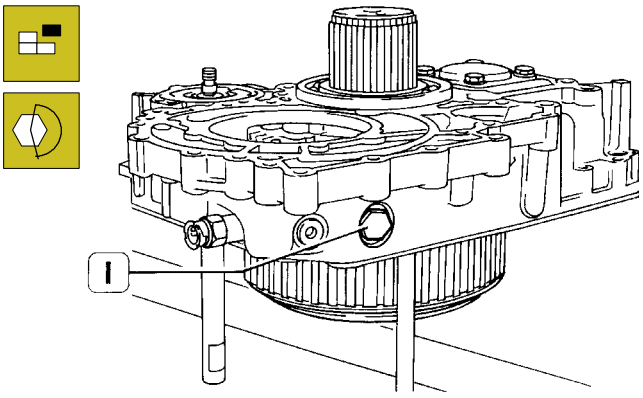
Figure 155



Fit a new gasket (7) on the plate (6).
Partially mount the ball bearing (3) with the box (4) on the E.R.U. shaft (2).
Insert the rod (7) in its seat in the box (4).
Place the fork (8) in the cut of the rod (9) and keeping this in position finish mounting the ball bearing (3) on the shaft (2).

When mounting the ball bearing (3) use a punch (1) to guide the pipe (5) so that it goes into its seat (→) in the box (4).

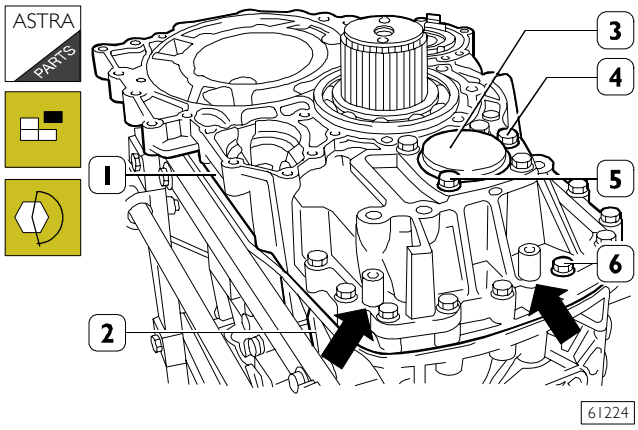
Figure 156



Secure the fork (5, Figure 155) to the box with the pins (1) and tighten them to the specified torque.

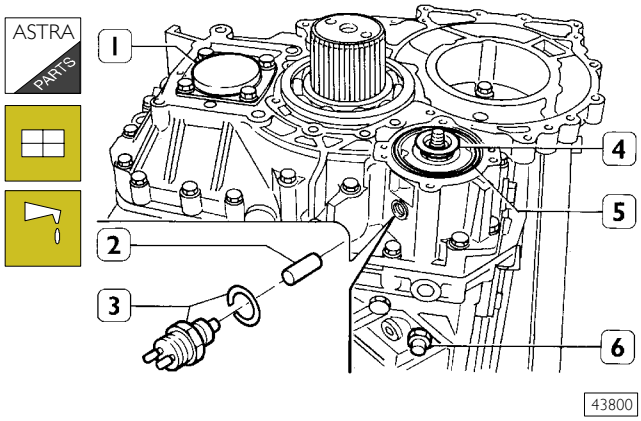
Refitting the epicyclic reduction unit (E.R.U)

Figure 157



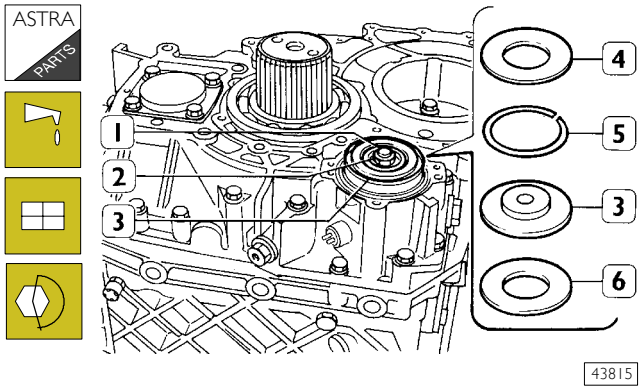
Fit a new gasket on the gearbox (2) and refit the E.R.U. box (1)
Fit the two centring pins (→) and tighten the securing screws to the specified torque.
Fit the cover (3) with a new gasket and tighten the screws (5) to the specified torque.
Tighten the cap (4).

Figure 158



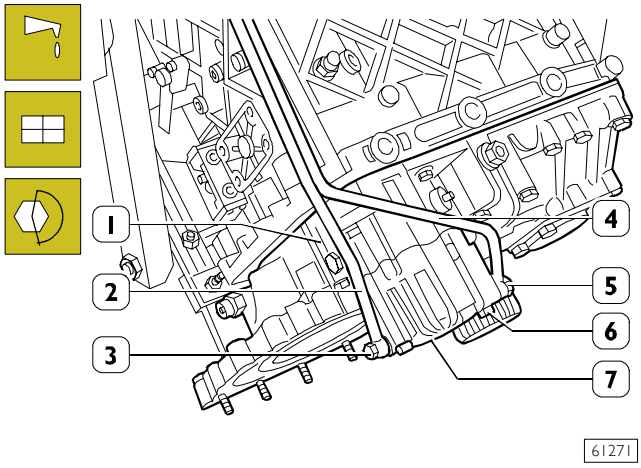
Insert the push rod (2) in the gearbox and mount the switch (3) with the washer. Mount the blocking pin (6).
Lubricate the sealing ring (5), the gasket (4) and fit them on the box (1).

Figure 159



Replace the sealing rings (4 and 6), the spacer ring (5) of the piston (3) and lubricate them.
Fit the piston (3) on the rod and tighten the nut (2) to the specified torque.

Figure 160



Lubricate inside the cylinder (7), mount it on the box (1) and tighten the securing screws (6) to the specified torque.
Connect the pipes (2 and 4) to the cylinder (7), tighten the unions (3 and 5) with new sealing washers to the specified torque.
Refit the hydraulic retarder and fill the group with the quantity and quality of oil prescribed.

REDUCTION GEAR UNIT
TC1800

SECTION 9.1

SECTION 9.1

Reduction gear unit TC1800

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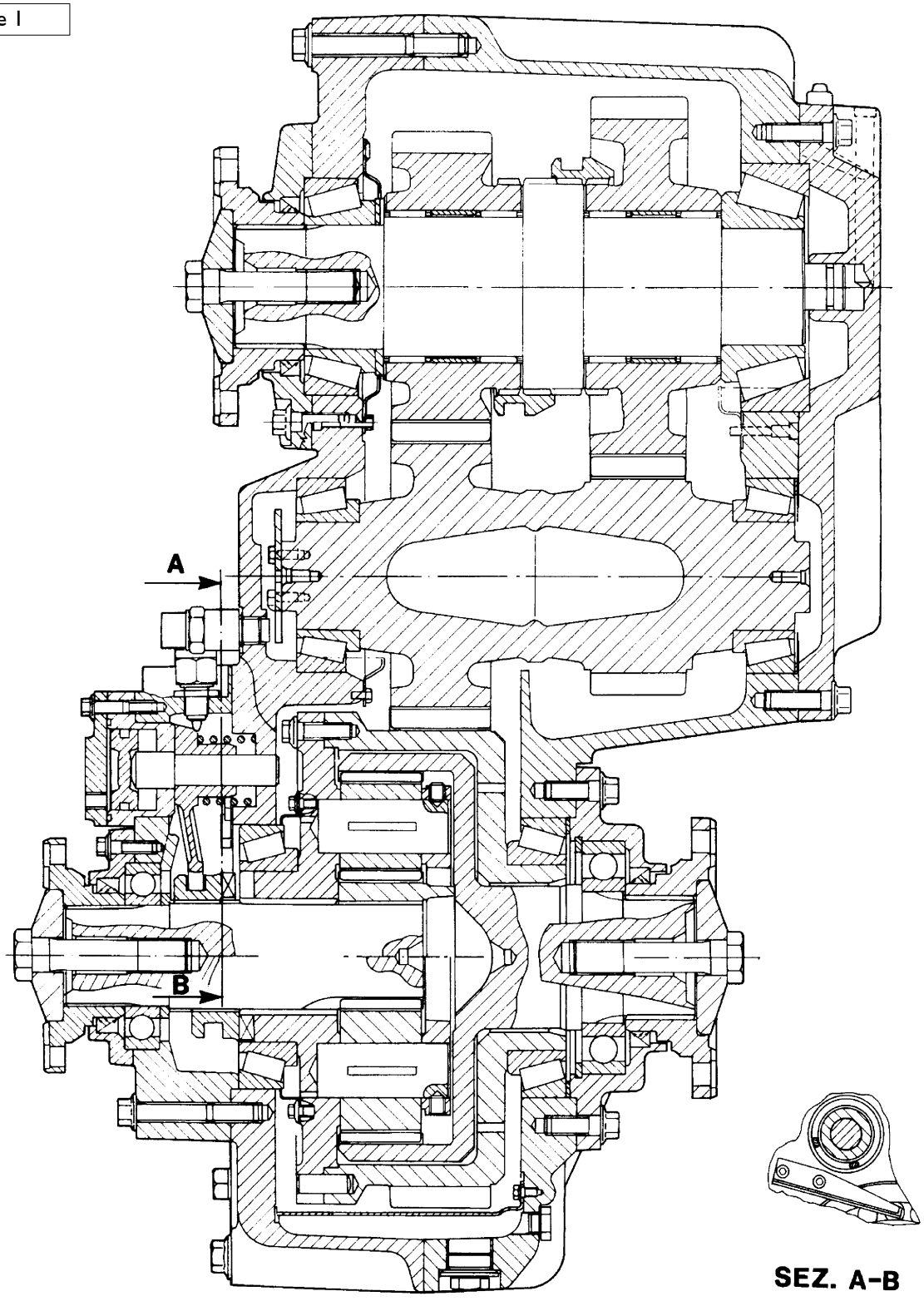
DESCRIPTION

The TC 1800 reduction gear unit is located between the gearbox and the intermediate axle.
It consists of a set of constant mesh helical spur gears.
These gears are fitted on three shafts: input shaft, countershaft and driving shaft.

A toothed sliding sleeve on the input shaft engages the normal and reduced gears.
The differential torque reduction gear for the front and rear axles and the differential reduction gear locking device are fitted on the driving shaft.

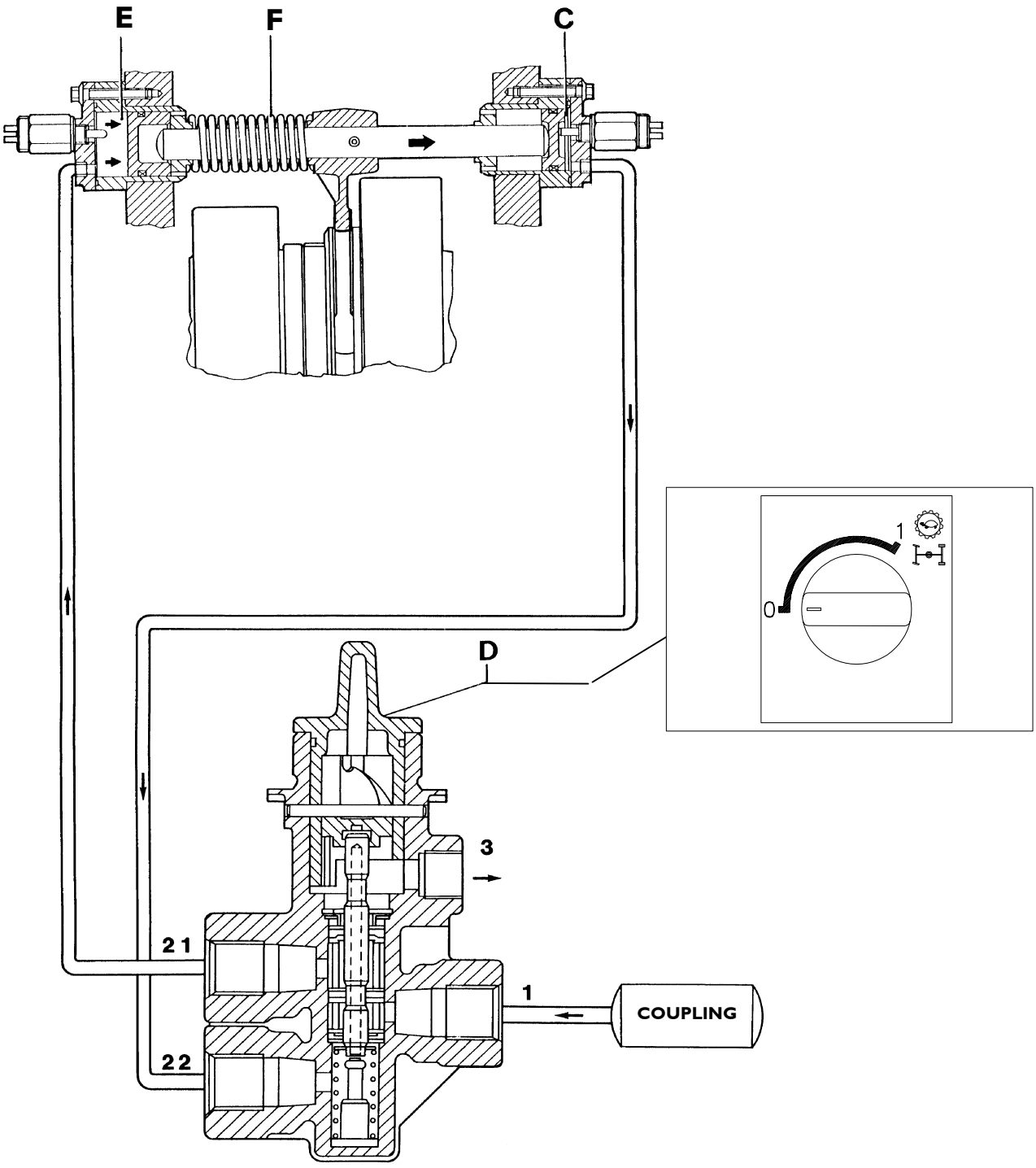
Figure 1



LONGITUDINAL SECTIONAL VIEW THROUGH THE REDUCTION GEAR UNIT

On-road

Figure 2



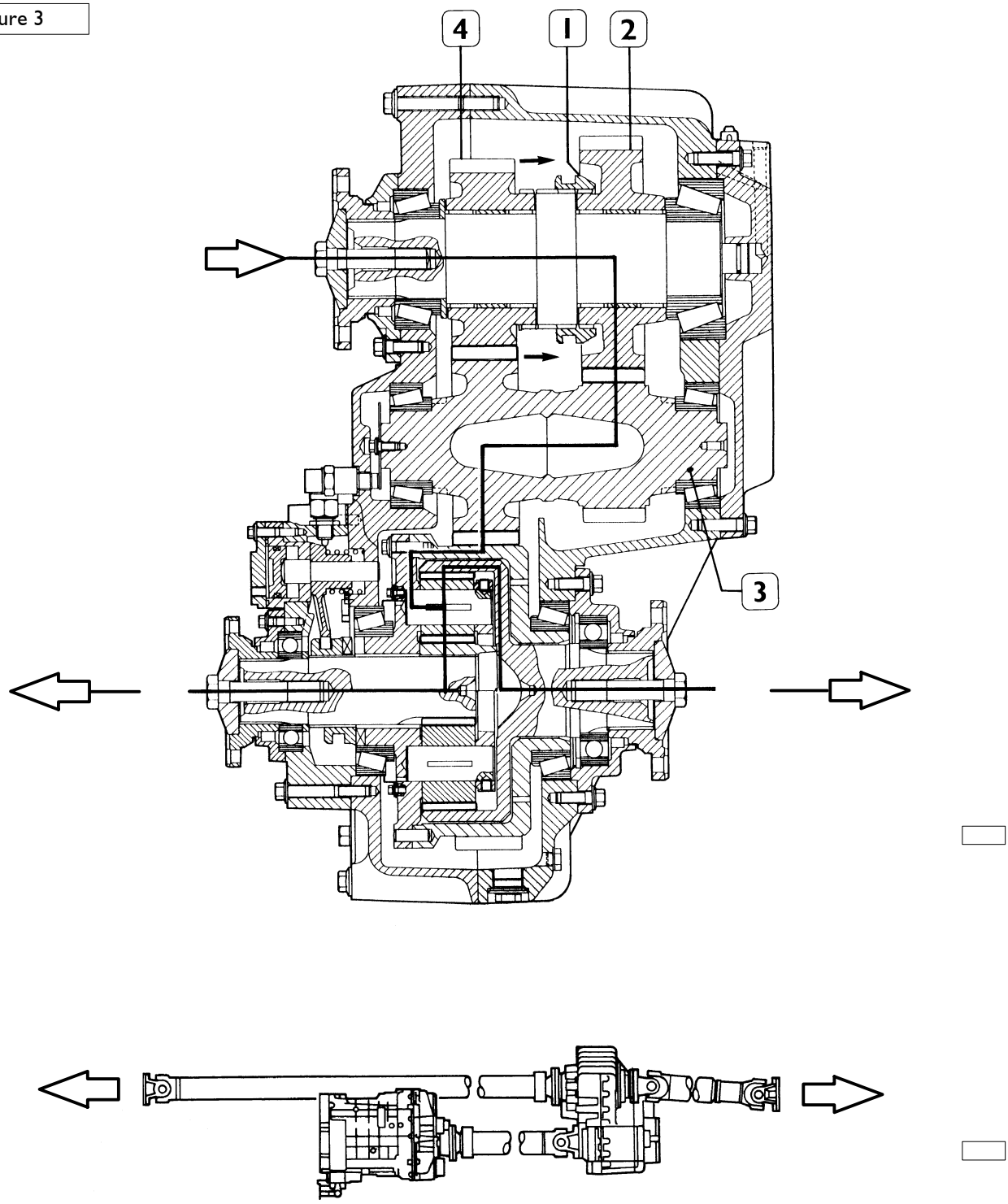
CONTROL KNOB "D" SET ON 0

With control knob "**D**" set on **0**, the incoming air to coupling **1** passes through the valve and comes out through coupling **21**, and by feeding chamber **E** causes the piston displacement to its end of stroke.

Spring **F** holds the fork and sleeve in the on-road gear ratio setting.
The air in chamber **C** is discharged through coupling **3**.

Transmission of motion pictorial diagram: on-road

Figure 3

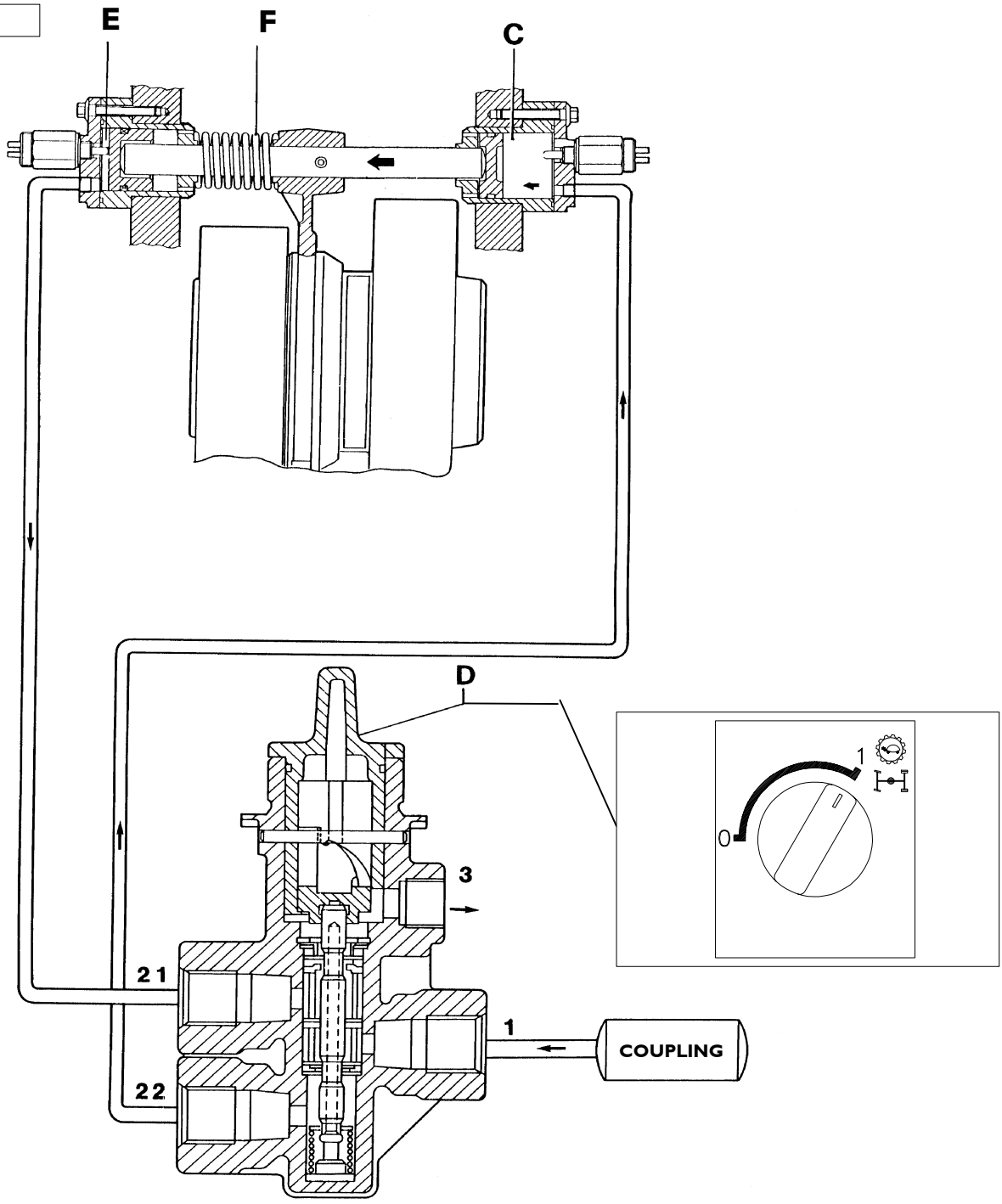


Sleeve (1) moves in the direction indicated by the arrow, meshing the gear (2) on the input shaft.

The motion is transmitted through the countershaft (3).

Off road

Figure 4



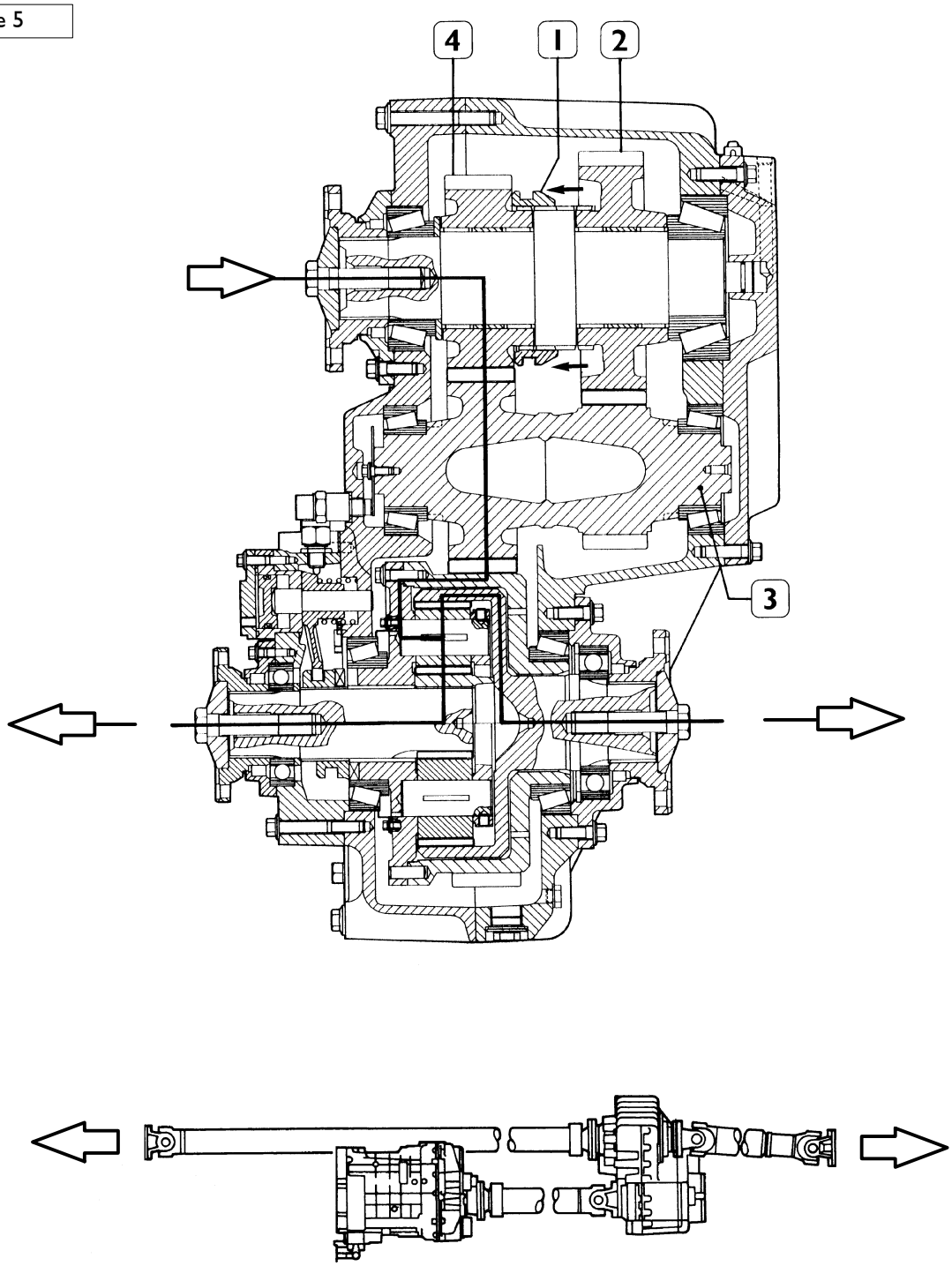
CONTROL KNOB "D" SET ON **I**

With control knob "**D**" set on **I**, the incoming air to coupling **I** passes through the valve and comes out through coupling **22**, and by feeding chamber **C** causes the piston displacement to its end of stroke.

The fork and sleeve are set on off-road gear ratio setting. The air in chamber **E** is discharged through coupling **3**.

Transmission of motion pictorial diagram: off-road

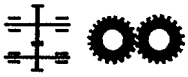
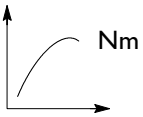
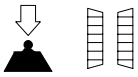
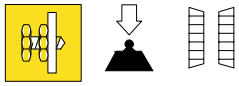
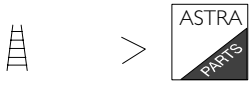
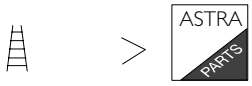
Figure 5



Sleeve (1) moves in the direction indicated by the arrow, meshing the gear (2) on the input shaft.

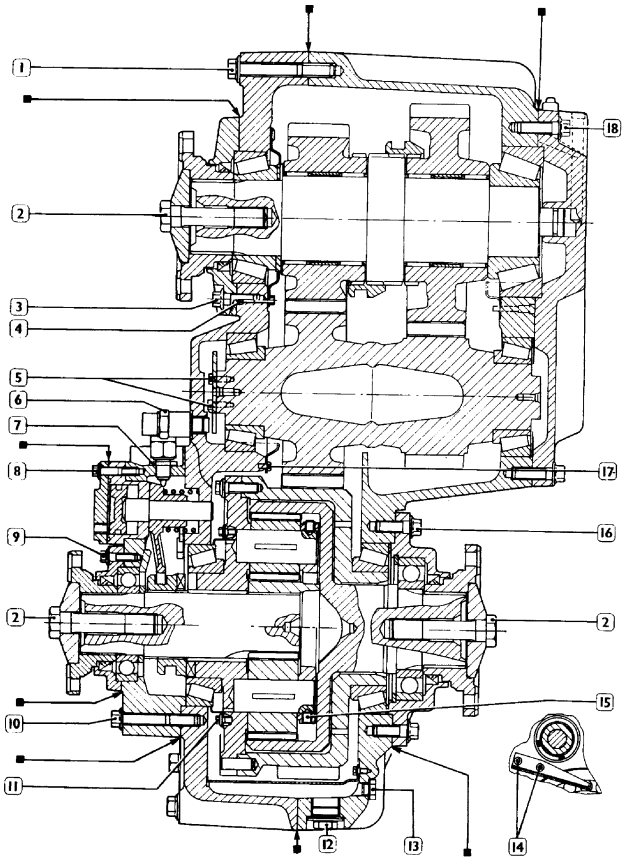
The motion is transmitted through the countershaft (3).

SPECIFICATIONS AND DATA

		TC 1800	
	Gears	Constant mesh helical gears	
	Transmission ratios normal (on road) reduced (off road)	1 : 1 1 : 1,6	
	Maximum input torque	18.000	
	Torque reduction	1 : 4	
	Bearings preload for: input shaft countershaft driving shaft	0,10 ÷ 0,15	0,05 ÷ 0,10
	Bearings preload adjustment	Through adjusting rings	
	Thickness of adjusting rings	1–1,1–1,2–1,3–1,4–1,5–1,6–1,7–1,8–1,9 1–1,6–1,7–1,8–1,9–2,0–2,1–2,2–2,3–2,4–2,5 1–1,1–1,2–1,3–1,4–1,5–1,6–1,7–1,8–1,9–2	
	Thickness of adjusting rings for pulse transmitter	1 - 1,5 mm 1 - 1,5	
	Quantity (*) kg (liter)	5,6 (6,2)	

(*) For the correct type of fluid, see section 2 - HYDRAULIC FLUID AND LUBRICANTS TABLE

Figure 6



39472

TIGHTENING TORQUES

	DESCRIPTION	TORQUE	
		Nm	Kgm
1	M14 screw	92 ± 9	9,2 ± 0,9
2	M22 x 1.5 pin	500 ± 50	50 ± 5
3	M12 screw	58 ± 6	5,8 ± 0,6
4	M6 screw	10	1
5	M6 screw	10	1
6	Pulse transmitter	45 ± 5	4,5 ± 0,5
7	Nut	45 ± 5	4,5 ± 0,5
8	M8 screw	19 ± 2	1,9 ± 0,2
9	M10 screw	45 ± 5	4,5 ± 0,5
10	M12 screw	58 ± 6	5,8 ± 0,6
11*	M6 screw	7	0,7
12	Screw plug	100 ± 10	10 ± 1
13*	Screw	4,5	0,45
14	Screw plug	60 ± 6	6 ± 0,6
15*	Set screw	33 ± 3	3,3 ± 0,3
16	M12 screw	58 ± 6	5,8 ± 0,6
17	Screw	5	0,5
18	M12 screw	58 ± 6	5,8 ± 0,6

* Apply LOCTITE AVX ■ Apply LOCTITE 510

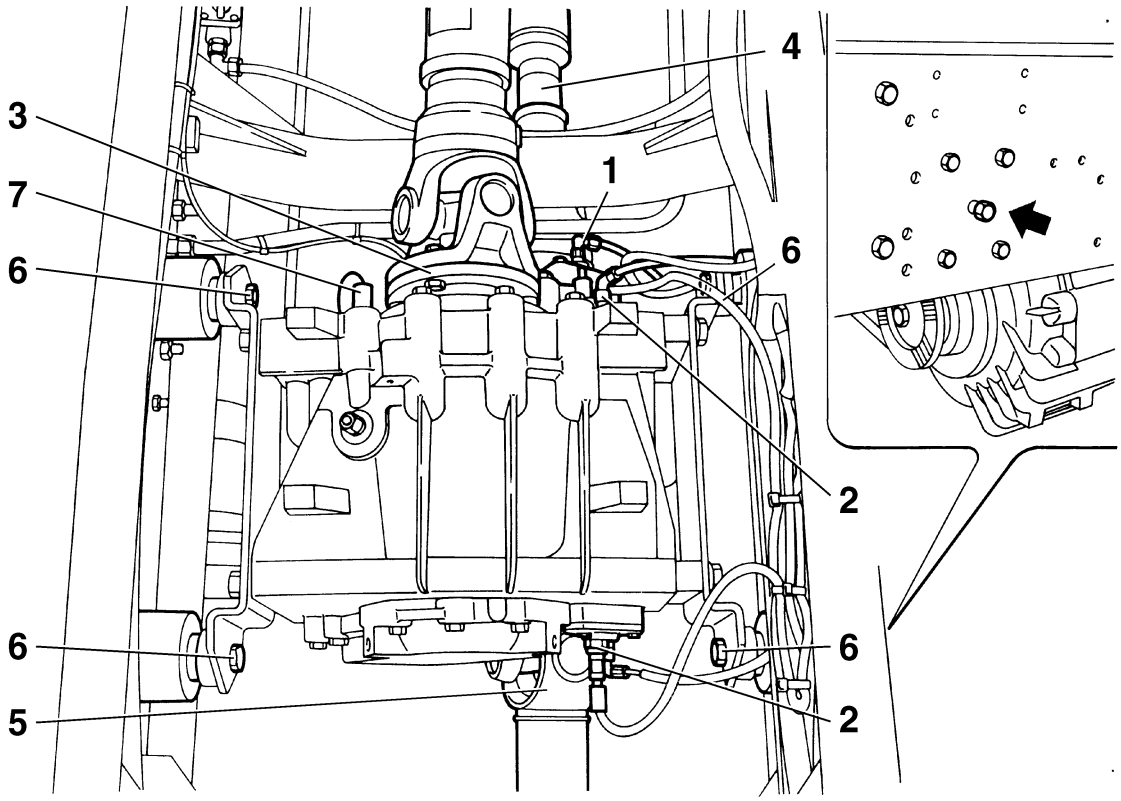
TOOLS

TOOL NO.	DESCRIPTION
99305121	Hot air operated equipment
99322205	Rotary stand for unit overhaul
99340205	Percussion puller
99341003	Simple effect axle
99341009	Pair of brackets
99341015	Clamp
99342143	Puller pin to remove planetary gear pins from epicyclic unit of transmission unit (to be used with 99340205)
99345049	Counter block for pullers
99345056	Counter block for pullers
99360502	Rings to remove and fit in place the transmission unit halfbox
99366067	M8 hooks (2) to remove and fit in place the transmission unit intermediate shaft
99370006	Handle for interchangeable beaters
99370317	Lever and relevant extension bar for flange stop
99370565	Element to fit the gasket in front driving shaft cover of transmission unit (to be used with 9937006)
99370362	Eye bolt (2) to remove and fit in place transmission unit epicyclic assembly
99370631	Stand to hold transmission unit during removal and fitting in place
99371051	Bracket to hold transmission unit during overhaul (to be used with 99322205)
99374253	Element to fit the gasket in input shaft cover, and transmission unit rear driving shaft (to be used with 99370006)
99389821	Dynamometric wrench (0-70 Nm) with square 3/8" coupling

STRIPPING DOWN - REFITTING THE REDUCTION GEAR UNIT

Stripping down

Figure 7



To remove the reduction gear unit proceed as follows:

- ❑ set the vehicle on a pit or on a hoist;
- ❑ open the battery case and disconnect the cables to avoid short-circuits;

The disposal of waste or residual fluid in unauthorised sites or in the public sewer system is prohibited.

- ❑ disconnect reduction gear unit electrical and pneumatic connections (1);
- ❑ disconnect reduction gear unit electrical and pneumatic connections (2);
- ❑ disconnect odometer cable (7) after removing the sealing;
- ❑ undo the screws fixing the input shaft flange (3), front output shaft flange (4) and rear output shaft flange (5) and secure temporarily the shafts to the chassis to avoid interference during next operations;
- ❑ disconnect hydraulic pipes from servo-clutch auxiliary pump (8);
- ❑ position a hydraulic lifting device under the transfer and remove the connecting screws to the four supporting pads (6);
- ❑ screw one screw to each pad as shown by the arrow to press the pad and enable unit removal;
- ❑ lower the hydraulic lifting device and remove the transfer from the bottom.

Refitting

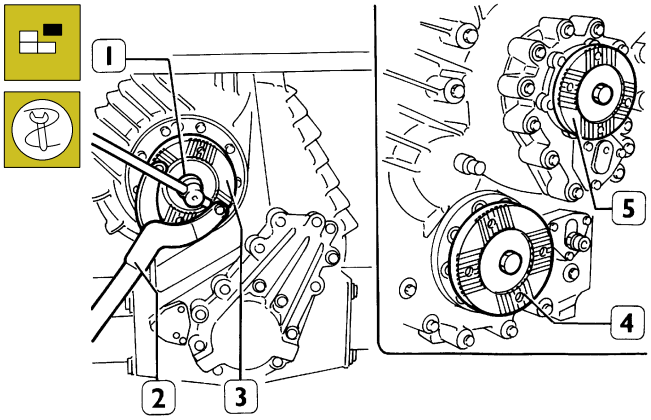
Reverse the operations for removal.

When refitting, drain out power steering hydraulic circuit as described in Section 15.

DISASSEMBLING THE REDUCTION GEAR UNIT AT THE BENCH

Set the reduction gear unit on rotary stand 99322205 with brackets 99371051, unscrew the plugs and drain the oil. Unscrew the pulse transmitter and the 3 indicator switches.

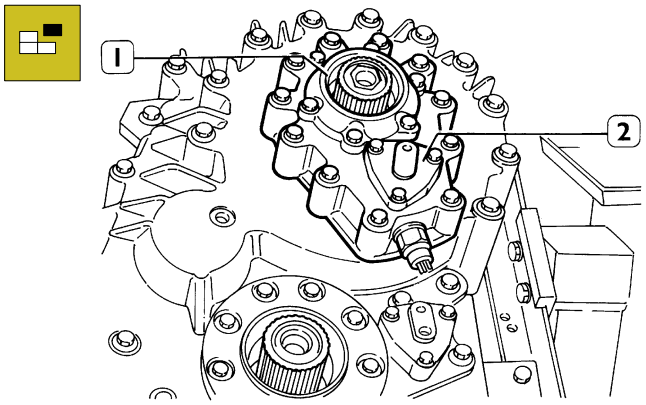
Figure 8



39870

Lock roation offlange (3) through lever 99370317 (2), use a suitable socket wrench (1) to remove the retaining screw and remove the flange; repeat the same operation for the flanges (4- 5) on the opposite side.

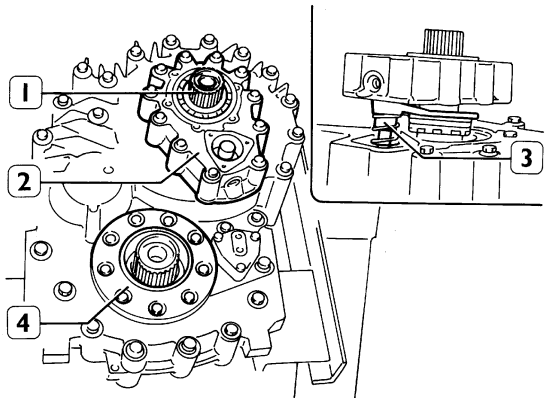
Figure 9



39871

Remove the 6 screws and the cover (1) with its seal ring; remove the 3 screws and cover (2) with reduction gear engagement piston.

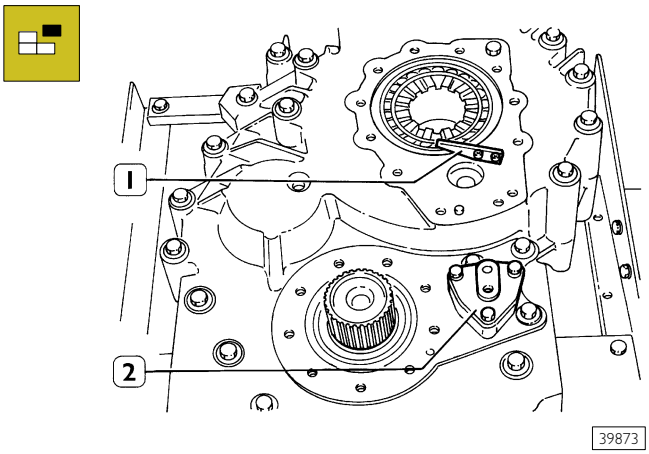
Figure 10



39872

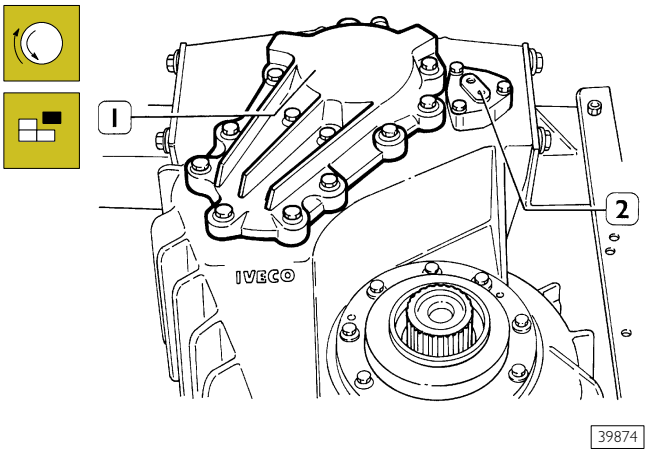
Remove the 11 screws and take away cover (2) together with reduction gear engagement control shaft (1) and fork (3); remove the 9 screws and remove cover (4) with its seal ring.

Figure 11



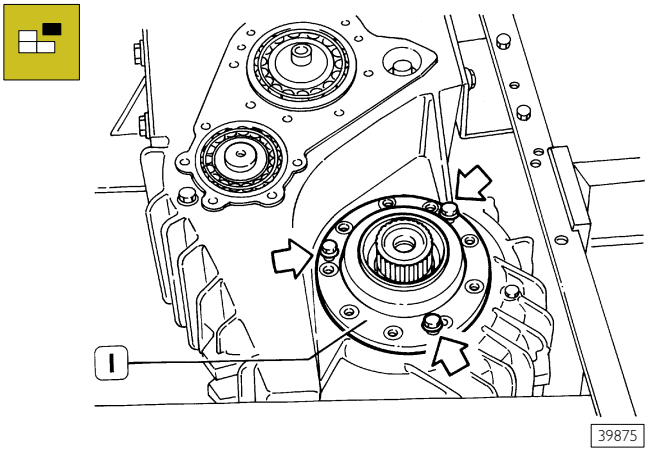
Remove the 3 screws and take away cover (2) with control piston and withdraw the internal spring; use a socket wrench for the screws and remove the safety plate (1).

Figure 12



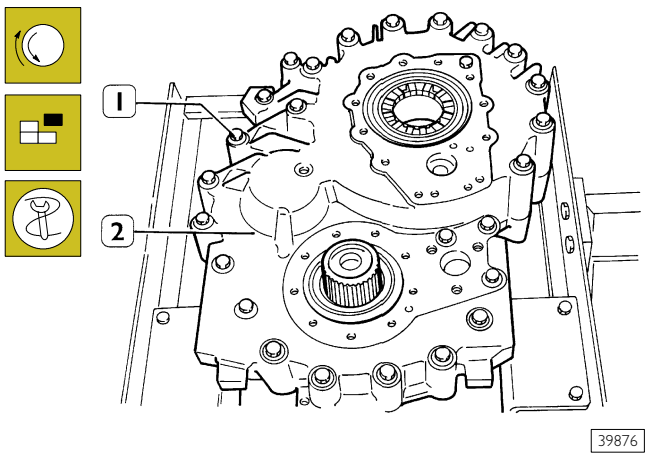
Rotate the unit 180 degrees.
Remove the 3 screws and take away cover (2) with piston rod; remove the 14 screws and take away the cover (1). Remove the adjusting rings.

Figure 13



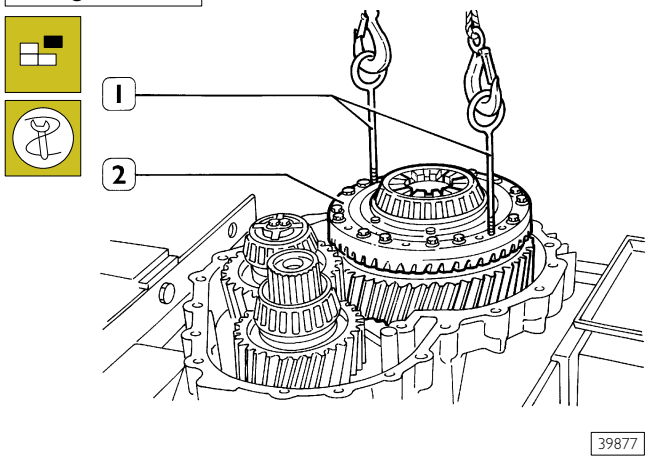
Remove the 9 screws, then fit 3 counteracting screws into the holes indicated by the arrows, take away the cover (1) and remove the adjusting rings.

Figure 14



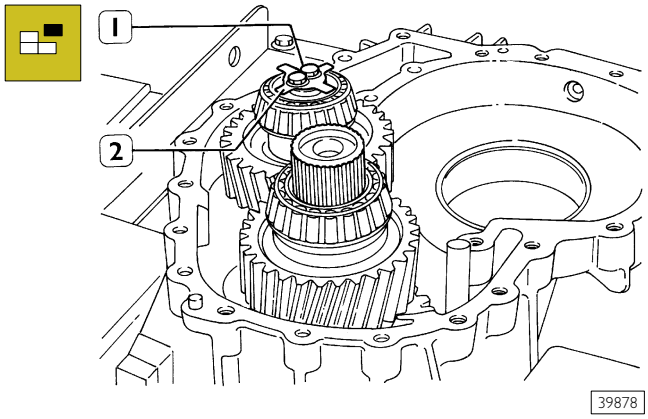
Rotate the unit 180°.
Remove screws (1) and with a hoist and ropes take away the housing (2).

Figure 15



Use eye bolt 99370565 (1), ropes and lifting device to withdraw the epicyclic reduction gear (2) from the housing.

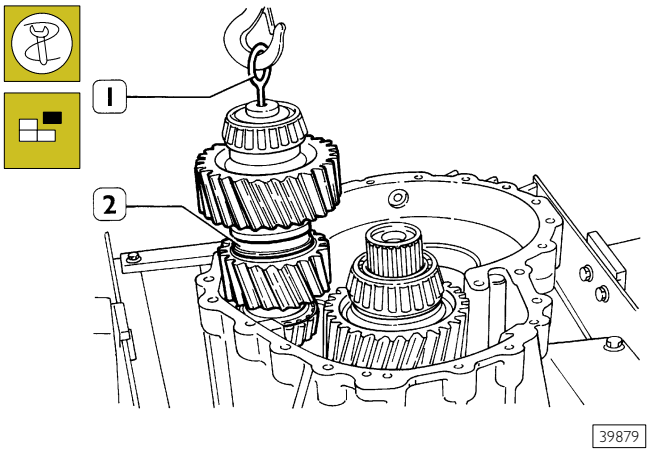
Figure 16



Up to No. 535: undo the sole screw (1) and remove the phonic wheel (2).

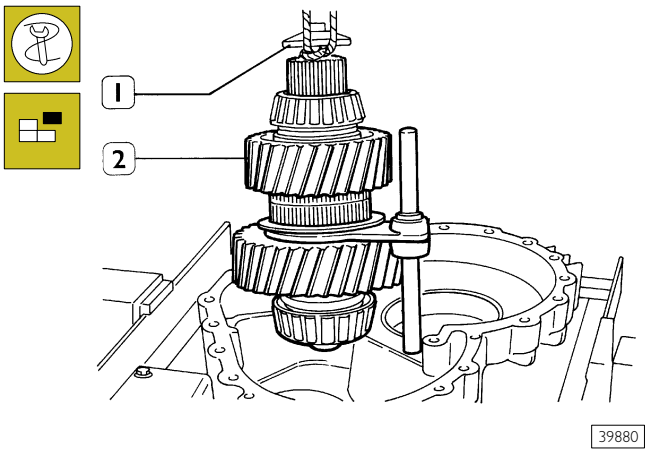
From No. 536: straighten the safety plate, undo the two screws (1) and remove the phonic wheel (2).

Figure 17



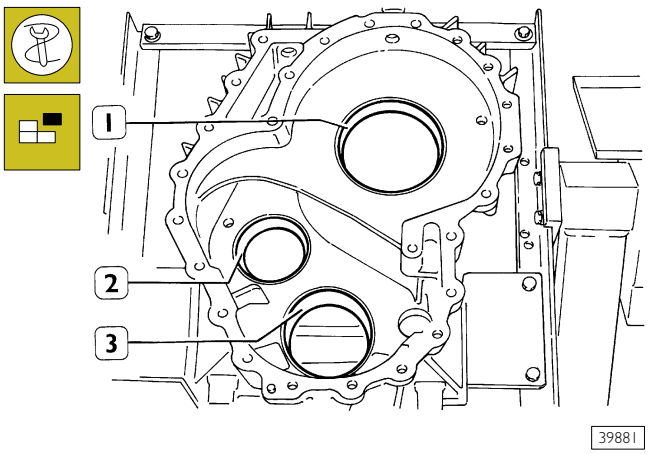
Using eye bolt 99366067 (1) rope and lifting device, release the countershaft (2) from the housing.

Figure 18



Screw the relevant screw and washer (1) onto the input shaft (2), use a rope and lifting device to withdraw the shaft (2) and control fork from the housing.

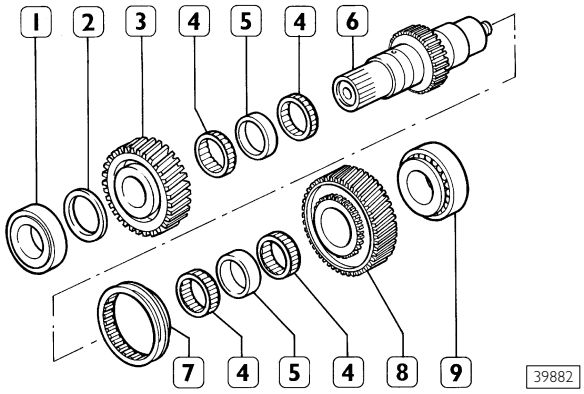
Figure 19



Using a suitable beater, remove the bearing outer rings (1-2-3).

DIS-ASSEMBLING THE INPUT SHAFT

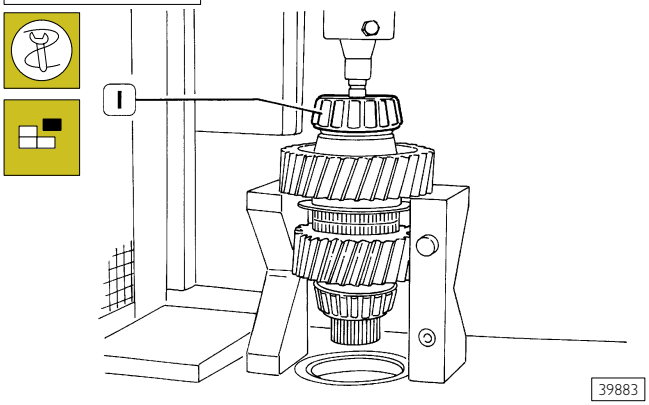
Figure 20



INPUT SHAFT COMPONENTS
1. Bearing - 2. Spacer ring - 3. Gear - 4. Roller bearings - 5. Spacer ring - 6. Shaft - 7. Sliding sleeve - 8. Gear - 9. Bearing

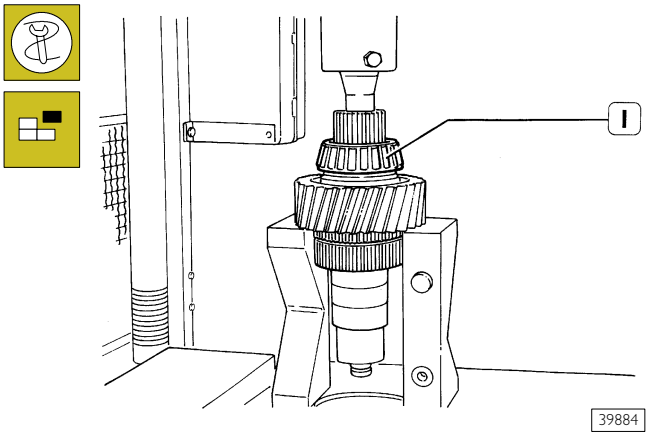
To dis-assemble the bearings (1, figure 22 and 23) it is necessary to use a hydraulic press.

Figure 21



Having withdrawn the bearing (1) manually withdraw the gear (8, figure 21), roller bearings (4), spacer ring (5) and sliding sleeve (7).

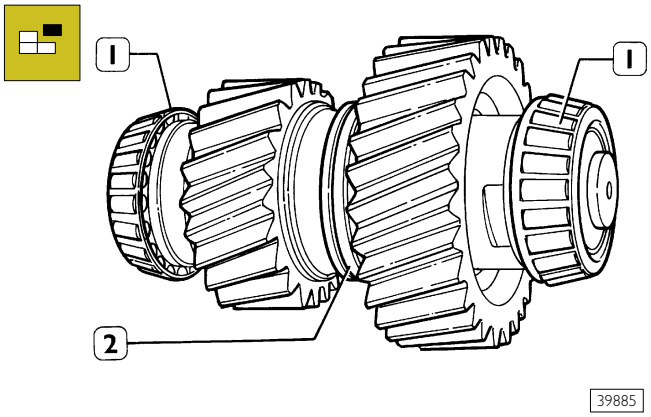
Figure 22



Remove bearing (1) and take away the spacer ring (2, figure 21), gear (3), roller bearings (4) and spacer ring (5).

DIS-ASSEMBLING THE COUNTERSHAFT

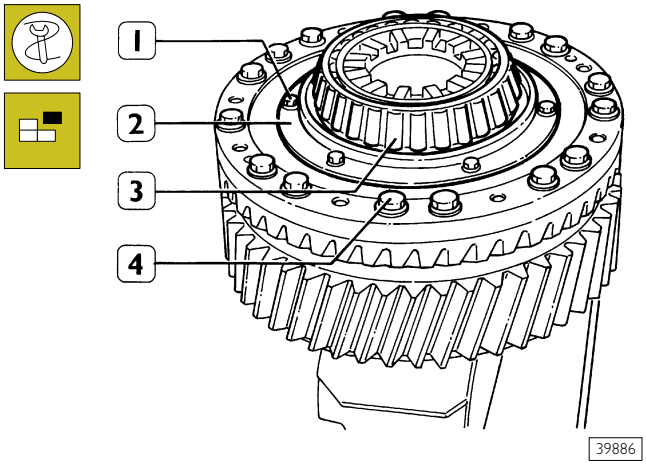
Figure 23



The removal of the bearings (1) from the countershaft (2) is a destructive operation.

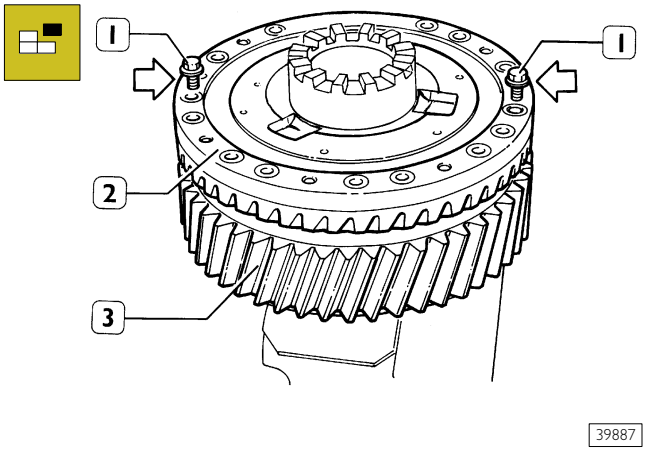
DIS-ASSEMBLING THE EPICYCLIC REDUCTION GEAR

Figure 24



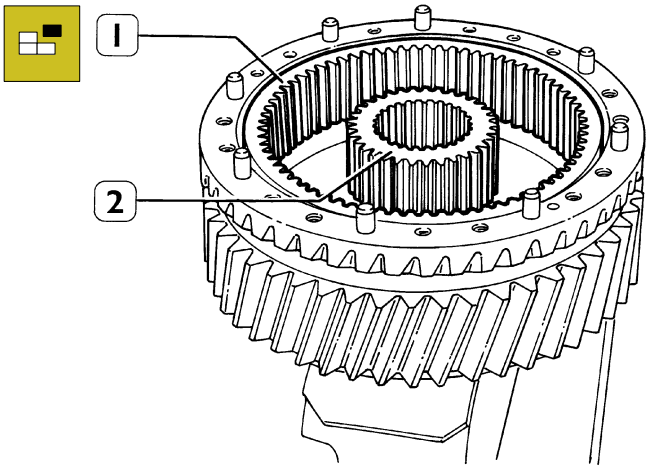
Remove screws (1) and take away the splash guardring (2), then using the appropriate puller remove the bearing (3), remove the screws (4).

Figure 25



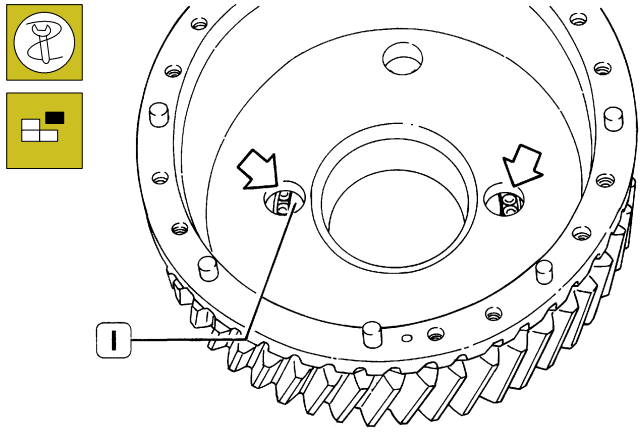
Using the 2 screws (1) in the holes indicated by the arrows, take the planetary gear carrier (2) away from the crown wheel (3).

Figure 26



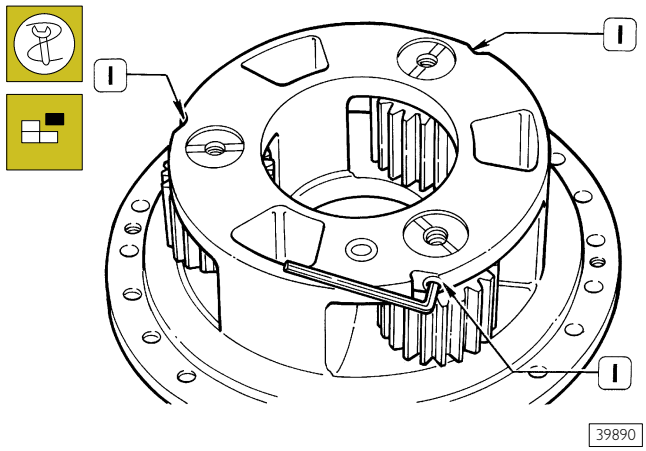
Remove the planetary gear (2) and take away the driving shaft (1)

Figure 27



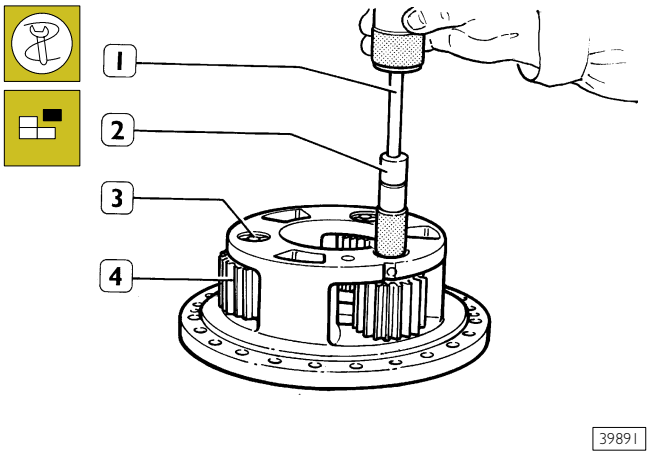
Using the suitable beater remove bearing (1) from the holes indicated by the arrows.

Figure 28



Use a socket wrench to remove the 3 securing set screws (1).

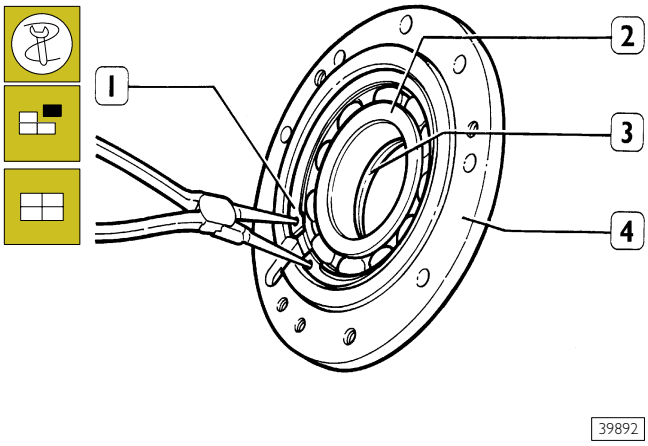
Figure 29



Use percussion puller 99340205 (1) with pin 99342143 (2) to remove the shafts (3) for the gears (4).

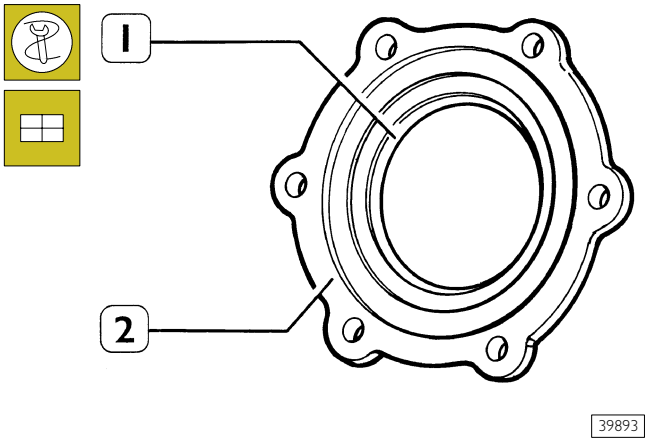
REPLACING THE SEAL RINGS ON THE DRIVING SHAFT COVERS

Figure 30



To replace the seal ring (3) on cover (4) of the rear driving shaft, remove the locking ring (1) and withdraw the bearing (2). To fit the seal ring (3) in place, use tool 99374253.

Figure 31



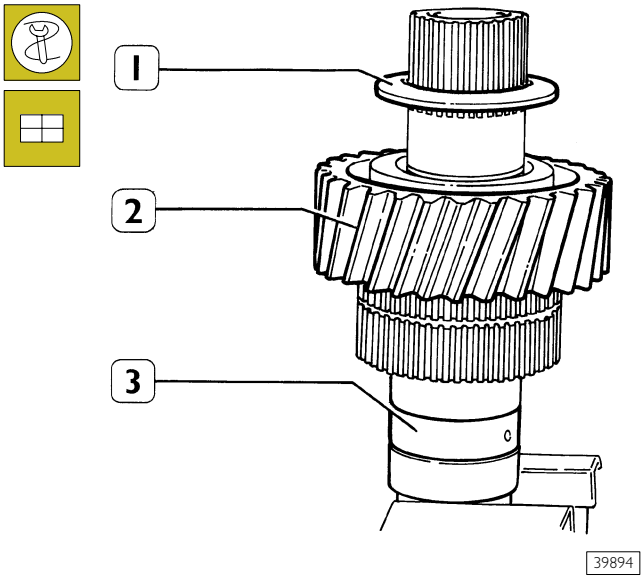
To fit seal ring (1) on front driving shaft cover (2), use tool 99370362.

CLEAN OUT AND CHECK

After the reduction gear unit has been removed, carefully clean all the parts.
Check that there are no signs of wear, seizure or cracking.
Seal rings and gaskets should always be replaced before re- fitting in place.

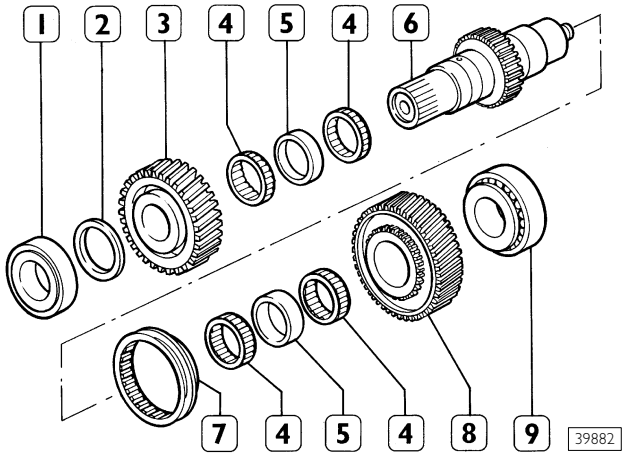
FITTING IN PLACE THE INPUT SHAFT

Figure 32



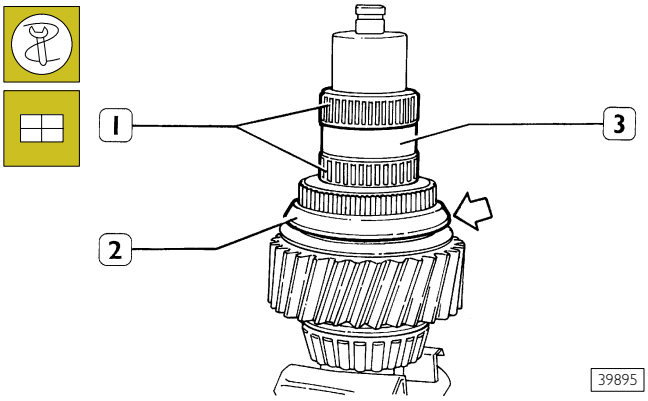
Clamp the shaft (3, Figure 33) in a vice, fit in place the roller bearings (4, Figure 34), with spacer (5, Figure 34), connect the gear (2, Figure 33) with the meshing tooth towards the sliding sleeve, fit the spacer ring (1, Figure 33).
Heat the roller bearing inner ring (1, Figure 34) to 80 °C - 90 °C and fit it on the shaft.

Figure 33



INPUT SHAFT COMPONENTS
1. Bearing - 2. Spacer ring - 3. Gear - 4. Roller bearings - 5. Spacer ring - 6. Shaft - 7. Sliding sleeve - 8. Gear - 9. Bearing

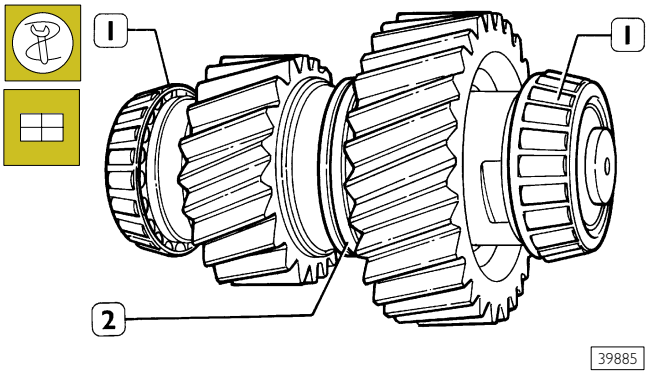
Figure 34



Turn the shaft over and clamp it in a vice.
Fit in place the sliding sleeve (2) with the flare (arrow) facing upward; fit the roller bearings (1) and spacer (3).
Fit in place the gear (8, figure 34) with the meshing toothset towards the sliding sleeve.
Heat to 80 °C to 90 °C the roller bearing inner ring (9, Figure 34) and fit onto the shaft.

FITTING IN PLACE THE COUNTERSHAFT

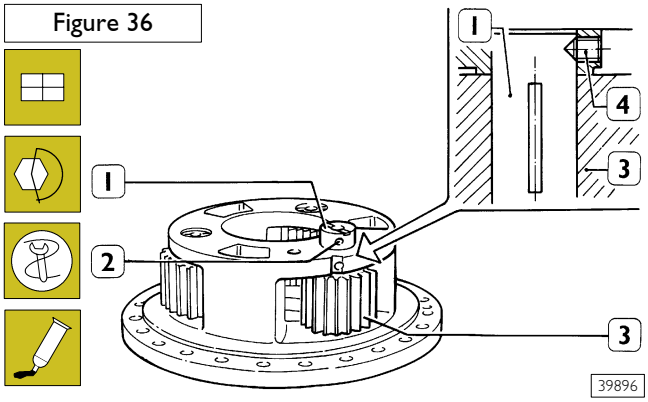
Figure 35



After heating the inner rings to 80 °C to 90 °C, fit the bearings (1) onto the shaft (2).

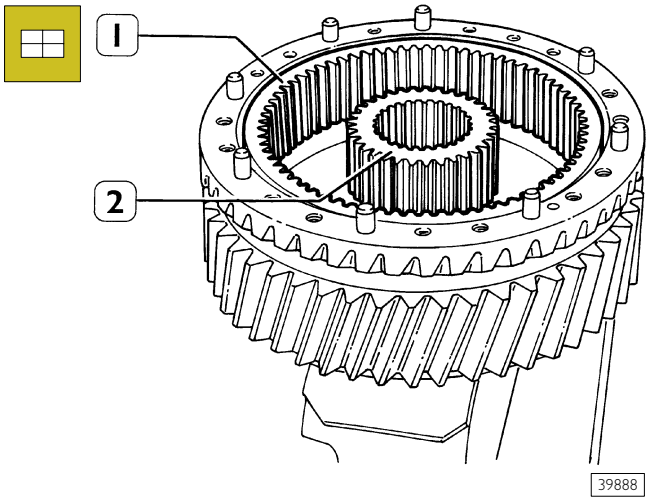
FITTING IN PLACE THE EPICYCLIC REDUCTION GEAR UNIT

Figure 36



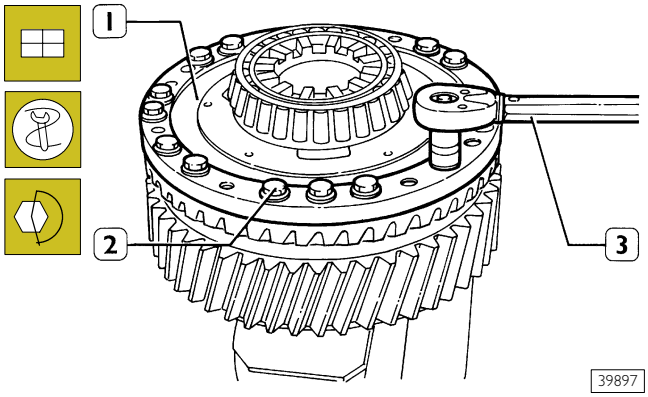
Fit the gears (3) onto the planetary gear carrier, connect the spindle (1) so that the hollow (2) coincides with the set screw hole (4). Apply LOCTITE AVX to the set screw (4) and lock it to a torque of 44 ± 4 Nm. Repeat the operation for the other spindles.
Turn the planetary gears carrier over and, after heating the inner ring to 80 °C to 90 °C, fit the bearing in place.

Figure 37



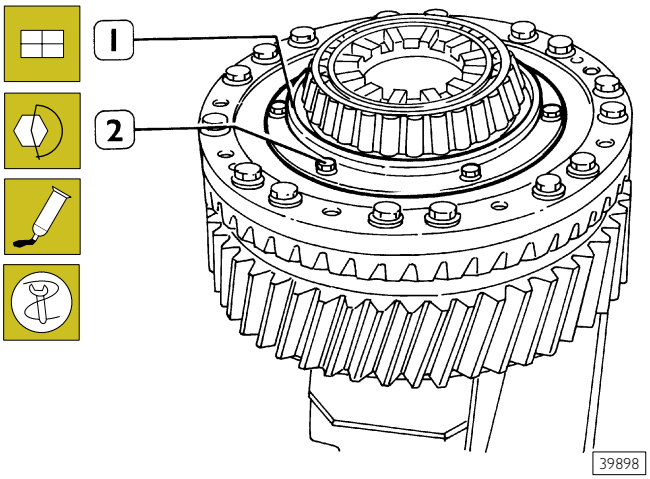
Fit the driving shaft, the planetary gear (2) on the crown wheel (1) and clamp the unit in a vice.

Figure 38



Fit in place the completed planetary gears carrier (1) coinciding the reference pins, tighten screws (2) and lock them with a dynomometric wrench (3) to the prescribed torque.
Turn the unit over and after heating the inner ring of the bearing to 80 °C to 90 °C, fit it in place.

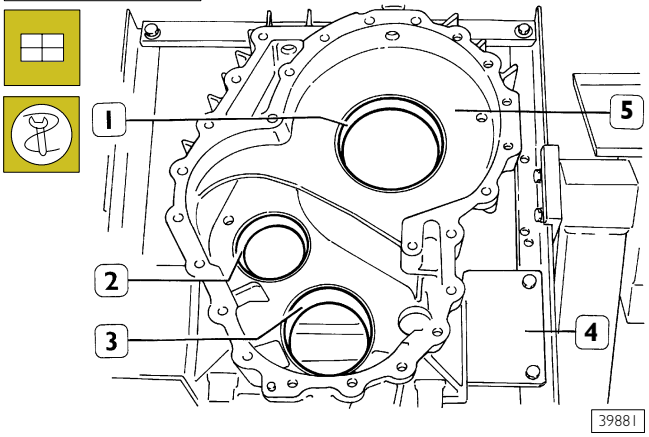
Figure 39



Fit in place the splash guard (1), apply LOCTITE AVX to the screws (2) and tighten them to a torque of 7 ± 1 Nm.
Turn the unit over and fit the bearing after heating the inner ring to 80 °C to 90 °C.

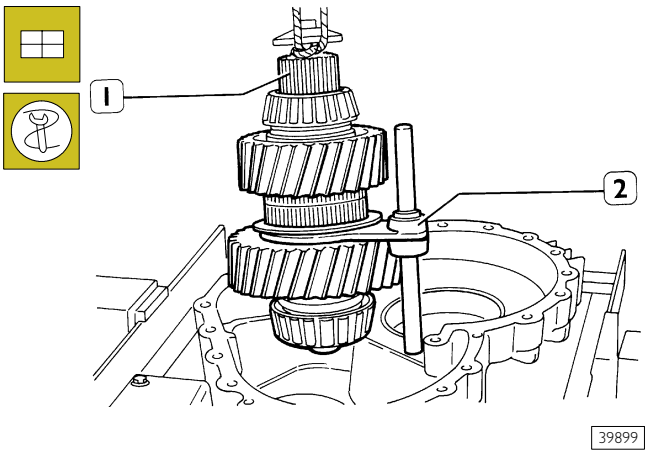
ASSEMBLING THE REDUCTION GEAR UNIT AT THE BENCH

Figure 40



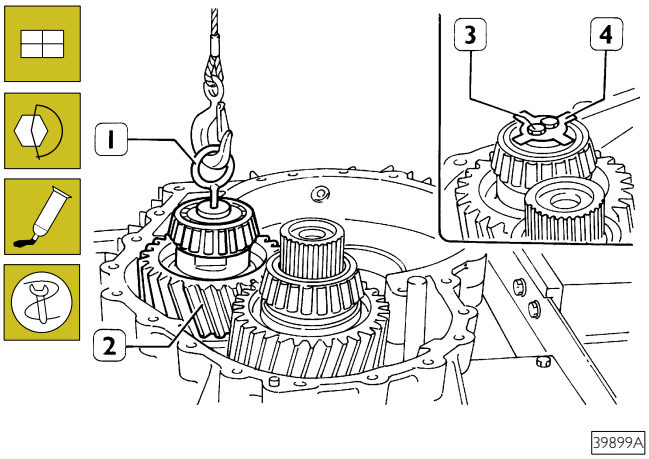
Set the housing (5) on stand 99322205 using brackets 9937105 (4); use the appropriate beater to fit the bearing outer rings (1-2-3).

Figure 41



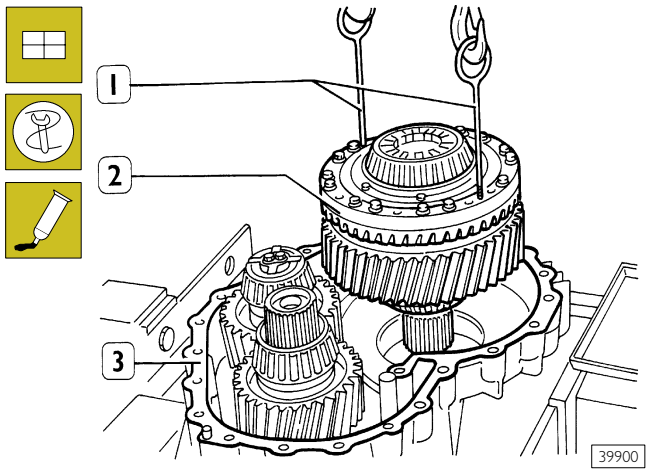
Using a rope and truck lift fit the input shaft (1) with the control fork (2) into the housing.

Figure 42



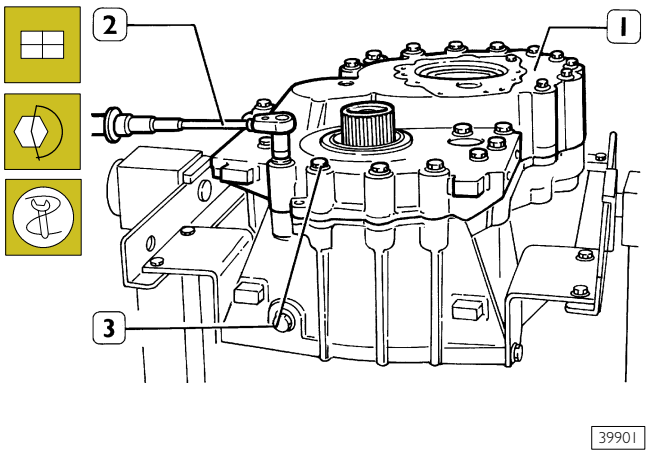
Use eye bolt 99366067 (1) to fit into place the countershaft (2). Up to No. 535: fit in place the phonic wheel (4), apply LOCTITE AVX to the sole screw (3) and tighten to the specified torque. From No. 536: fir in place the phonic wheel (4), the safety plate and tighten the screws (3) to the specified torque, bend the safety plate.

Figure 43



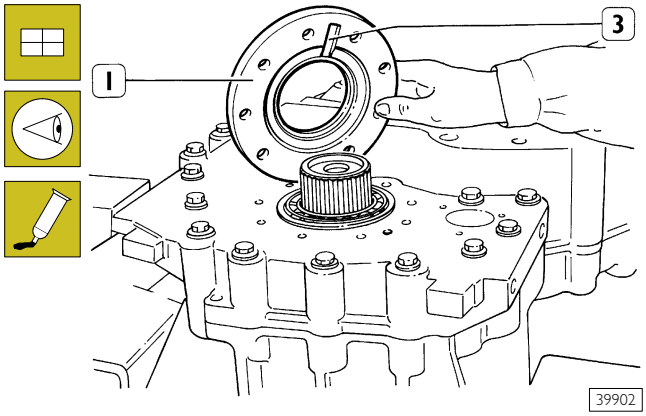
Use eye bolt 99370565 (1) to fit the epicyclic reduction gear (2) into the housing. Fit gasket (3) in the housing.

Figure 44



Fit in place the housing (1) and use a dynomometric wrench (2) to tighten the screws (3) to the specified torque.

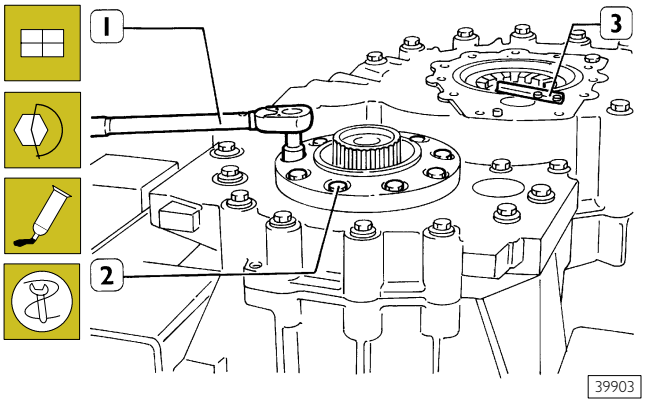
Figure 45



Fit in place the gasket (2), fit the cover (1) with its seal ring.

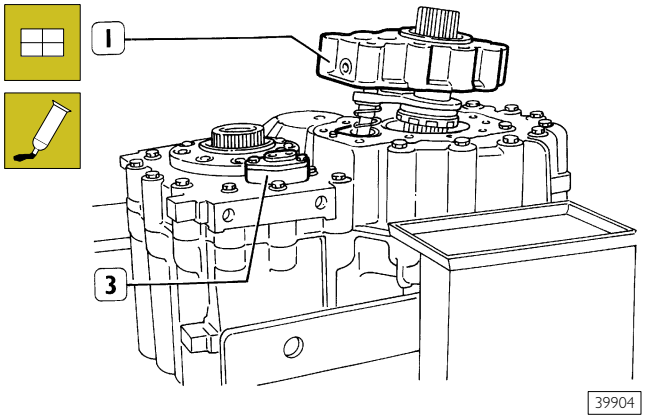
The oil passage (3) must be in the position shown in the figure.

Figure 46



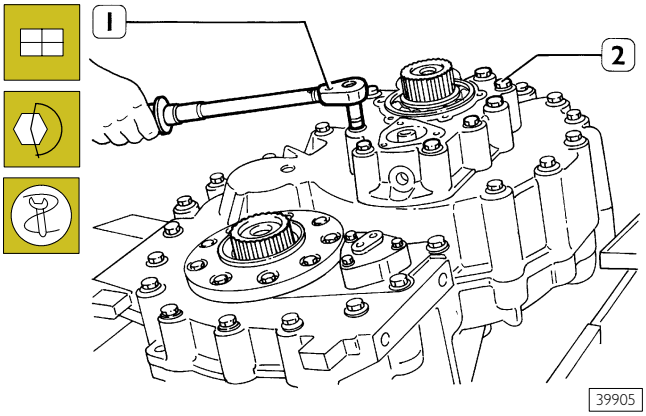
Lock the cover screws (2) with a dynamometric wrench (1) to a torque of 50 ± 5 Nm. Set the locking plate (3) in position, apply LOCTIT AVX to the screws and tighten them to a torque of 4.5 Nm.

Figure 47



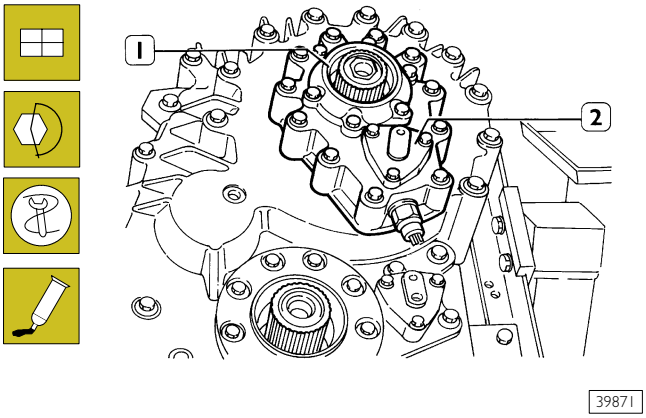
Fit in place the cover (3) with the control piston and internal spring. Fit the gasket (2) and cover (1) together with the shaft and reduction gear control fork.

Figure 48



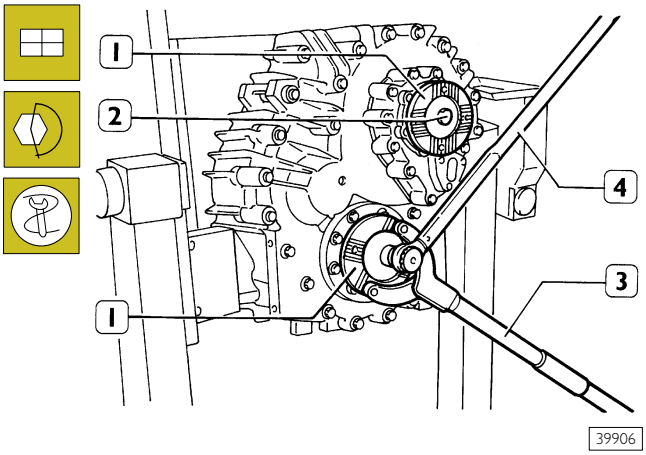
Use a dynamometric wrench (1) to tighten the screws (2) to a torque of 78 ± 8 Nm.

Figure 49



Fit in place the cover (2) with the control piston. Set the gaskets in place, fit cover (1) and tighten the screws to a torque of 30 ± 3 Nm.

Figure 50



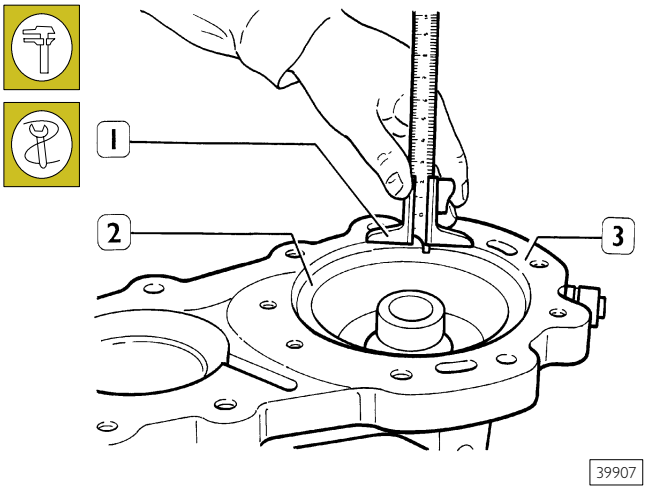
Connect the two flanges (1) fit the washers and with a lever (3) and dynamometric wrench (4) tighten screws (2) to a torque of 500 ± 50 Nm.

ADJUSTMENTS

Shaft bearings pre-load adjustment

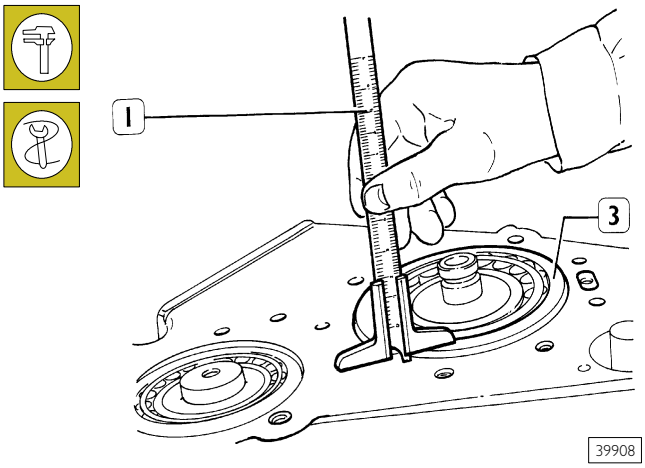
INPUT SHAFT

Figure 51



❑ With a caliper (1), find the depth of the seat(2) for the bearing on the cover (3):

Figure 52

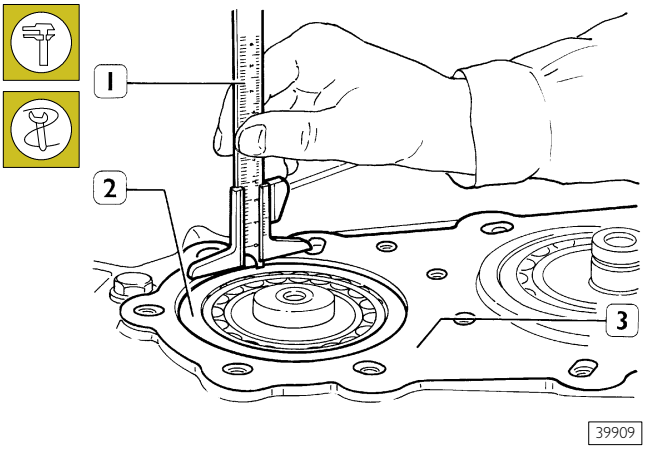


❑ Set the gasket (2) on the housing, and use a caliper (1) to find the protrusion between bearing outer ring (3) and gasket (2).

The difference between these two measurements is the adjusting ring shim; add 0.10 to 0.15 mm (preload) to the value obtained.

COUNTERSHAFT

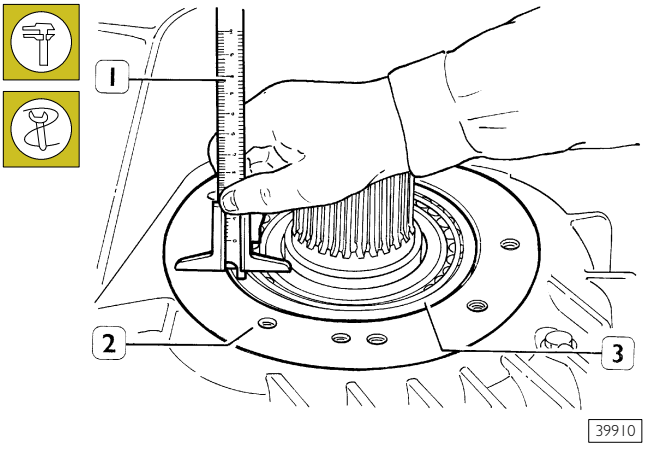
Figure 53



❑ Use a caliper (1) to find the distance between the gasket (3) on the housing and bearing outer ring (2).
Add the specified preload to this value.

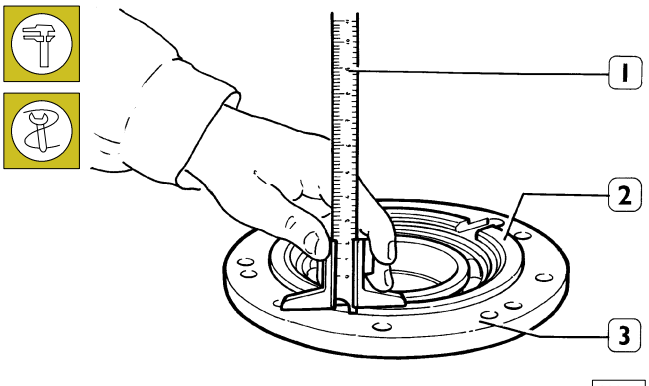
DRIVING SHAFT

Figure 54



❑ Fit the gasket (2) in the housing, use a caliper to find the the depth of the bearing outer ring (3) in relation to the face with the gasket.

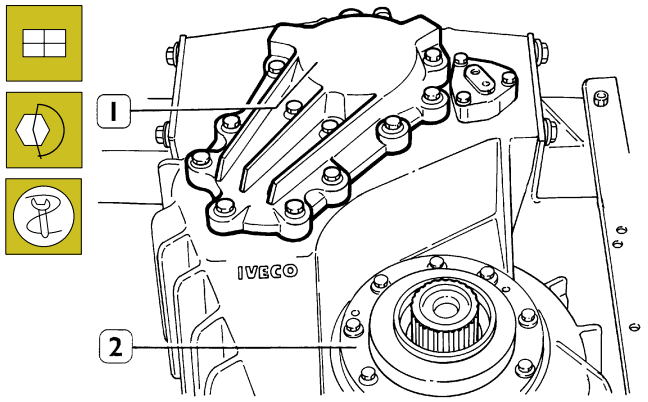
Figure 55



39911

❑ Usea caliper (1) to find the distance between the outer edge of the bearing collar (2) and the cover face (3) The difference between these two measurements is the value for the adjusting ring; add 0.10 to 0.15 mm (preload) to this value.

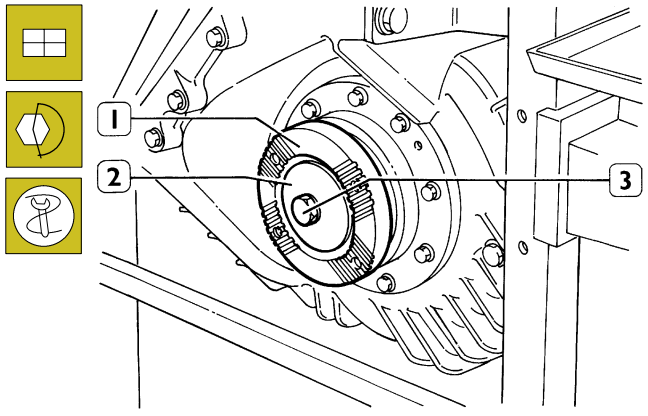
Figure 56



39912

Fit the adjusting rings, assemble the covers (1-2) and tighten the screws to a torque of 50 ± 5 Nm.

Figure 57



39913

Connect the flange (1), fit washer (2) using a lever and dynamometric wrench tighten the screw (3) to a torque of 500 ± 50 Nm.

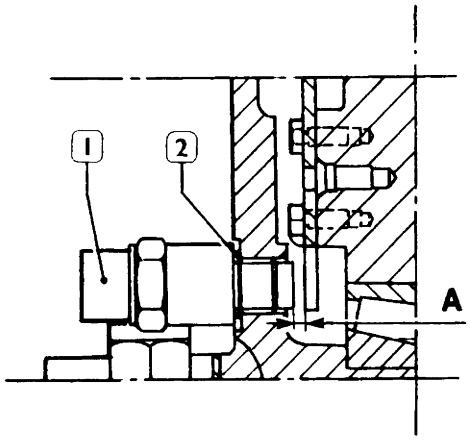
Fit the indication switch and the pulse transmitter and adjust as described in the following paragraphs.

Indication switch adjustment

Screw on the switch to electric contacts closing, screw on once and then tighten the lock nut to the prescribed torque.

Pulse transmitter adjustment

Figure 58



42447

Select the adjusting ring (2) to obtain A equal to 2 - 2,8 mm when fitting the pulse transmitter (1).

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REDUCTION GEAR UNIT
TC2200

SECTION 9.2

SECTION 9.2

Reduction gear unit TC2200

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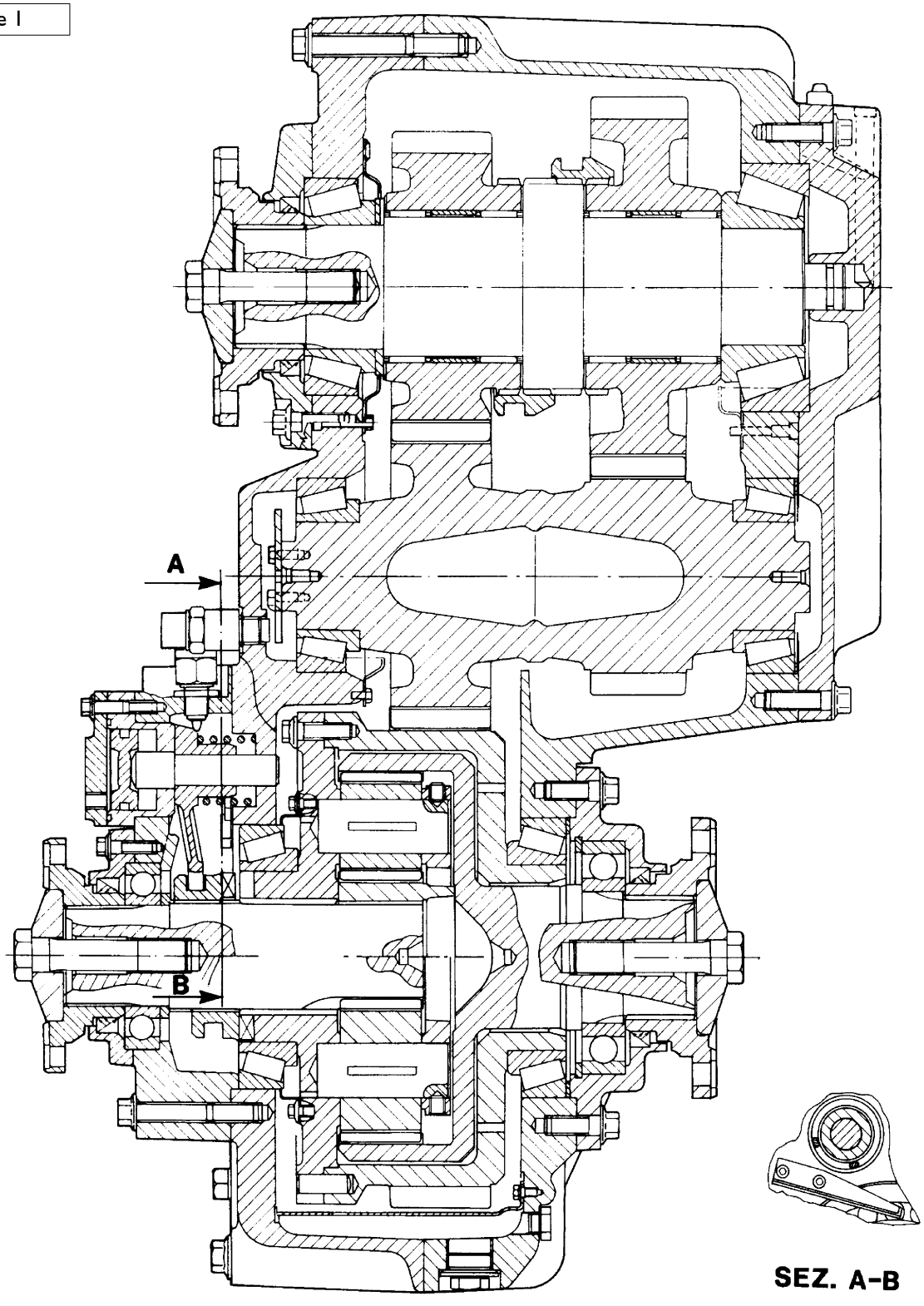
DESCRIPTION

The TC 1800 reduction gear unit is located between the gearbox and the intermediate axle.
It consists of a set of constant mesh helical spur gears.
These gears are fitted on three shafts: input shaft, countershaft and driving shaft.

A toothed sliding sleeve on the input shaft engages the normal and reduced gears.
The differential torque reduction gear for the front and rear axles and the differential reduction gear locking device are fitted on the driving shaft.

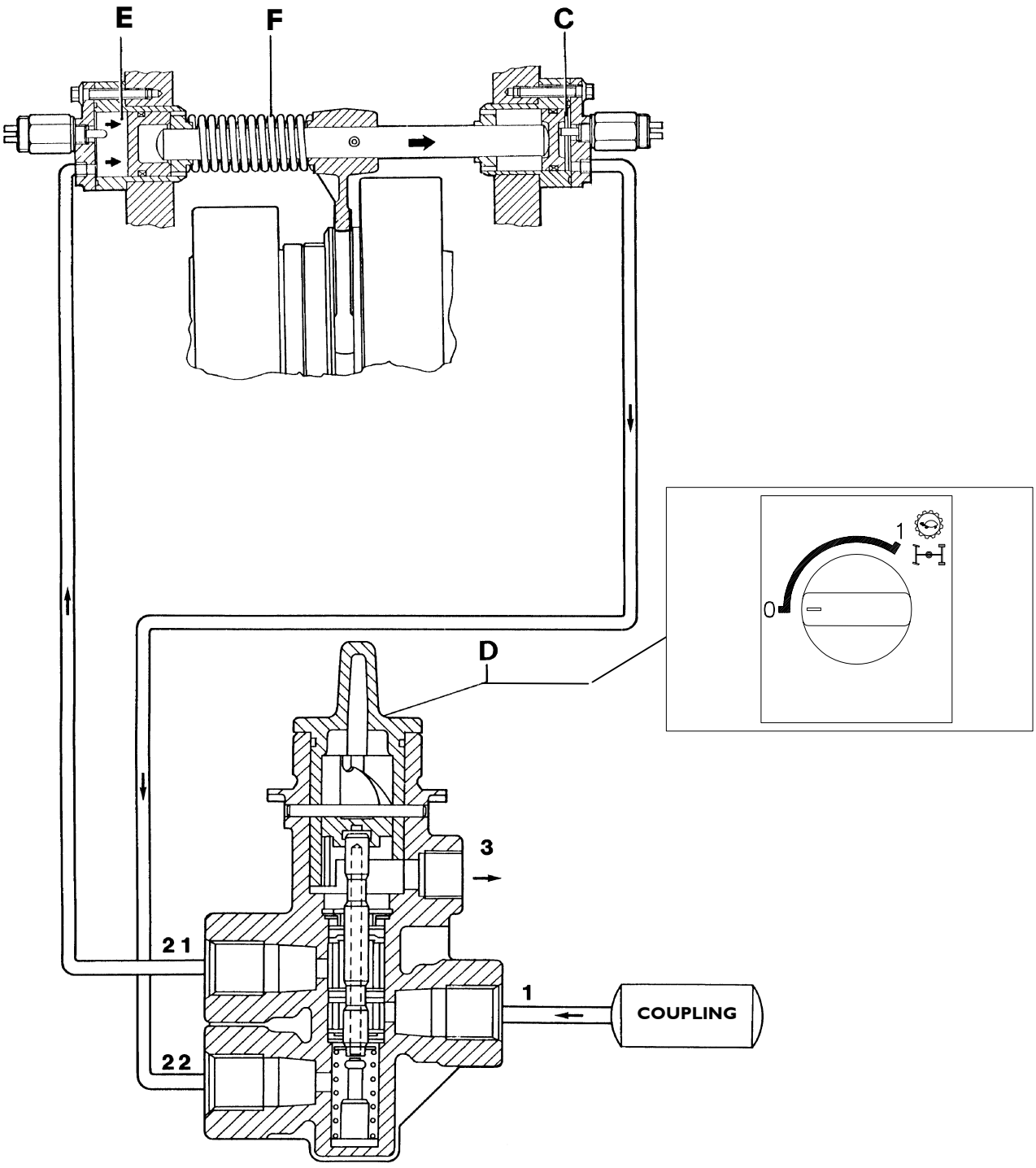
Figure 1



LONGITUDINAL SECTIONAL VIEW THROUGH THE REDUCTION GEAR UNIT

On-road

Figure 2



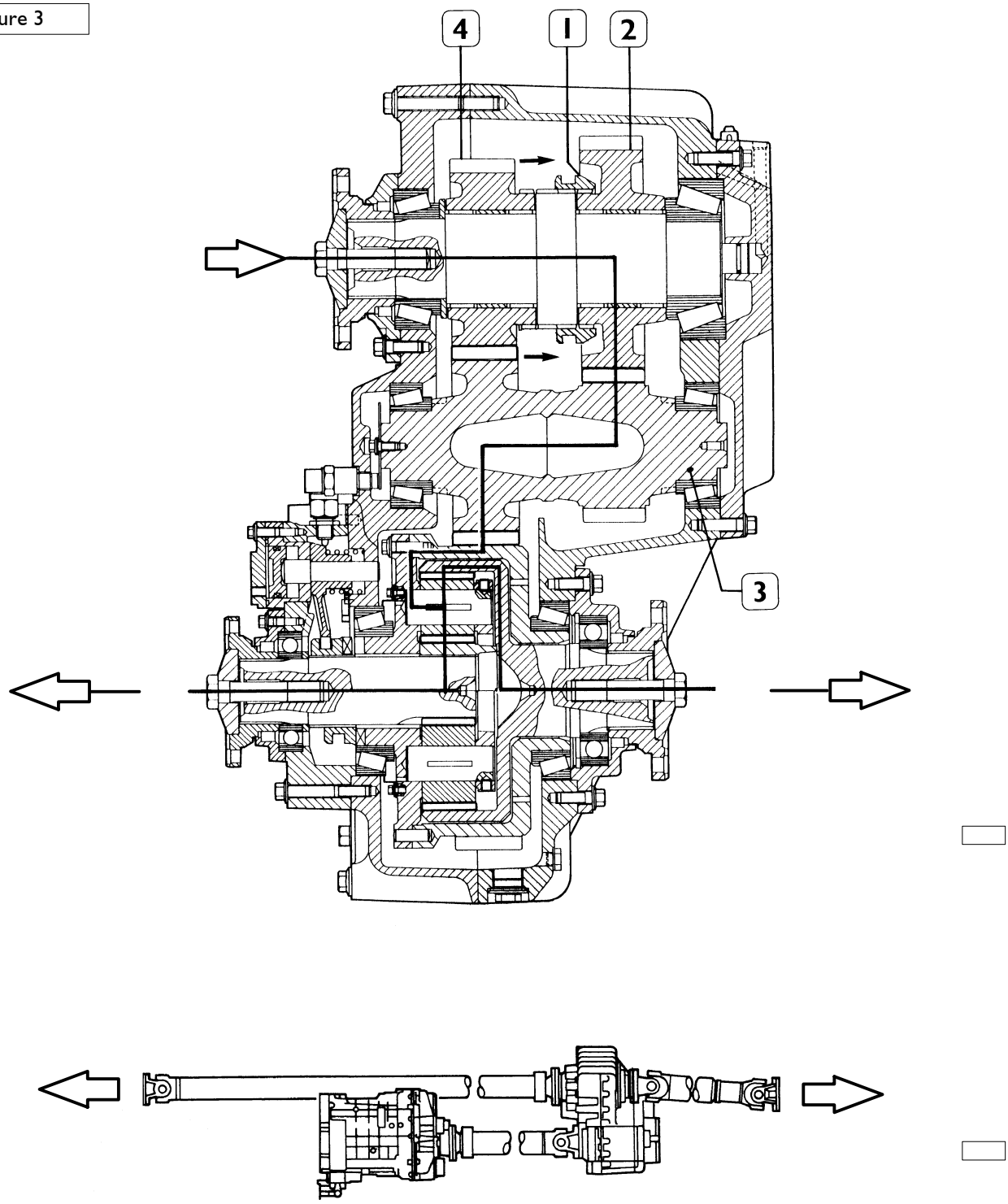
CONTROL KNOB "D" SET ON 0

With control knob "**D**" set on **0**, the incoming air to coupling **1** passes through the valve and comes out through coupling **2 1**, and by feeding chamber **E** causes the piston displacement to its end of stroke.

Spring **F** holds the fork and sleeve in the on-road gear ratio setting.
The air in chamber **C** is discharged through coupling **3**.

Transmission of motion pictorial diagram: on-road

Figure 3

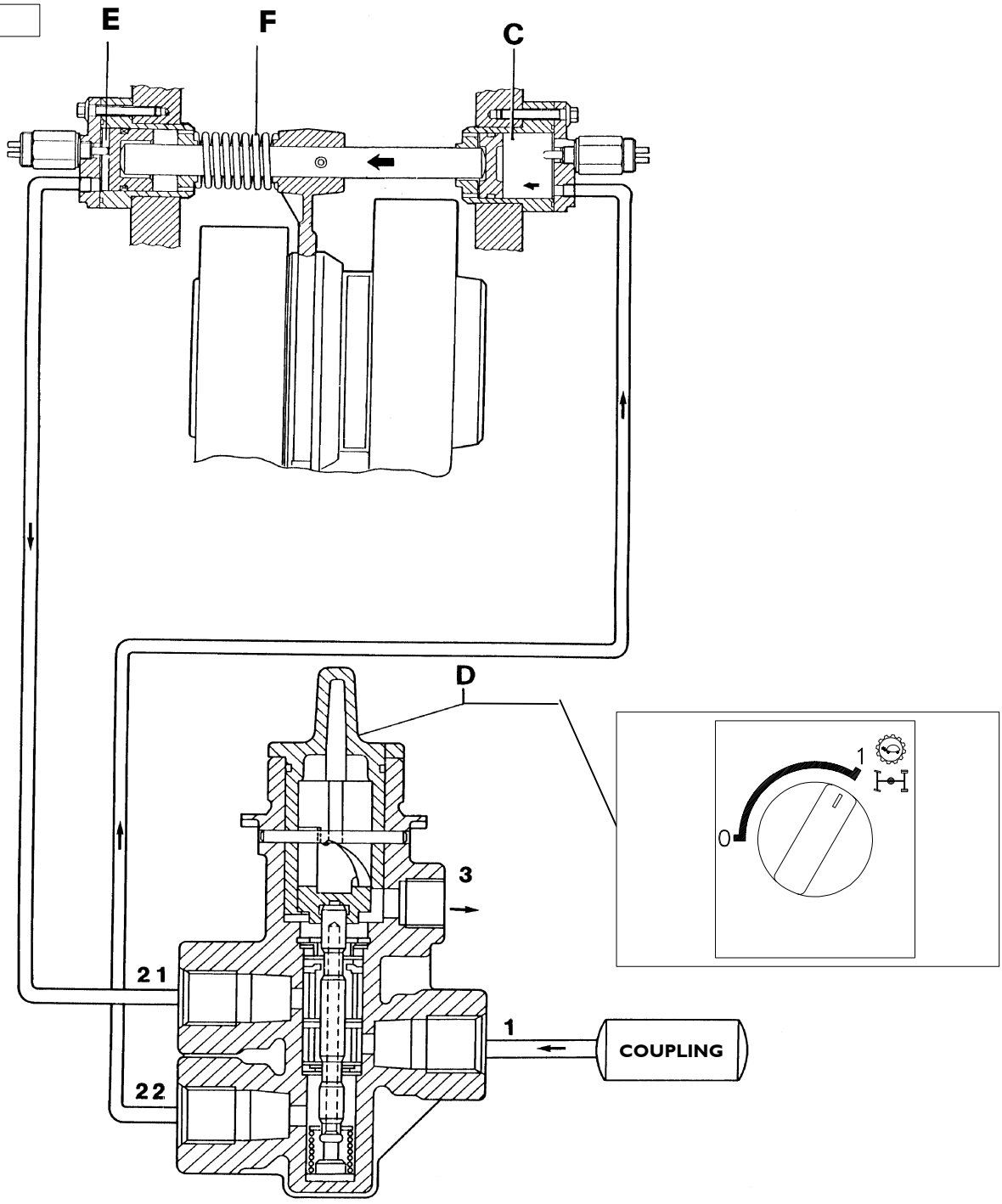


Sleeve (1) moves in the direction indicated by the arrow, meshing the gear (2) on the input shaft.

The motion is transmitted through the countershaft (3).

Off road

Figure 4



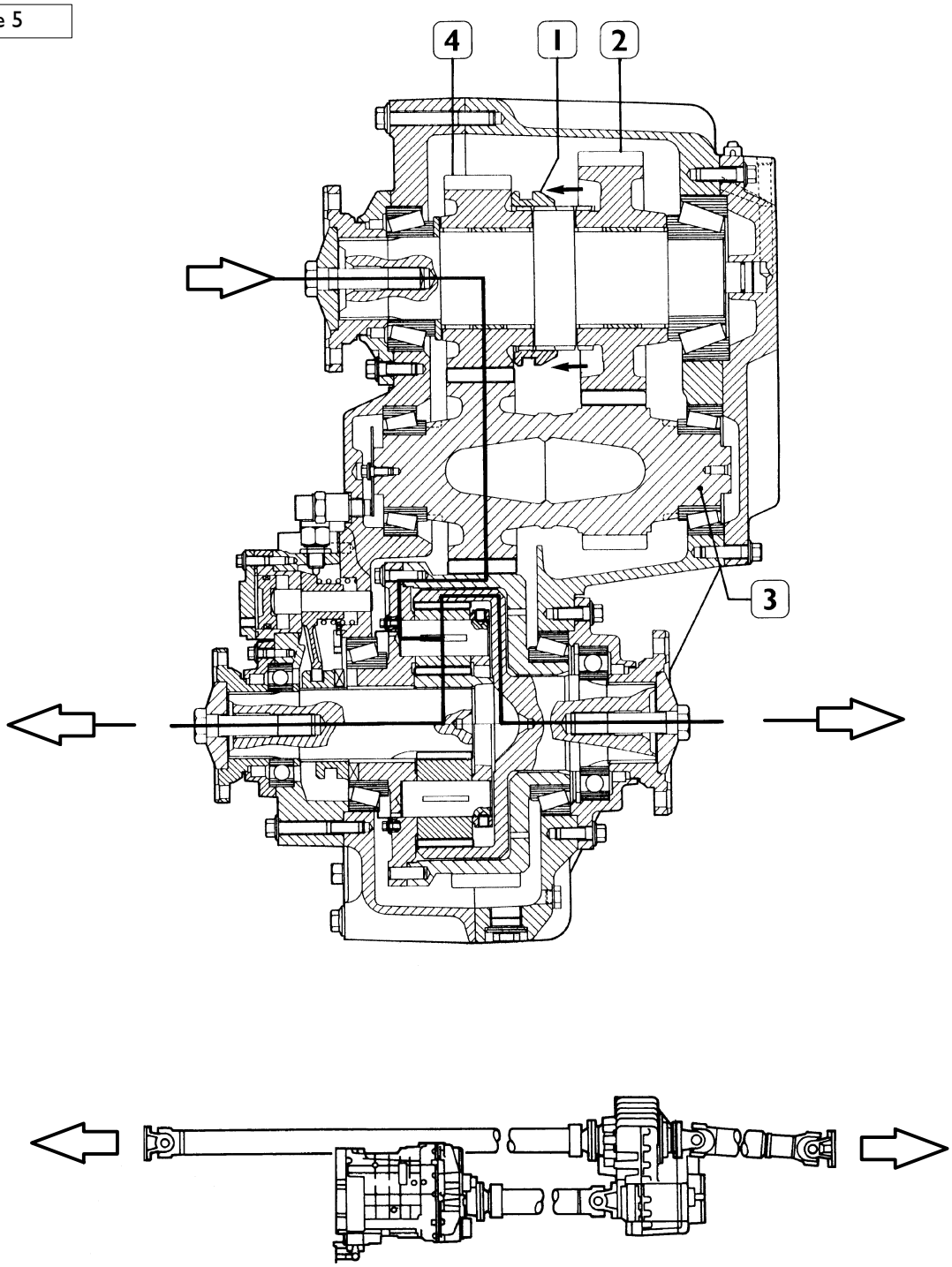
CONTROL KNOB "D" SET ON **I**

With control knob "**D**" set on **I**, the incoming air to coupling **I** passes through the valve and comes out through coupling **22**, and by feeding chamber **C** causes the piston displacement to its end of stroke.

The fork and sleeve are set on off-road gear ratio setting. The air inchamber **E** is discharged through coupling **3**.

Transmission of motion pictorial diagram: off-road

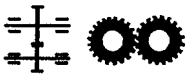
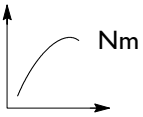
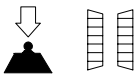
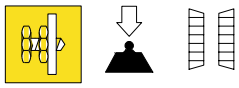
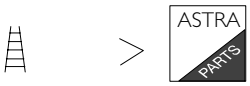
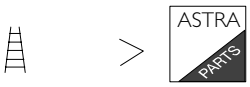
Figure 5



Sleeve (1) moves in the direction indicated by the arrow, meshing the gear (2) on the input shaft.

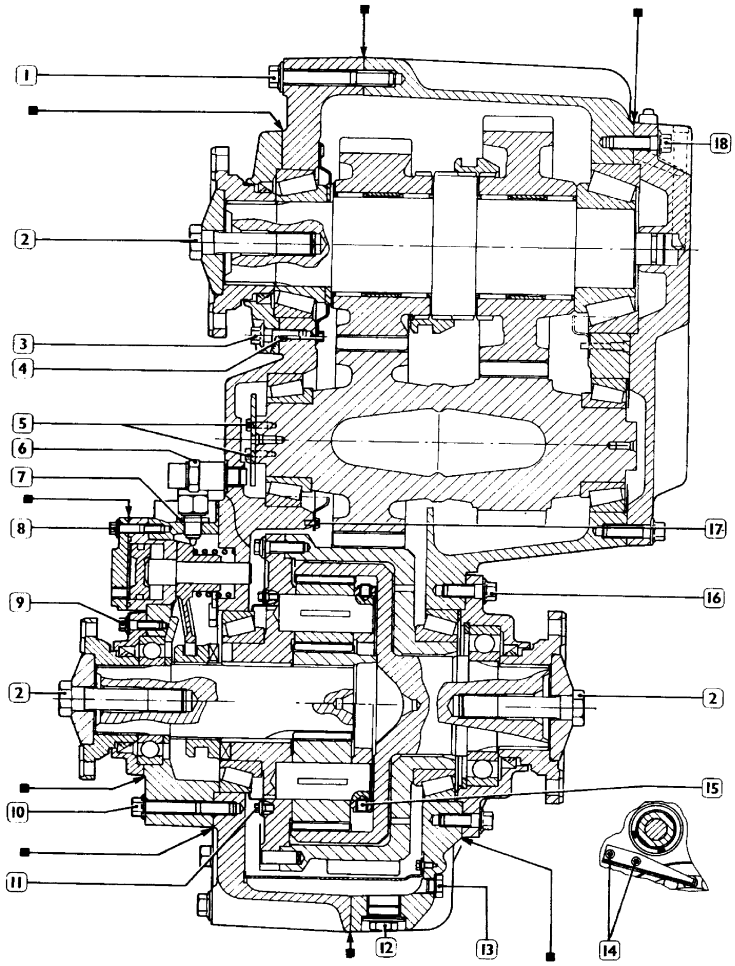
The motion is transmitted through the countershaft (3).

SPECIFICATIONS AND DATA

REDUCTION GEAR UNIT	TYPE	TC 2200
	Gears	Constant mesh helical gears
	Transmission ratios normal (on road) reduced (off road)	1 : 1 1 : 1,6
	Maximum input torque	22.000 Nm
	Torque reduction	1 : 4
	Bearings preload for: input shaft countershaft driving shaft	0,05 ÷ 0,10 mm
	Bearings preload adjustment	Through adjusting rings
	Thickness of adjusting rings	1–1,1–1,2–1,3–1,4–1,5–1,6–1,7–1,8–1,9 mm 1–1,6–1,7–1,8–1,9–2,0–2,1–2,2–2,3–2,4–2,5 mm 1–1,1–1,2–1,3–1,4–1,5–1,6–1,7–1,8–1,9–2 mm
	Thickness of adjusting rings for pulse transmitter	1 - 1,5 mm 1 - 1,5
	Quantity (*) kg (liter)	5,6 (6,2)

(*) For the correct type of fluid, see section 2 - HYDRAULIC FLUID AND LUBRICANTS TABLE

Figure 6



TIGHTENING TORQUES

	DESCRIPTION	TORQUE	
		Nm	Kgm
1	M14 screw	92 ± 9	9,2 ± 0,9
2	M22 x 1.5 pin	500 ± 50	50 ± 5
3	M12 screw	58 ± 6	5,8 ± 0,6
4	M6 screw	10	1
5	M6 screw	10	1
6	Pulse transmitter	45 ± 5	4,5 ± 0,5
7	Nut	45 ± 5	4,5 ± 0,5
8	M8 screw	19 ± 2	1,9 ± 0,2
9	M10 screw	45 ± 5	4,5 ± 0,5
10	M12 screw	58 ± 6	5,8 ± 0,6
11*	M6 screw	7	0,7
12	Screw plug	100 ± 10	10 ± 1
13*	Screw	4,5	0,45
14	Screw plug	60 ± 6	6 ± 0,6
15*	Set screw	33 ± 3	3,3 ± 0,3
16	M12 screw	58 ± 6	5,8 ± 0,6
17	Screw	5	0,5
18	M12 screw	58 ± 6	5,8 ± 0,6

* Apply LOCTITE AVX ■ Apply LOCTITE 510

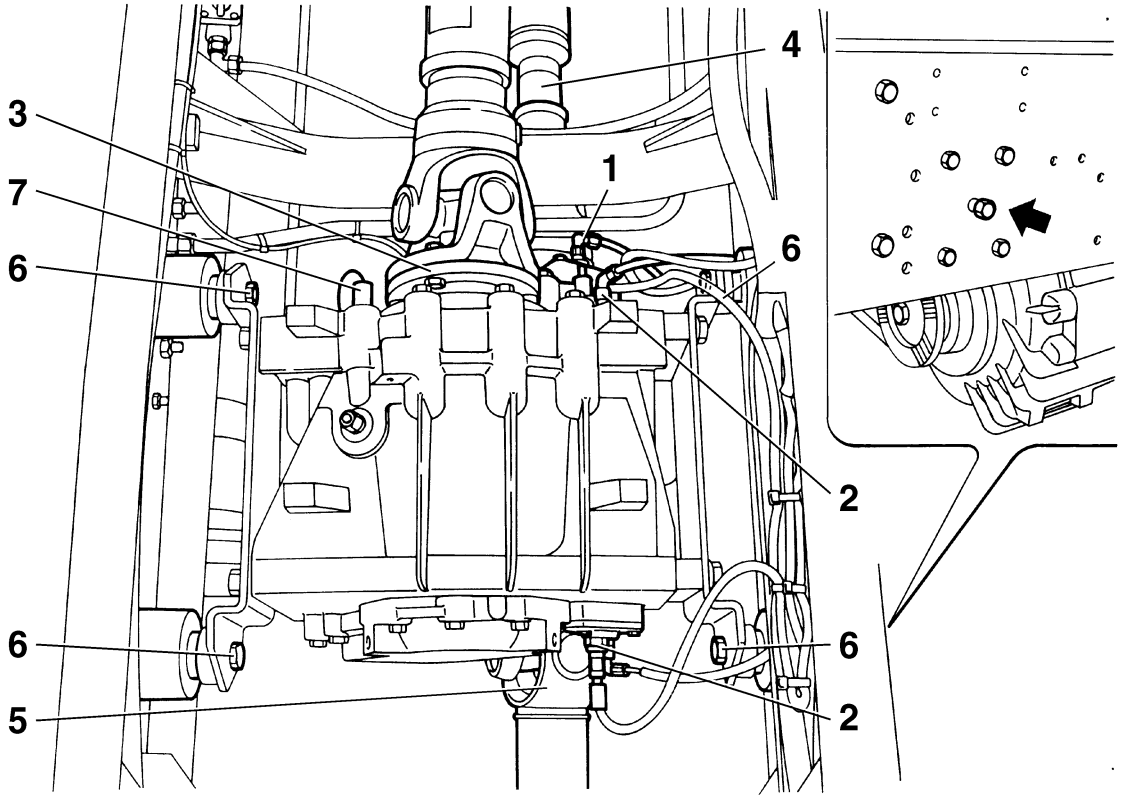
TOOLS

TOOL NO.	DESCRIPTION
99305121	Hot air operated equipment
99322205	Rotary stand for unit overhaul
99340205	Percussion puller
99341003	Simple effect axle
99341009	Pair of brackets
99341015	Clamp
99342143	Puller pin to remove planetary gear pins from epicyclic unit of transmission unit (to be used with 99340205)
99345049	Counter block for pullers
99345056	Counter block for pullers
99360502	Rings to remove and fit in place the transmission unit halfbox
99366067	M8 hooks (2) to remove and fit in place the transmission unit intermediate shaft
99370006	Handle for interchangeable beaters
99370317	Lever and relevant extension bar for flange stop
99370565	Element to fit the gasket in front driving shaft cover of transmission unit (to be used with 9937006)
99370362	Eye bolt (2) to remove and fit in place transmission unit epicyclic assembly
99370631	Stand to hold transmission unit during removal and fitting in place
99371051	Bracket to hold transmission unit during overhaul (to be used with 99322205)
99374253	Element to fit the gasket in input shaft cover, and transmission unit rear driving shaft (to be used with 99370006)
9938982 1	Dynamometric wrench (0-70 Nm) with square 3/8" coupling

STRIPPING DOWN - REFITTING THE REDUCTION GEAR UNIT

Stripping down

Figure 7



To remove the reduction gear unit proceed as follows:

- ❑ set the vehicle on a pit or on a hoist;
- ❑ open the battery case and disconnect the cables to avoid short-circuits;

The disposal of waste or residual fluid in unauthorised sites or in the public sewer system is prohibited.

- ❑ disconnect reduction gear unit electrical and pneumatic connections (1);
- ❑ disconnect reduction gear unit electrical and pneumatic connections (2);
- ❑ disconnect odometer cable (7) after removing the sealing;
- ❑ undo the screws fixing the input shaft flange (3), front output shaft flange (4) and rear output shaft flange (5) and secure temporarily the shafts to the chassis to avoid interference during next operations;
- ❑ disconnect hydraulic pipes from servo-clutch auxiliary pump (8);
- ❑ position a hydraulic lifting device under the transfer and remove the connecting screws to the four supporting pads (6);
- ❑ screw one screw to each pad as shown by the arrow to press the pad and enable unit removal;
- ❑ lower the hydraulic lifting device and remove the transfer from the bottom.

Refitting

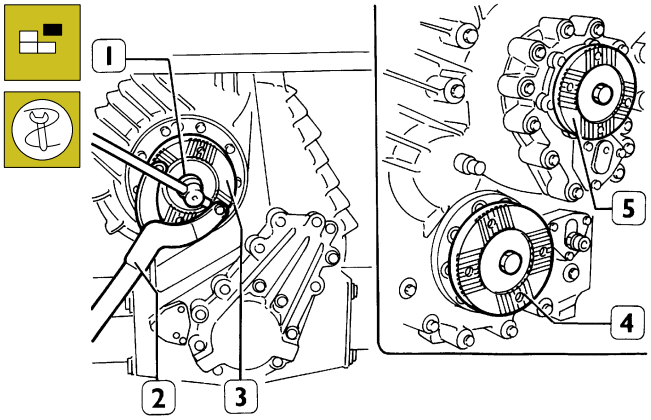
Reverse the operations for removal.

When refitting, drain out power steering hydraulic circuit as described in Section 15.

DISASSEMBLING THE REDUCTION GEAR UNIT AT THE BENCH

Set the reduction gear unit on rotary stand 99322205 with brackets 99371051, unscrew the plugs and drain the oil. Unscrew the pulse transmitter and the indicator switches.

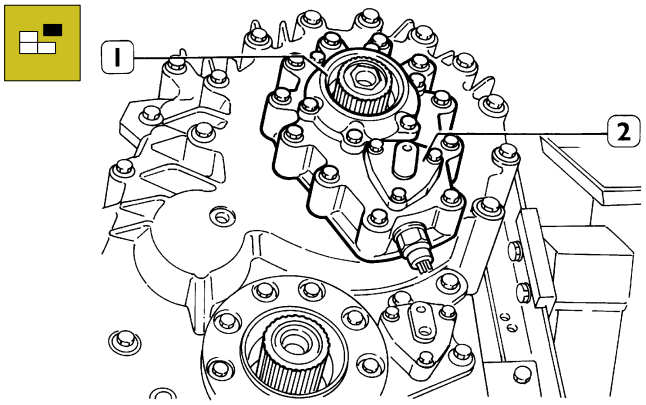
Figure 8



39870

Lock roation offlange (3) through lever 99370317 (2), use a suitable socket wrench (1) to remove the retaining screw and remove the flange; repeat the same operation for the flanges (4- 5) on the opposite side.

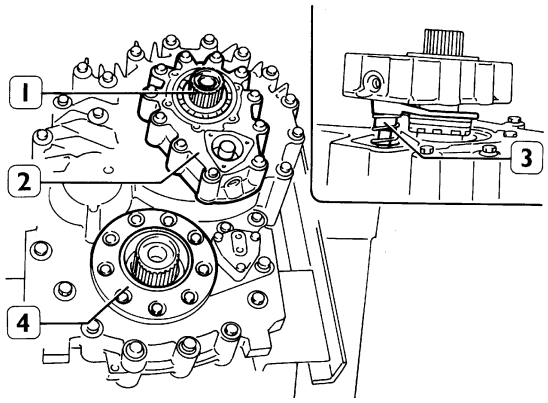
Figure 9



39871

Remove the 6 screws and the cover (1) with its seal ring; remove the 3 screws and cover (2) with reduction gear engagement piston.

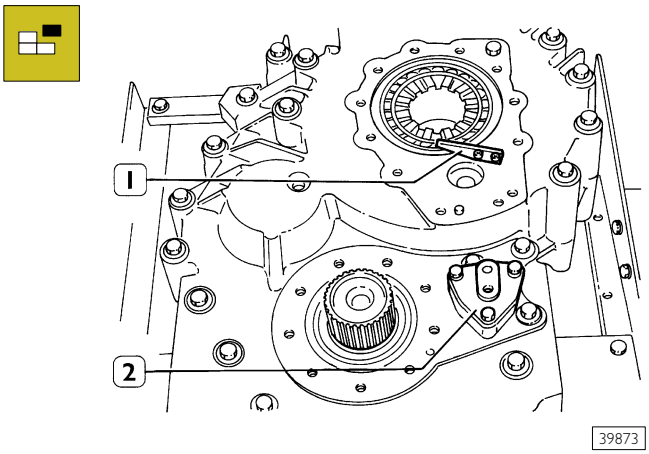
Figure 10



39872

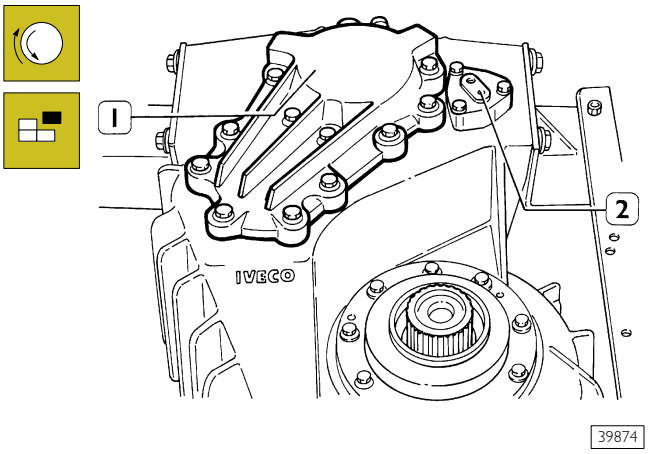
Remove the 11 screws and take away cover (2) together with reduction gear engagement control shaft (1) and fork (3); remove the 9 screws and remove cover (4) with its seal ring.

Figure 11



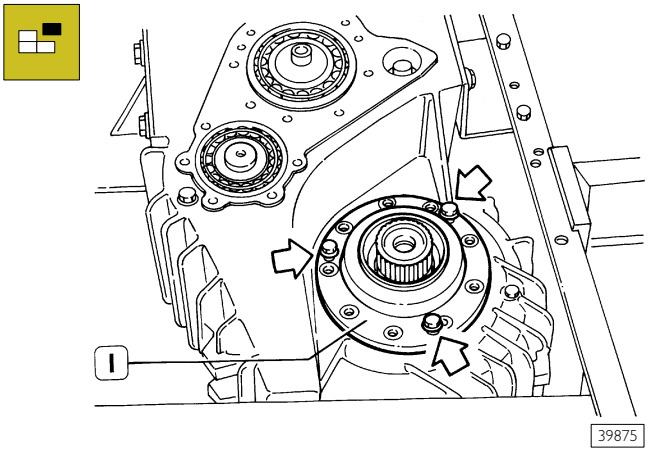
Remove the 3 screws and take away cover (2) with control piston and withdraw the internal spring; use a socket wrench for the screws and remove the safety plate (1).

Figure 12



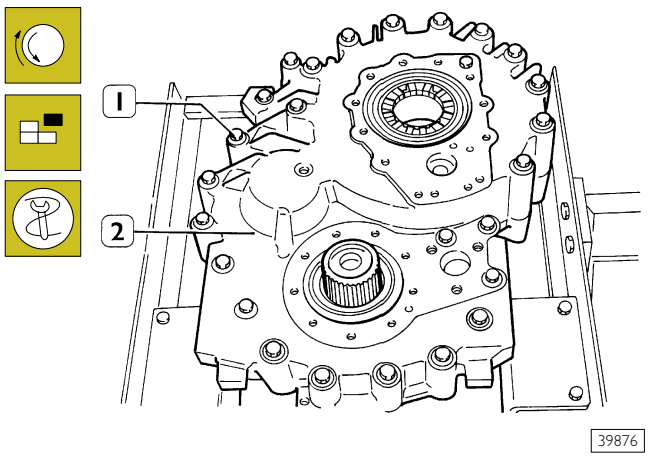
Rotate the unit 180°.
Remove the 3 screws and take away cover (2) with piston rod; remove the 14 screws and take away the cover (1). Remove the adjusting rings.

Figure 13



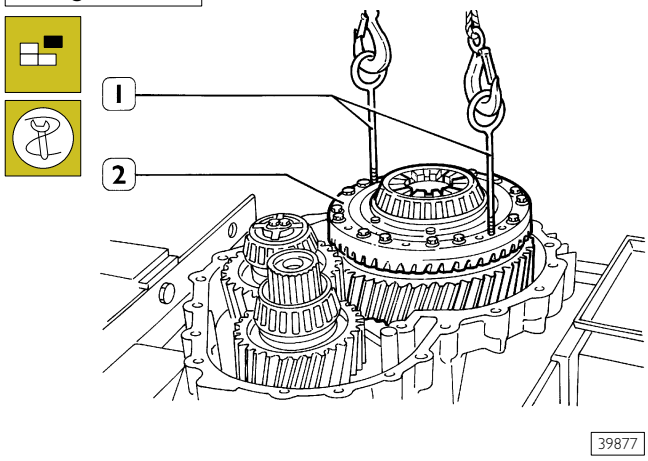
Remove the 9 screws, then fit 3 counteracting screws into the holes indicated by the arrows, take away the cover (1) and remove the adjusting rings.

Figure 14



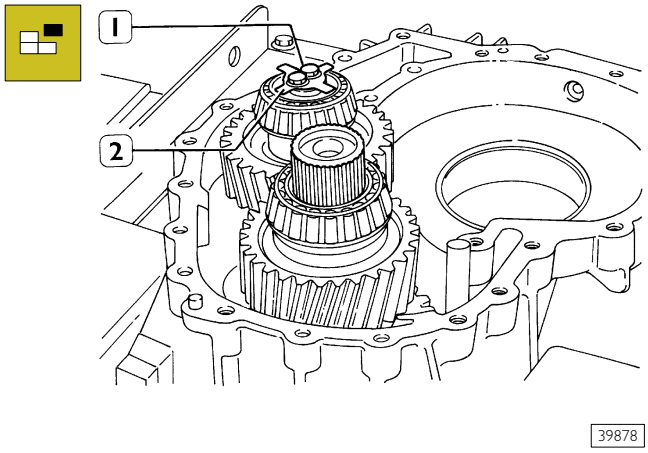
Rotate the unit 180°.
Remove screws (1) and with a hoist and ropes take away the housing (2).

Figure 15



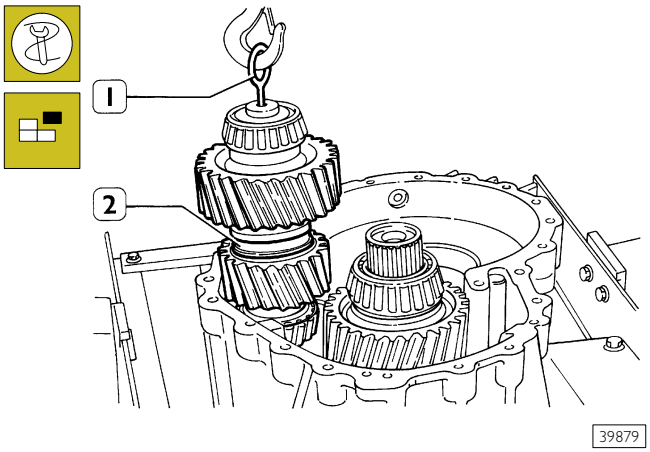
Use eye bolt 99370565 (1), ropes and lifting device to withdraw the epicyclic reduction gear (2) from the housing.

Figure 16



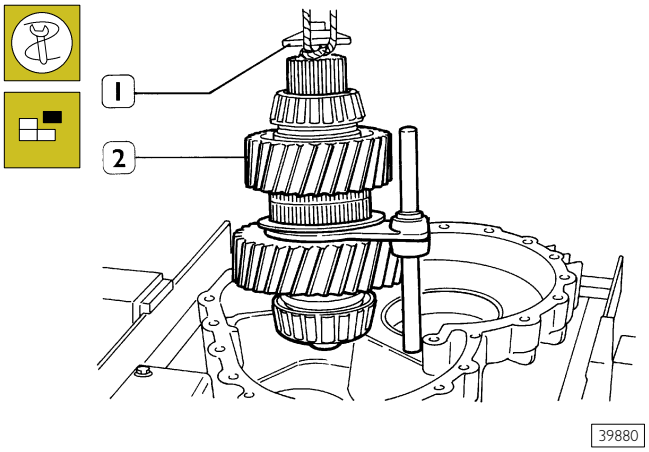
Remove screw (1) and phonic wheel (2)

Figure 17



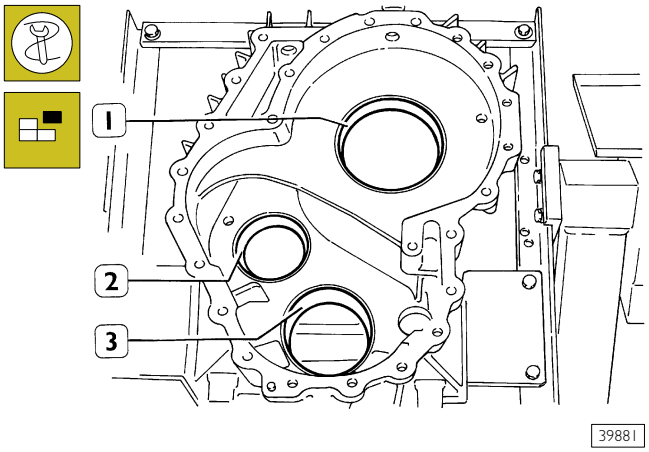
Using eye bolt 99366067 (1) rope and lifting device, release the countershaft (2) from the housing.

Figure 18



Screw the relevant screw and washer (1) onto the input shaft, use a rope and lifting device to withdraw the shaft (2) and control fork from the housing.

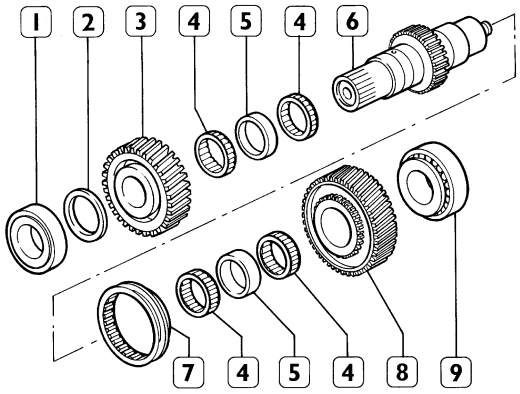
Figure 19



Using a suitable beater, remove the bearing outer rings (1-2-3).

DIS-ASSEMBLING THE INPUT SHAFT

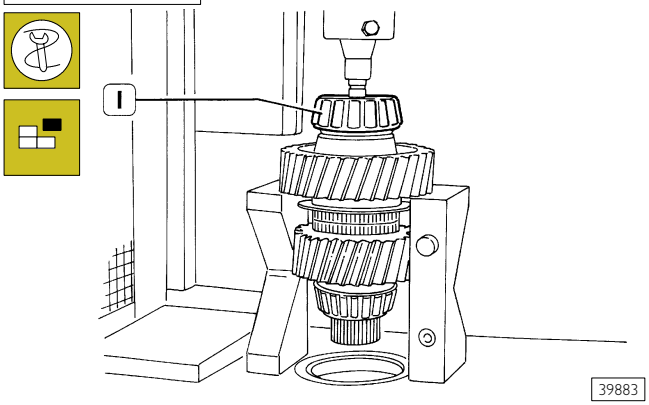
Figure 20



INPUT SHAFT COMPONENTS
1. Bearing - 2. Spacer ring - 3. Gear - 4. Roller bearings - 5. Spacer ring - 6. Shaft - 7. Sliding sleeve - 8. Gear - 9. Bearing

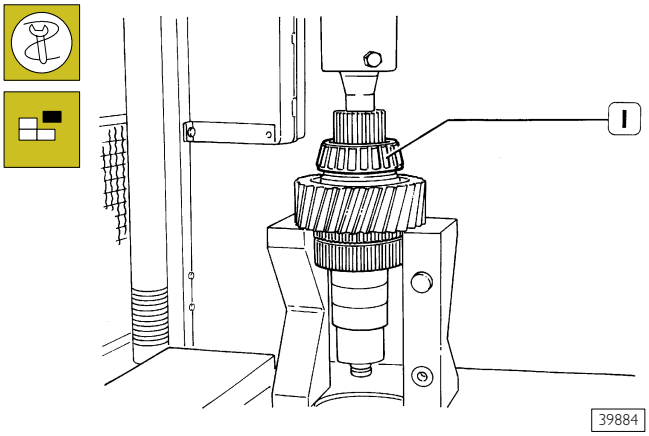
To dis-assemble the bearings (1, figure 21 and 22) it is necessary to use a hydraulic press.

Figure 21



Having withdrawn the bearing (1) manually withdraw the gear (8, figure 20), roller bearings (4), spacer ring (5) and sliding sleeve (7).

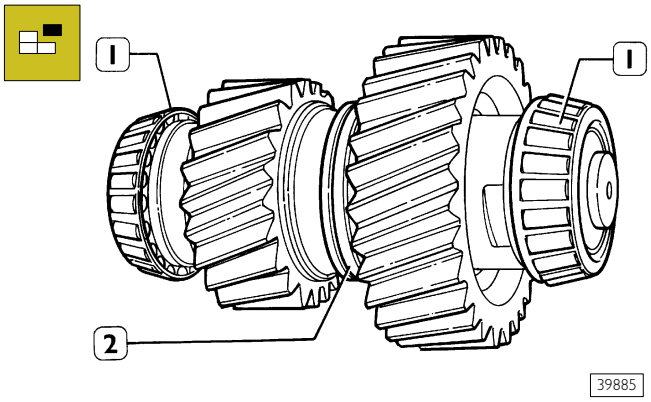
Figure 22



Remove bearing (1) and take away the spacer ring (2, figure 20), gear (3), roller bearings (4) and spacer ring (5).

DIS-ASSEMBLING THE COUNTERSHAFT

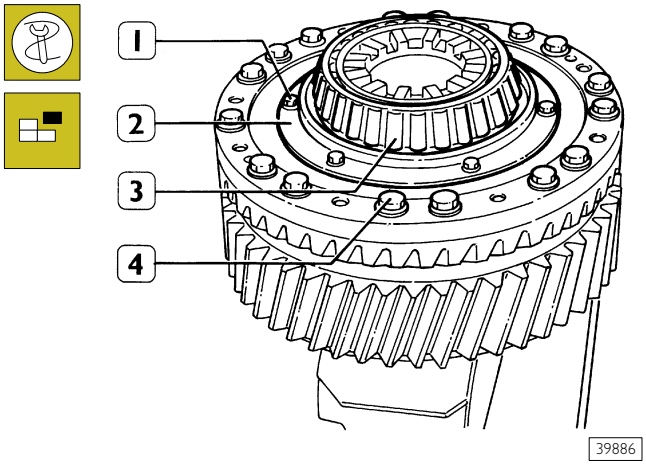
Figure 23



The removal of the bearings (1) from the countershaft (2) is a destructive operation.

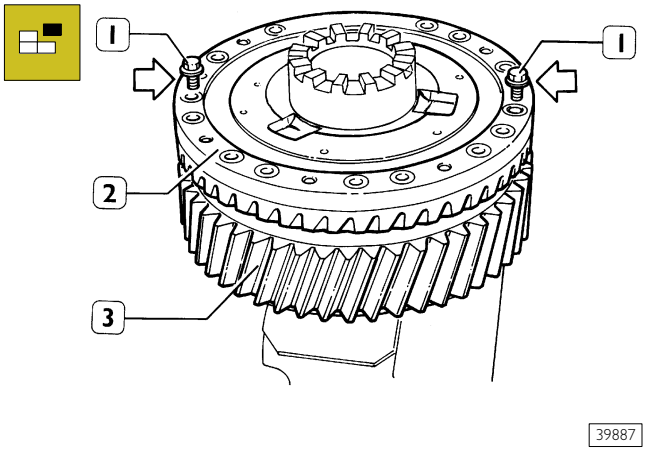
DIS-ASSEMBLING THE EPICYCLIC REDUCTION GEAR

Figure 24



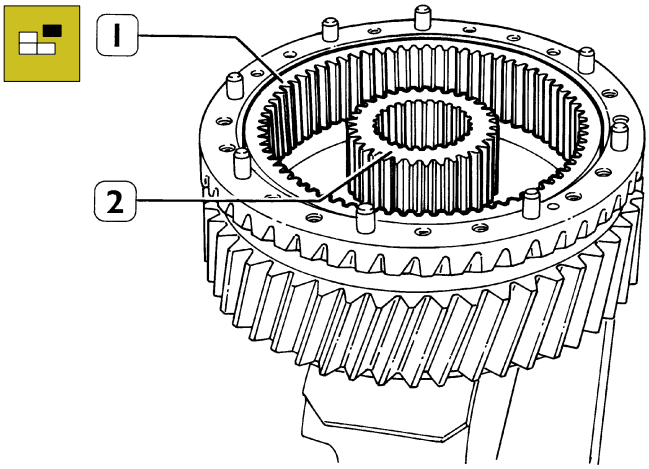
Remove screws (1) and take away the splash guardring (2), then using the appropriate puller remove the bearing (3), remove the screws (4).

Figure 25



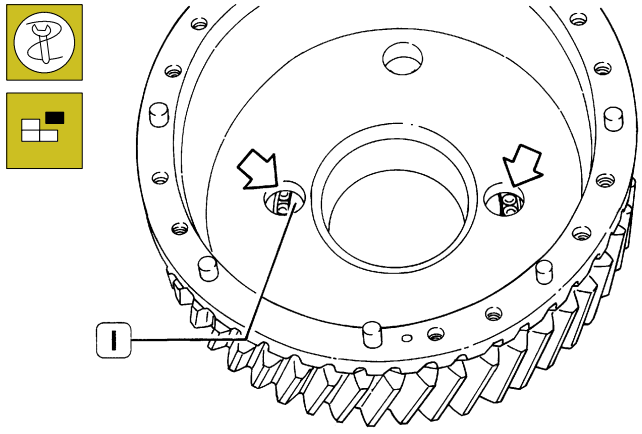
Using the 2 screws (1) in the holes indicated by the arrows, take the planetary gear carrier (2) away from the crown wheel (3).

Figure 26



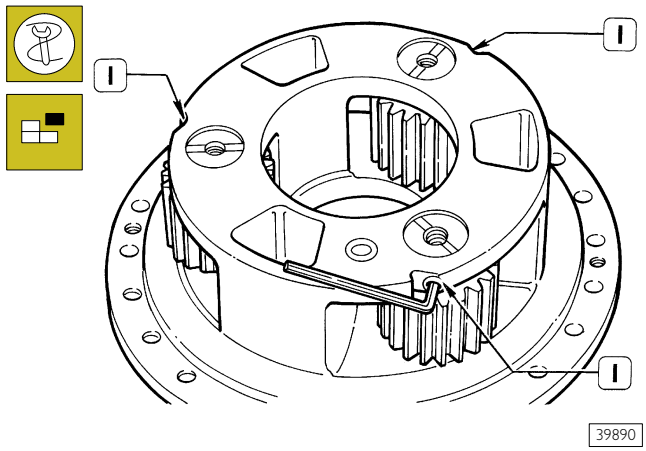
Remove the planetary gear (2) and take away the driving shaft (1)

Figure 27



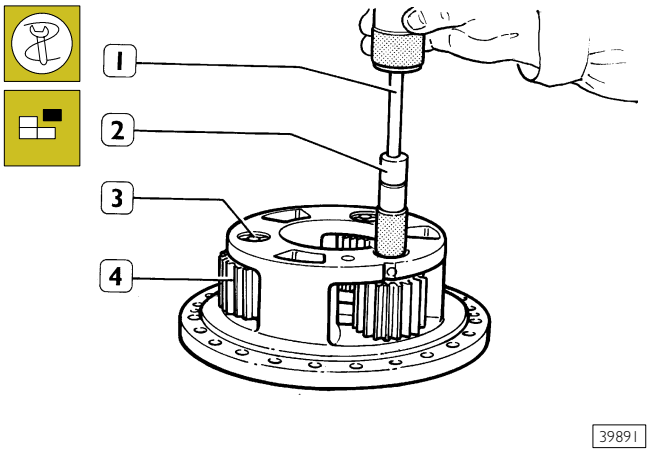
Using the suitable beater remove bearing (1) from the holes indicated by the arrows.

Figure 28



Use a socket wrench to remove the 3 securing set screws (1).

Figure 29

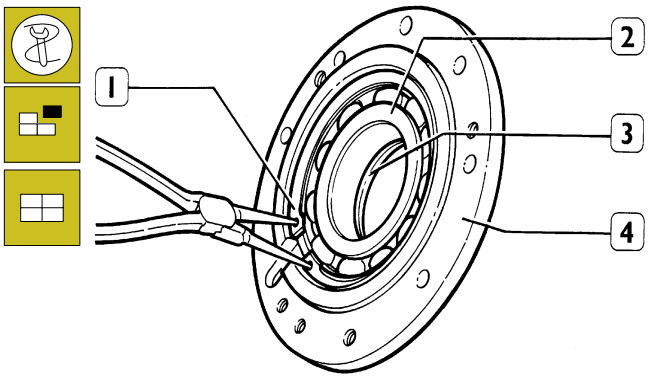


39891

Use percussion puller 99340205 (1) with pin 99342143 (2) to remove the shafts (3) for the gears (4).

REPLACING THE SEAL RINGS ON THE DRIVING SHAFT COVERS

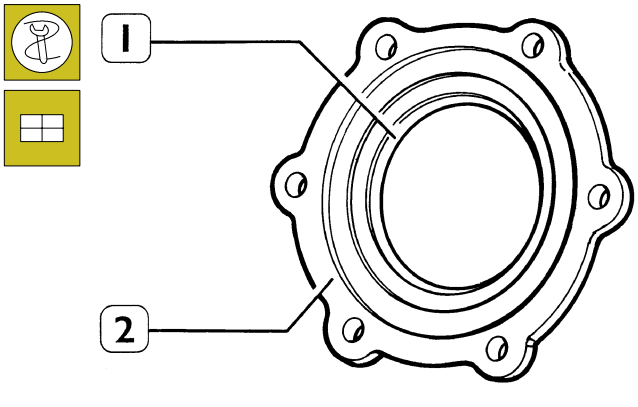
Figure 30



39892

To replace the seal ring (3) on cover (4) of the rear driving shaft, remove the locking ring (1) and withdraw the bearing (2). To fit the seal ring (3) in place, use tool 99374253.

Figure 31



39893

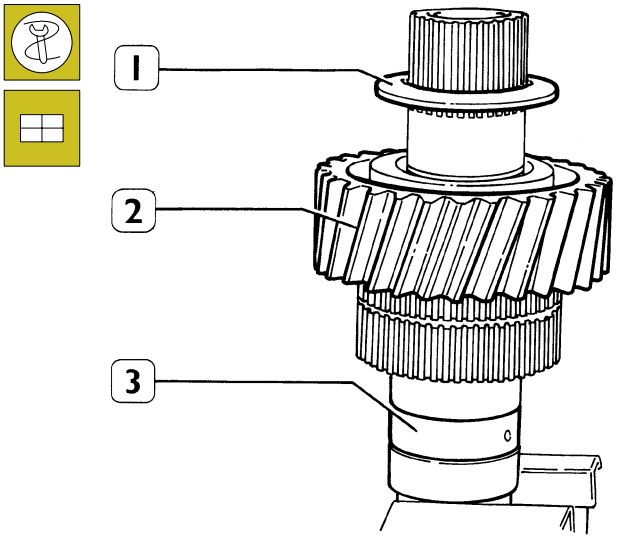
To fit seal ring (1) on front driving shaft cover (2), use tool 99370362.

CLEAN OUT AND CHECK

After the reduction gear unit has been removed, carefully clean all the parts.
Check that there are no signs of wear, seizure or cracking.
Seal rings and gaskets should always be replaced before re- fitting in place.

FITTING IN PLACE THE INPUT SHAFT

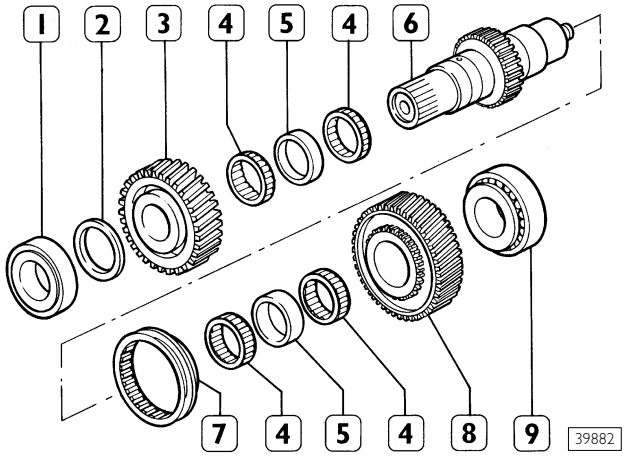
Figure 32



39894

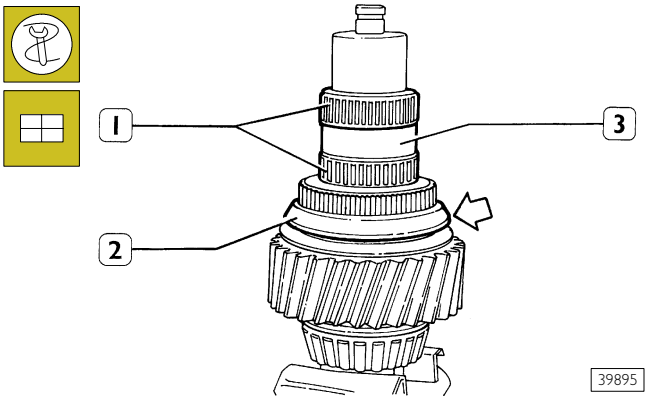
Clamp the shaft (3, Figure 32) in a vice, fit in place the roller bearings (4, Figure 33), with spacer (5, Figure 33), connect the gear (2, Figure 32) with the meshing tooth towards the sliding sleeve, fit the spacer ring (1, Figure 32).
Heat the roller bearing inner ring (1, Figure 33) to 80 °C - 90 °C and fit it on the shaft.

Figure 33



INPUT SHAFT COMPONENTS
1. Bearing - 2. Spacer ring - 3. Gear - 4. Roller bearings - 5. Spacer ring - 6. Shaft - 7. Sliding sleeve - 8. Gear - 9. Bearing

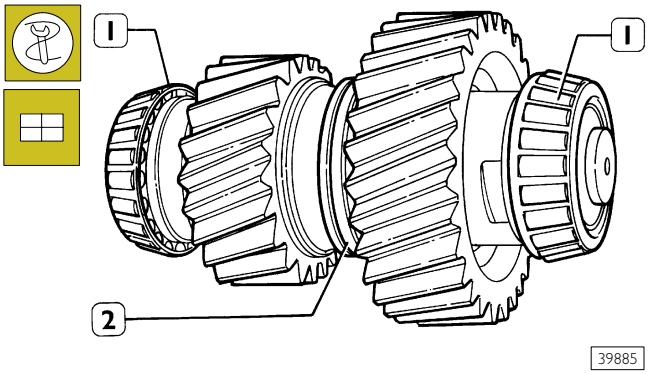
Figure 34



Turn the shaft over and clamp it in a vice.
Fit in place the sliding sleeve (2) with the flare (arrow) facing upward; fit the roller bearings (1) and spacer (3).
Fit in place the gear (8, figure 33) with the meshing toothset towards the sliding sleeve.
Heat to 80 °C - 90 °C the roller bearing inner ring (9, Figure 33) and fit onto the shaft.

FITTING IN PLACE THE COUNTERSHAFT

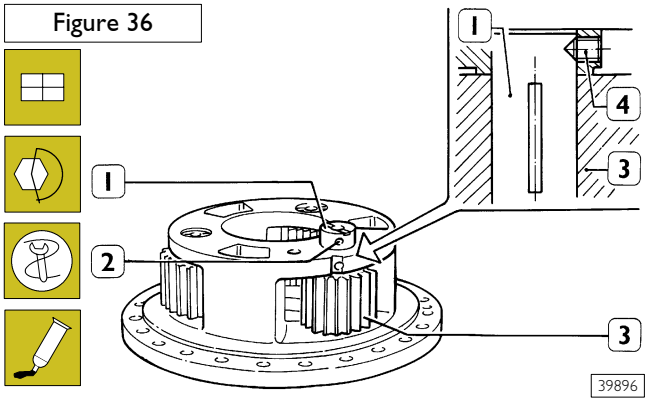
Figure 35



After heating the inner rings to 80° - 90 °C, fit the bearings (1) onto the shaft (2).

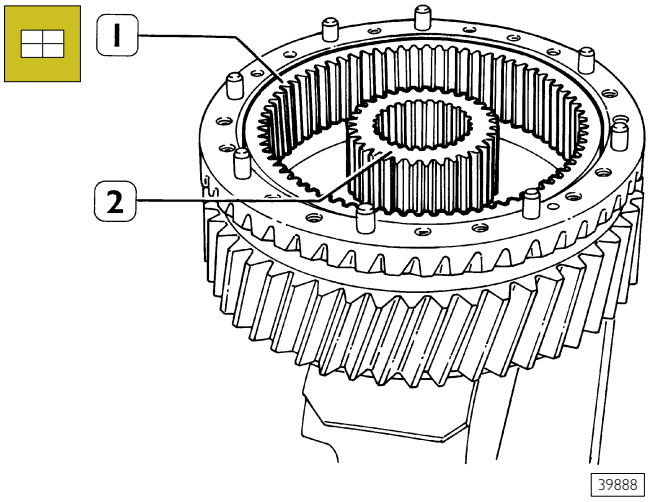
FITTING IN PLACE THE EPICYCLIC REDUCTION GEAR UNIT

Figure 36



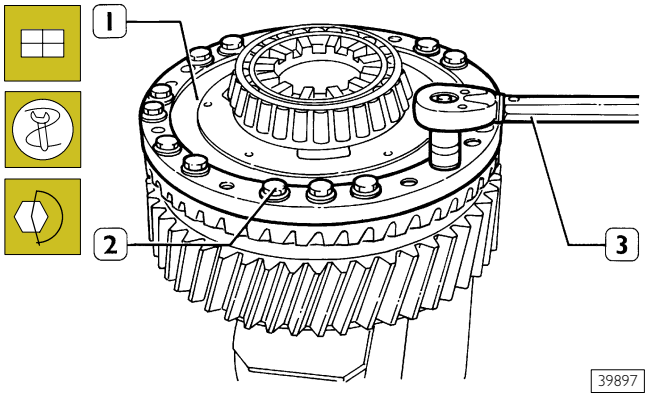
Fit the gears (3) onto the planetary gear carrier, connect the spindle (1) so that the hollow (2) coincides with the set screw hole (4). Apply LOCTITE AVX to the set screw (4) and lock it to a torque of 44 ± 4 Nm. Repeat the operation for the other spindles.
Turn the planetary gears carrier over and, after heating the inner ring to 80 °C - 90 °C, fit the bearing in place.

Figure 37



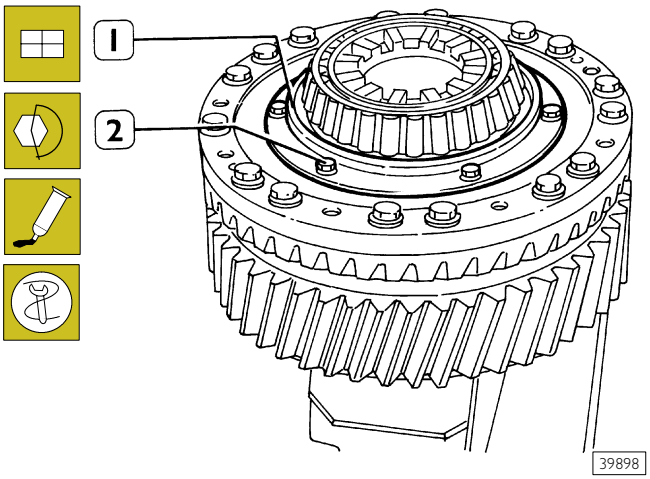
Fit the driving shaft, the planetary gear (2) on the crown wheel (1) and clamp the unit in a vice.

Figure 38



Fit in place the completed planetary gears carrier (1) coinciding the reference pins, tighten screws (2) and lock them with a dynomometric wrench (3) to the prescribed torque.
Turn the unit over and after heating the inner ring of the bearing to 80 °C - 90 °C, fit it in place.

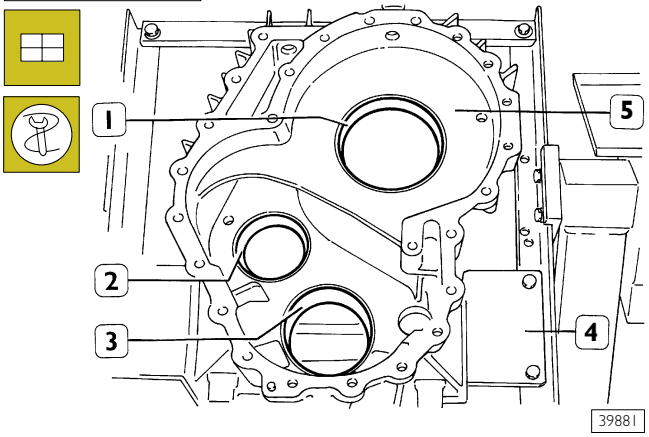
Figure 39



Fit in place the splash guard (1), apply LOCTITE AVX to the screws (2) and tighten them to a torque of 7 ± 1 Nm.
Turn the unit over and fit the bearing after heating the inner ring to 80 °C - 90 °C.

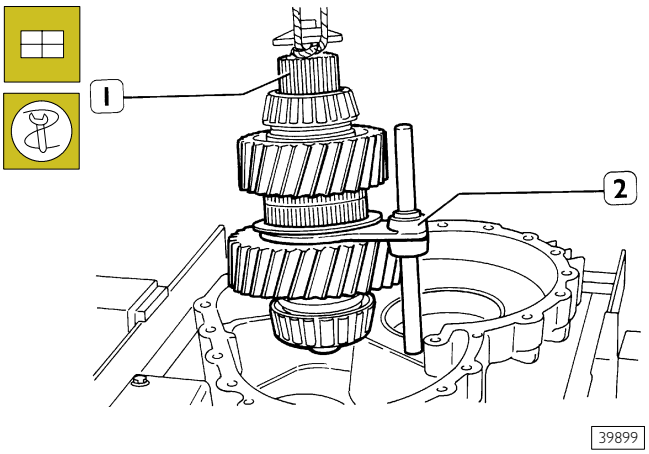
ASSEMBLING THE REDUCTION GEAR UNIT AT THE BENCH

Figure 40



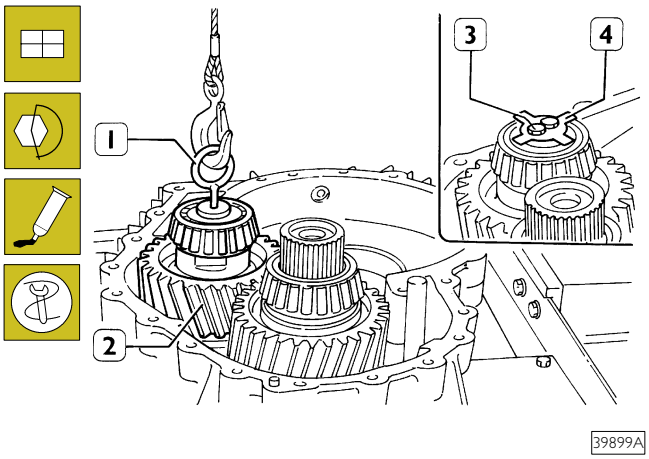
Set the housing (5) on stand 99322205 using brackets 9937105 (4); use the appropriate beater to fit the bearing outer rings (1-2-3).

Figure 41



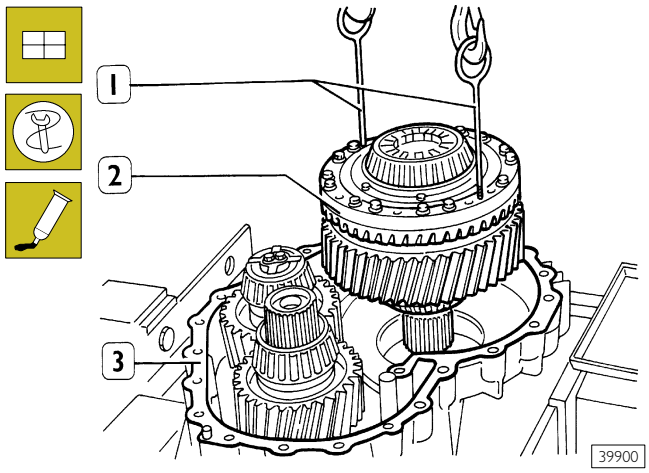
Using a rope and truck lift fit the input shaft (1) with the control fork (2) into the housing.

Figure 42



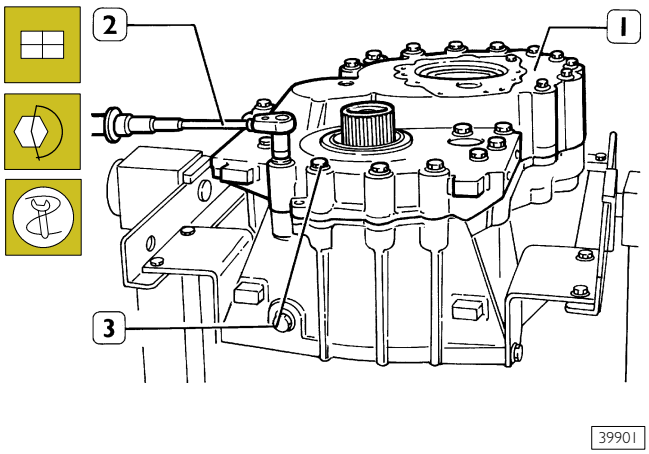
Use eye bolt 99366067 (1) to fit into place the countershaft (2). fit in place the phonic wheel (4), the safety plate and tighten the screws (3) to the specified torque, bend the safety plate.

Figure 43



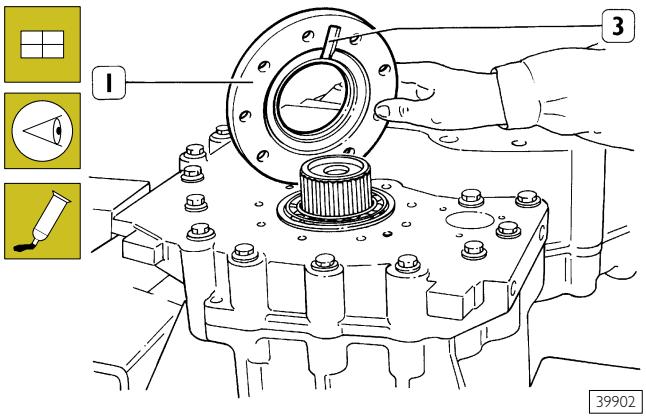
Use eye bolt 99370565 (1) to fit the epicyclic reduction gear (2) into the housing. Fit gasket (3) in the housing.

Figure 44



Fit in place the housing (1) and use a dynomometric wrench (2) to tighten the screws (3) to the specified torque.

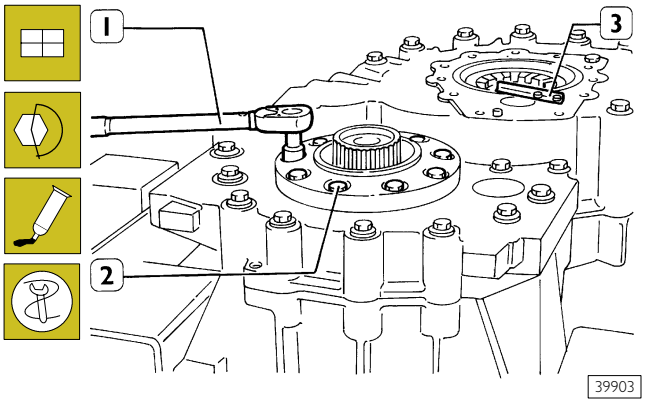
Figure 45



Fit in place the gasket, fit the cover (1) with its seal ring.

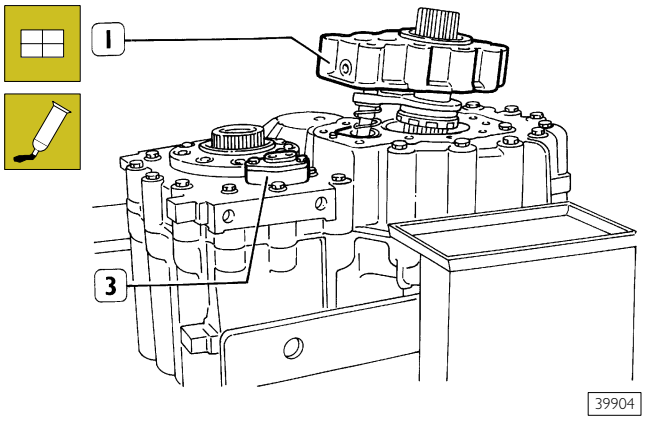
The oil passage (3) must be in the position shown in the figure.

Figure 46



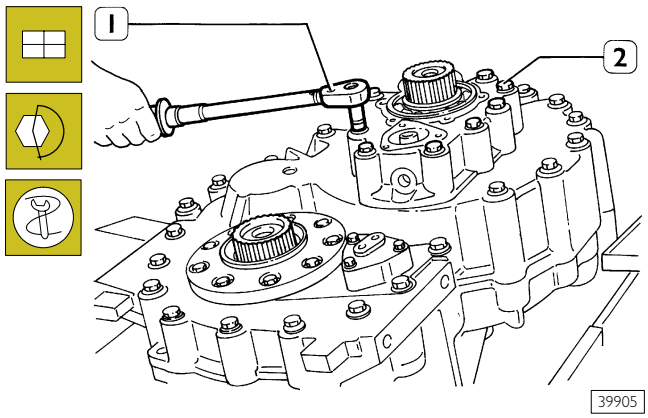
Lock the cover screws (2) with a dynamometric wrench (1) to a torque of 50 ± 5 Nm. Set the locking plate (3) in position, apply LOCTIT AVX to the screws and tighten them to a torque of 4.5 Nm.

Figure 47



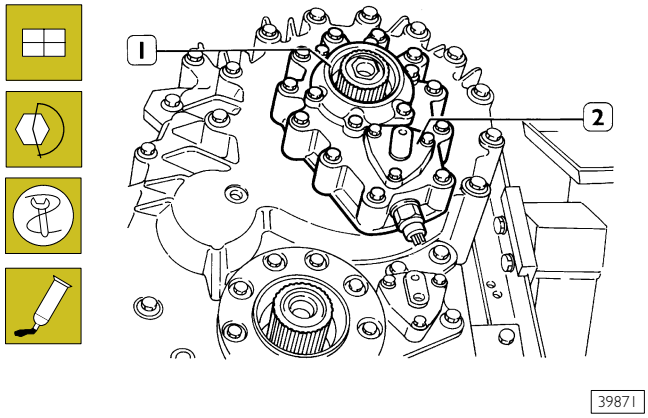
Fit in place the cover (3) with the control piston and internal spring. Fit the gasket and cover (1) together with the shaft and reduction gear control fork.

Figure 48



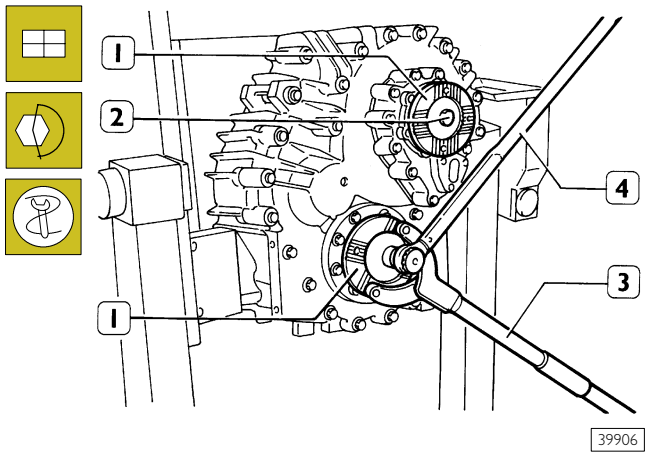
Use a dynamometric wrench (1) to tighten the screws (2) to a torque of 78 ± 8 Nm.

Figure 49



Fit in place the cover (2) with the control piston. Set the gaskets in place, fit cover (1) and tighten the screws to a torque of 30 ± 3 Nm.

Figure 50



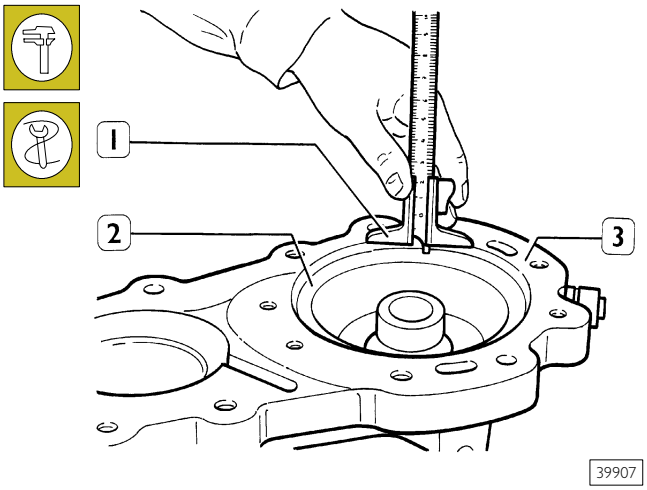
Connect the two flanges (1) fit the washers and with a lever (3) and dynamometric wrench (4) tighten screws (2) to a torque of 500 ± 50 Nm.

ADJUSTMENTS

Shaft bearings pre-load adjustment

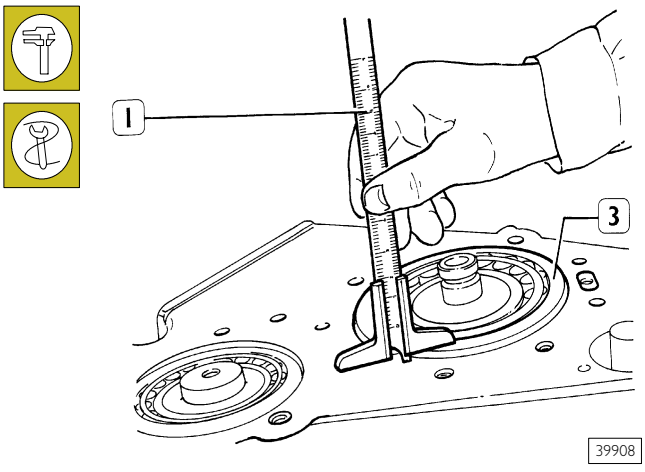
INPUT SHAFT

Figure 51



❑ With a caliper (1), find the depth of the seat(2) for the bearing on the cover (3):

Figure 52

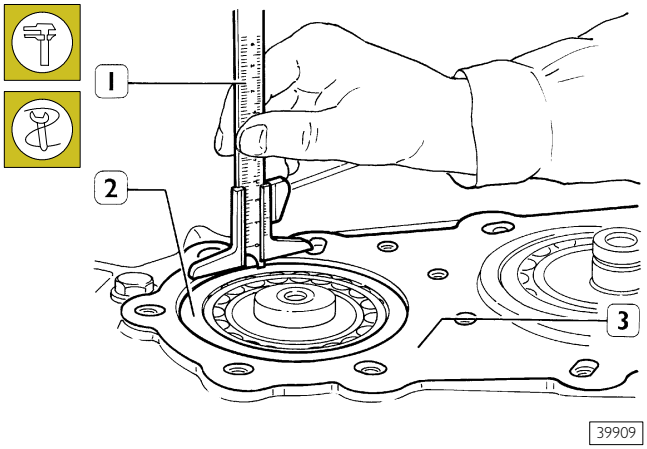


❑ Set the gasket (2) on the housing, and use a caliper (1) to find the protrusion between bearing outer ring (3) and gasket (2).

The difference between these two measurements is the adjusting ring shim; add 0.10 to 0.15 mm (preload) to the value obtained.

COUNTERSHAFT

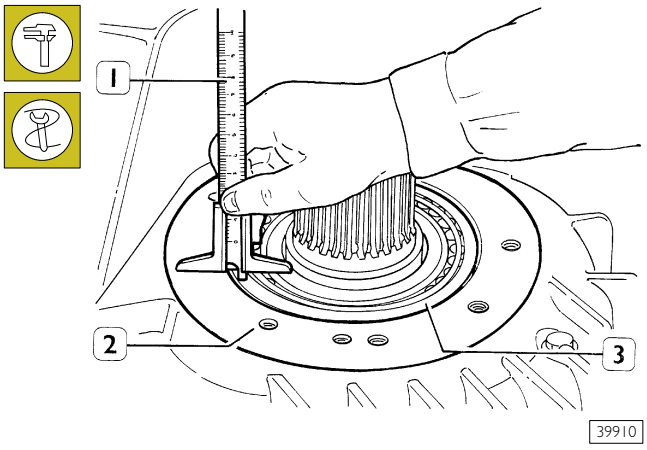
Figure 53



❑ Use a caliper (1) to find the distance between the gasket (3) on the housing and bearing outer ring (2).
Add the specified preload to this value.

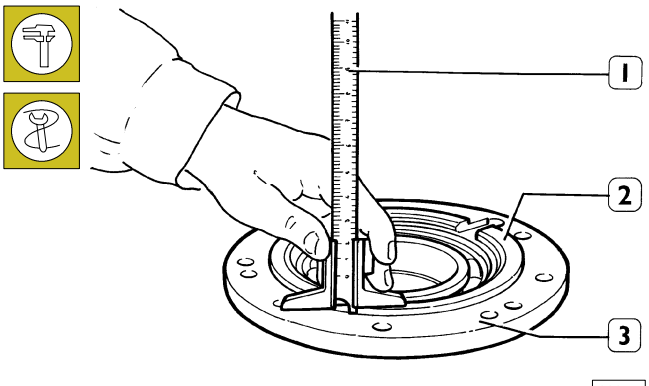
DRIVING SHAFT

Figure 54



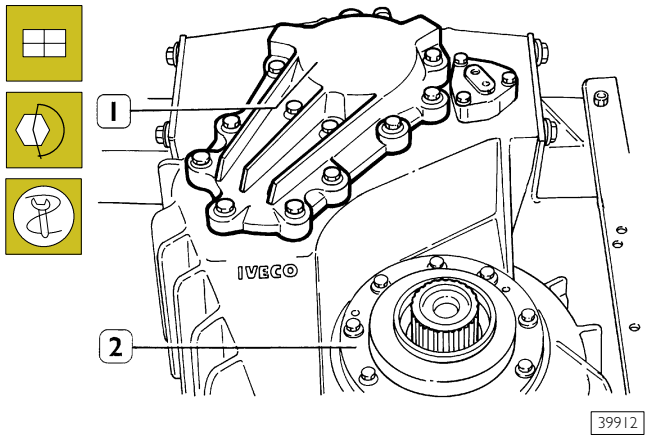
❑ Use a caliper (1) to find the distance between the outer edge of the bearing collar (2) and the cover face (3).

Figure 55



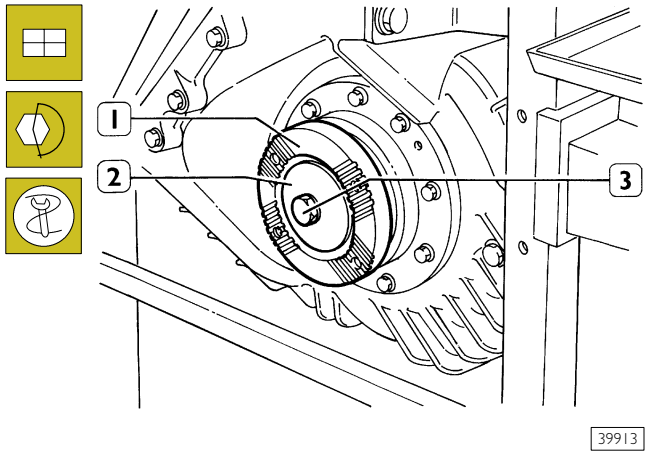
❑ Use a caliper (1) to find the distance between the outer edge of the bearing collar (2) and the cover face (3) The difference between these two measurements is the value for the adjusting ring; add 0.10 to 0.15 mm (preload) to this value.

Figure 56



Fit the adjusting rings, assemble the covers (1-2) and tighten the screws to a torque of 50 ± 5 Nm.

Figure 57



Connect the flange (1), fit washer (2) using a lever and dynamometric wrench tighten the screw (3) to a torque of 500 ± 50 Nm.

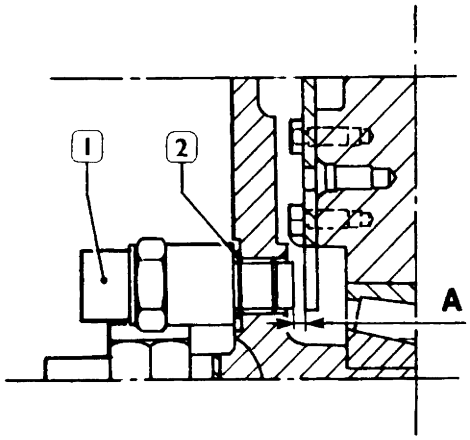
Fit the indication switch and the pulse transmitter and adjust as described in the following paragraphs.

Indication switch adjustment

Screw on the switch to electric contacts closing, screw on once and then tighten the lock nut to the prescribed torque.

Pulse transmitter adjustment

Figure 58



Select the adjusting ring (2) to obtain **A** equal to 2 - 2,8 mm when fitting the pulse transmitter (1).

Tighten oil drain plugs.
Fill the unit with the specified oil.

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PROPELLER SHAFTS

SECTION 10

SECTION 10

Propeller shafts

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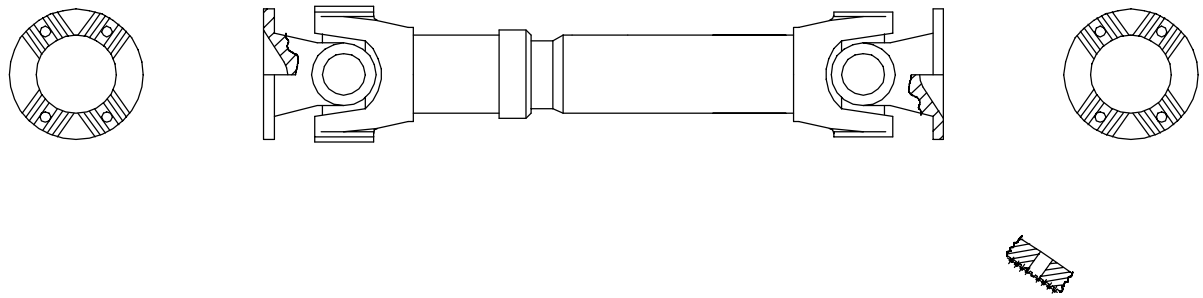
DESCRIPTION

The transmission of motion from the engine-gear unit to the reduction gear unit (if any) and to axle/s is done through the propeller shaft (which may be a single section, or two or three sections with floating support). This is connected to the ends through universal joints.

The front end of the propeller shaft, besides the universal joint, features a splined sliding sleeve that enables the shaft to vary its length to absorb any drive axial displacement, due to rear axle rocking.

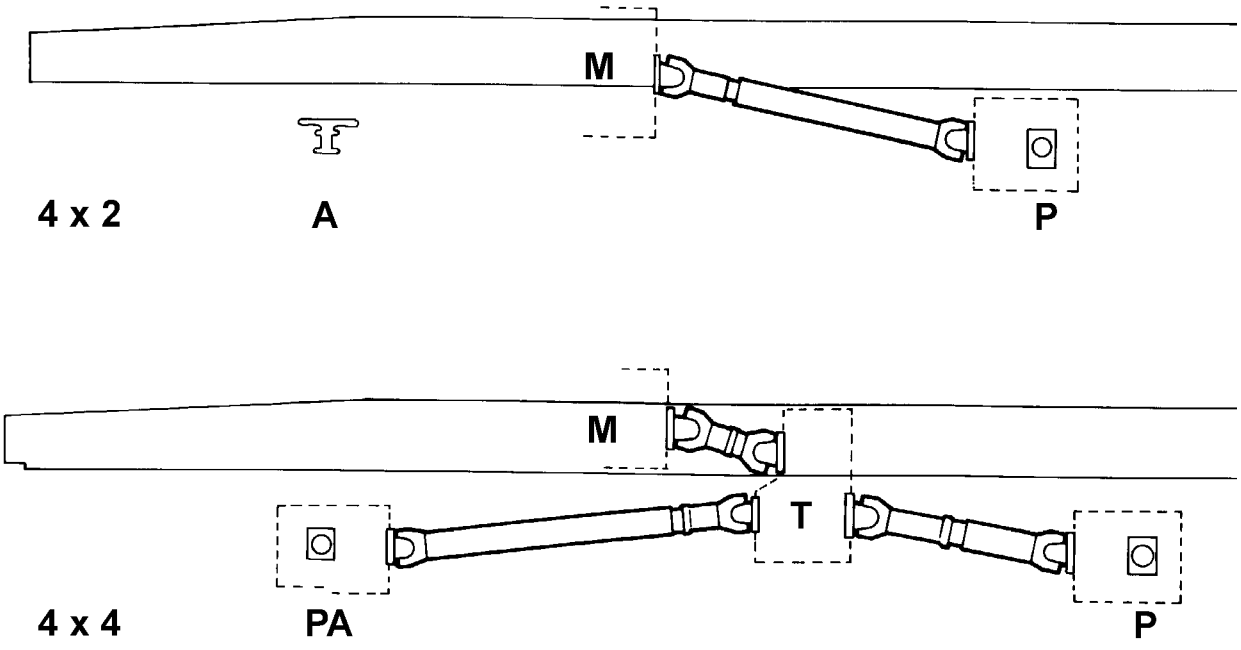
Figure 1



PROPELLER SHAFT

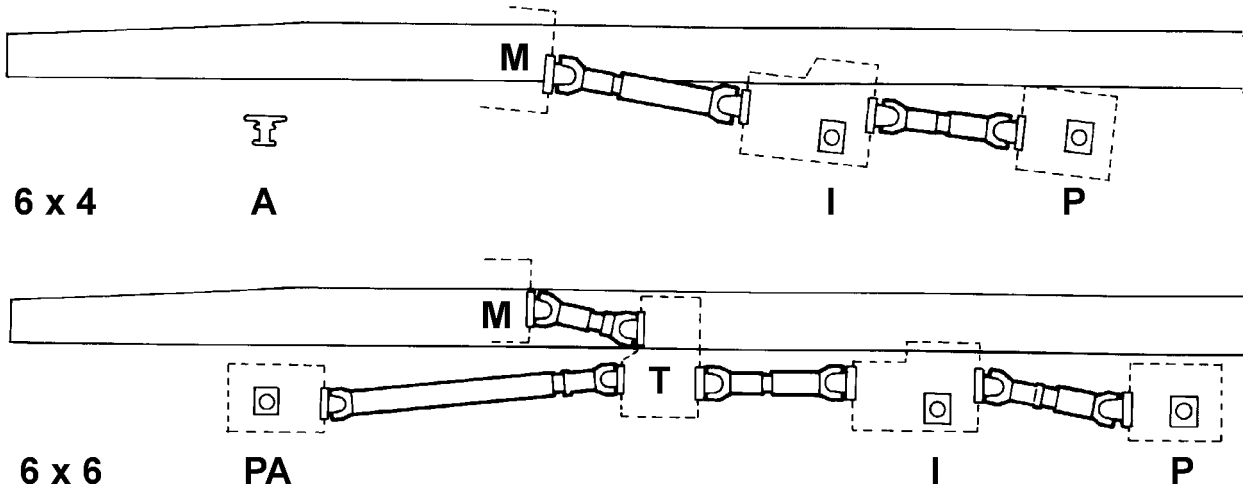
2-axle vehicles

Figure 2



3-axle vehicles

Figure 3

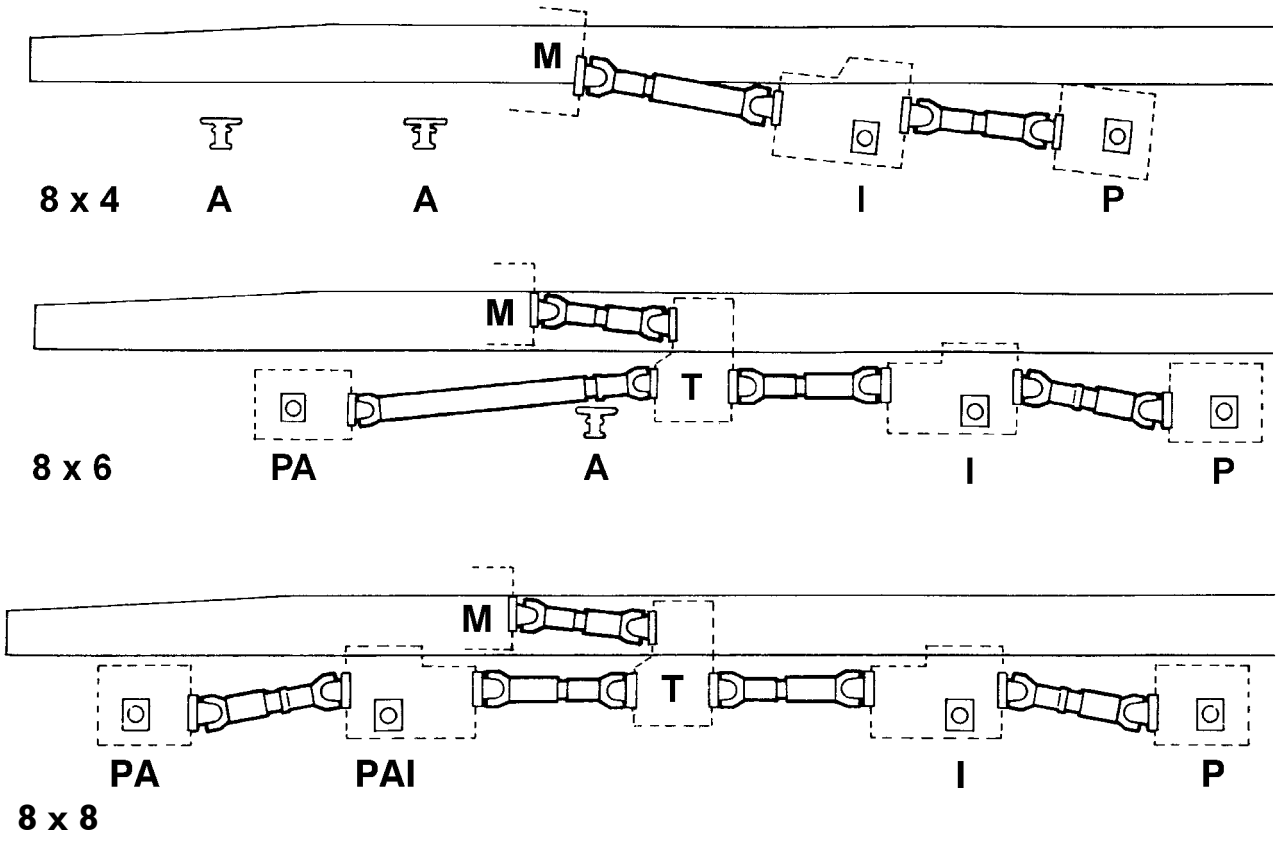


4-axle vehicles

Figure 4

M = engine-gear unit
T = transfer
A = axle

PA = front axle
I = intermediate axle
P = rear axle



DIAGNOSTIC

Propeller shaft operation faults:

1 - Driving noise and vibrations

1 DRIVING NOISE AND VIBRATION

Shaft strain – YES → Replace the shaft

NO

Shaft is out of balance – YES → Check balancing and determine the points where balancing counterweights are to be welded

NO

Spline excessive slack – YES → Replace the shaft

NO

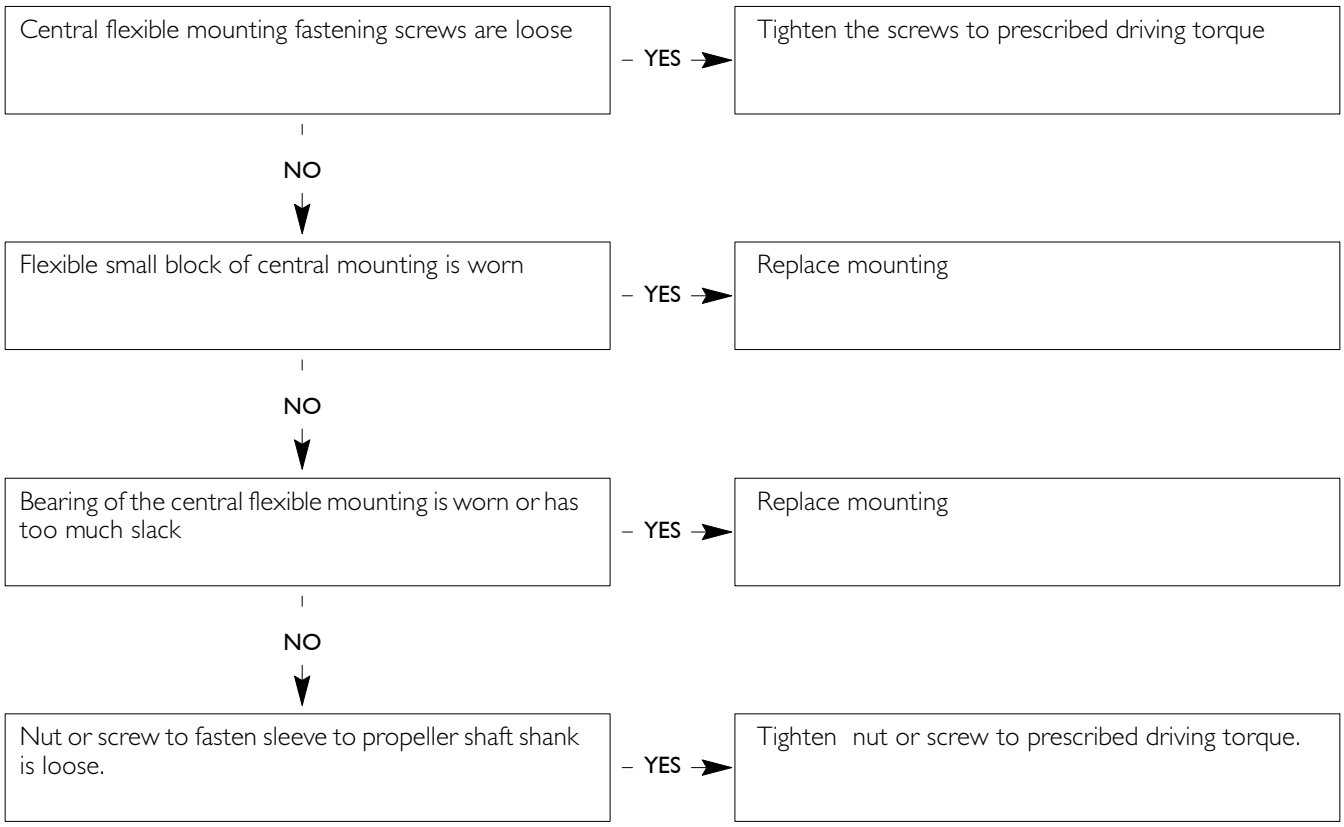
Screws and nuts to fasten the shaft to the sleeves on the gearbox or the rear axle are loose – YES → Check accurately, then tighten loose screws and nuts; if necessary replace any damaged parts.

NO

Propeller shaft universal joints are seized or badly worn – YES → Overhaul or replace the universal joints.

NO

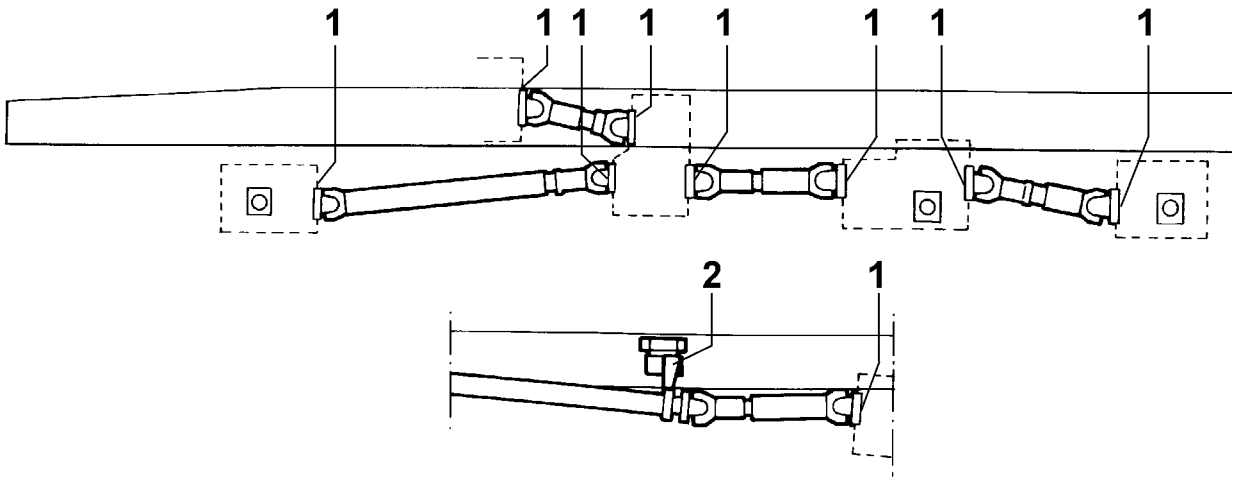
Insufficient lubrication – YES → Lubricate through the specific greasers.


Central flexible mounting fastening screws are loose
YES
Tighten the screws to prescribed driving torque
NO
Flexible small block of central mounting is worn
YES
Replace mounting
NO
Bearing of the central flexible mounting is worn or has too much slack
YES
Replace mounting
NO
Nut or screw to fasten sleeve to propeller shaft shank is loose.
YES
Tighten nut or screw to prescribed driving torque.

TIGHTENING TORQUES

The figure below shows the most complex version and stands valid for every type.

Figure 5



DESCRIPTION		TORQUE	
		Nm	kgm
1. Nut for Flange to propeller shaft fastening screw	(M12 nut thread) (M14 nut thread)	120 190	(12) (19)
2. Nut for bolt fixing propeller shaft flange		146,5	(14,6)

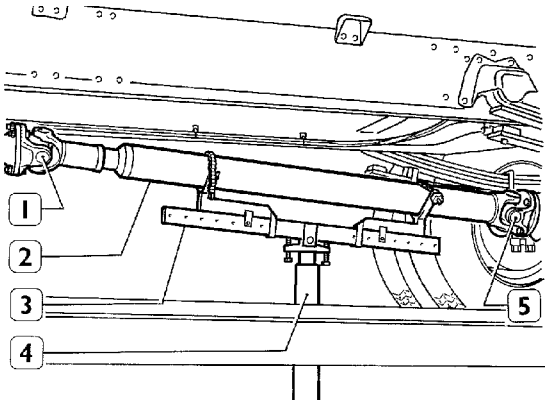
TOOLS

TOOL NO.	DESCRIPTION
99370618	Support to hold propeller shaft during removal and re-fitting in place

REMOVING AND RE-FITTING IN REPAIR OPERATIONS

Place the vehicle on a flat ground and operate the parking brake.

Figure 6

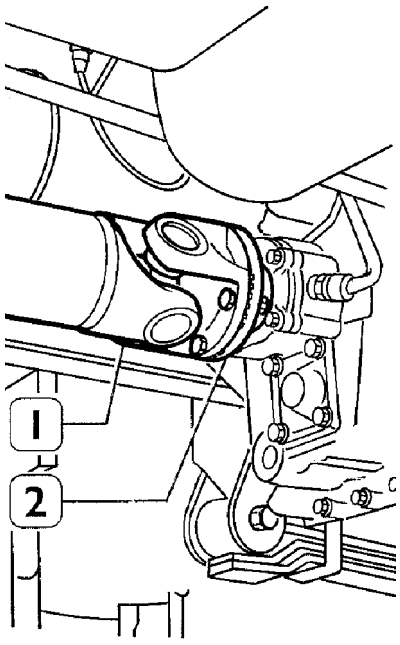


Place a hydraulic jack (4) fitted with support 99370618 (3) underneath the rear propeller shaft (2).

Disconnect the propeller shaft (2) from the rear axle and the flexible support by unscrewing the flange fastening screws and nuts (1 and 5).

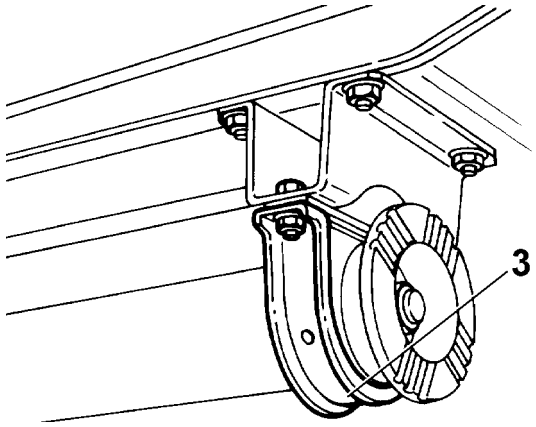
Lower the hydraulic jack completely, thus removing the propeller shaft.

Figure 7



Repeat the same operations for the other propeller shafts (1) disconnecting them from the flange (2) of the connected units.

Figure 8

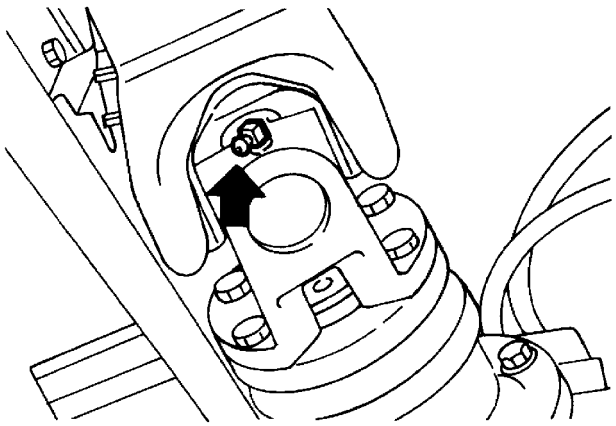


Remove the idle gear, if any.
To refit in place, follow the steps given for the removal in reverse.

A tightening torque lower than the specified one causes stress on the threaded component which can separate from the body to which it is tightened;
a tightening torque higher than the specified one causes excessive distortion of the parts being in touch.

When fitting the propeller shaft assembly on vehicle, take care to position the side with internal keying (sliding fork sleeve) on unit drive output side.

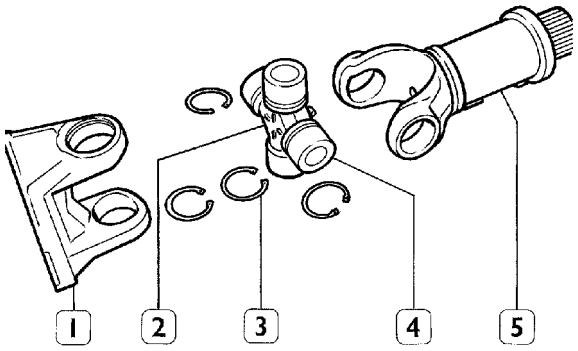
Figure 9



Then, grease the propeller shaft through the grease nipples of a greasing pump.
Check for grease leaking from sealing rings which indicate thorough greasing.

UNIVERSAL JOINT
Removing

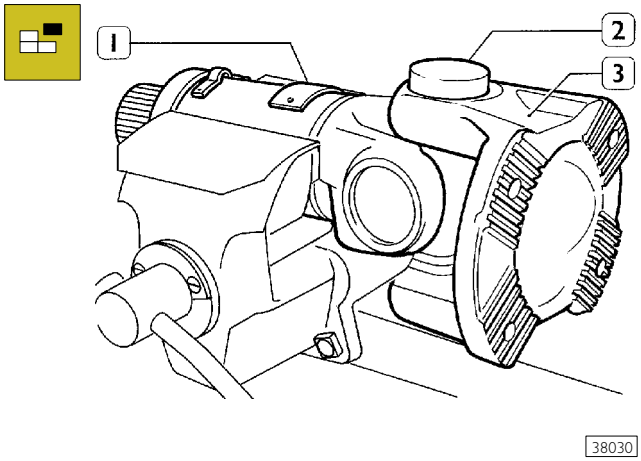
Figure 10



38029

UNIVERSAL JOINT COMPONENTS
1. Fork – 2. Spider – 3. Circlips – 4. Bearings – 5. Sliding sleeve

Figure 11



38030

Clamp the universal joint (1) in a vice.

Punch the sliding sleeve and the main components to obtain reference marks to be followed for correct alignment during assembling.

Using suitable pliers remove the circlips (3, Figure 10).

Use a hammer to beat the fork (3, Figure 11) until the bearing (2) starts to come out from its housing, i.e. when the spider interferes with the fork.

Turn the part over and repeat the above operations.

Manually remove one of the two bearings (2).

Remove the fork (3) and use a punch to remove the other bearing.

Repeat this procedure to remove the bearings from the other fork and free the spider.

To disassemble the opposite joint, repeat the operations described previously.

Cleaning

Wash removed parts with oil or petrol keeping parts immersed for the time necessary to remove any particles of hardened grease.

Clean accurately every part by hard bristle brush and dry with compressed air jet.

Checks

Propeller shafts are supplied ready for use.

They are balanced statically and dynamically; it is however possible to check correct static balancing and eccentricity during complete overhaul.

Perform the following operations:

- ❑ position the propeller shaft on a centering tester;
- ❑ turn the shaft around its own axis and with a dial gauge previously set to zero, check that eccentricity of the propeller shaft on the central tubular part is not over 0.5 mm;
- ❑ move the dial gauge towards the ends of the propeller shaft;
- ❑ eccentricity must not exceed 0.3 mm;
- ❑ should higher values than the specified one be found, straighten and balance the shaft by means of suitable press and equipment, these operations shall be carried out by skilled workers.

The plates welded to the propeller shafts are balancing plates.

Should these plates be missing, the shaft must be balanced again.

Inspect the splines for wear and check whether the tubular part of the shaft shows weld defects or cracks; replace the propeller shaft if it has any crack, wear or distortion.

Check whether forks show cracks, wear or distortions.

Slight notches or burrs can be removed by an abrasive stone.

Check spiders, these must not show cracks.

Needle bearing pins must not show scratches or wear signs.

Using a propeller shaft not balanced correctly or in defective conditions, causes vibrations which can become unacceptable in certain cases, and **can be extremely dangerous** for the units but also for the driver since breaking of the propeller shaft can result in disastrous effects.

Assembling

To dis-assemble the opposite joint, repeat the operations described above.

Insert the spider into the joint fork and in the fork-sleeve. Fit in place the bearings with the rollers on the spider pins, then fit the circlips.

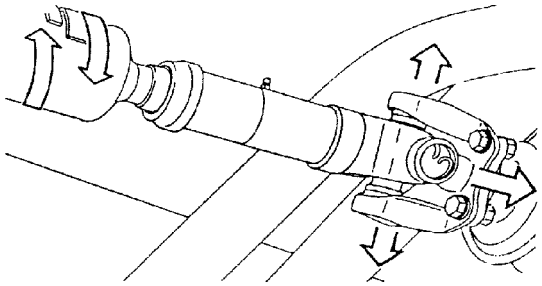
When assembling the spiders, take special care to the correct fitting of circlips in their housings.

When fitting the shaft, check also that alignment reference marks, performed before disassembling, coincide perfectly.

A wrong connection can result in noisy propeller shaft and can cause wear or damages to the whole drive line.

CHECKING THE PROPELLER SHAFTS ON THE VEHICLE

Figure 12



23808

The propeller shafts are supplied by the manufacturer as units ready for assembly.
They are statically and dynamically balanced.

The plates welded to the propeller shafts are counterweights. If the plates are missing the shaft must be re-balanced.
Operating on the propeller shaft and at the same time, in the opposite direction, on the sliding sleeve (arrows) check that there is not too much slack between the splines.
Operating on the sleeve forks (arrow) check that the spiders are not worn; if they are, replace them as described above.

AXLE

SECTION 11

SECTION 11

Axle

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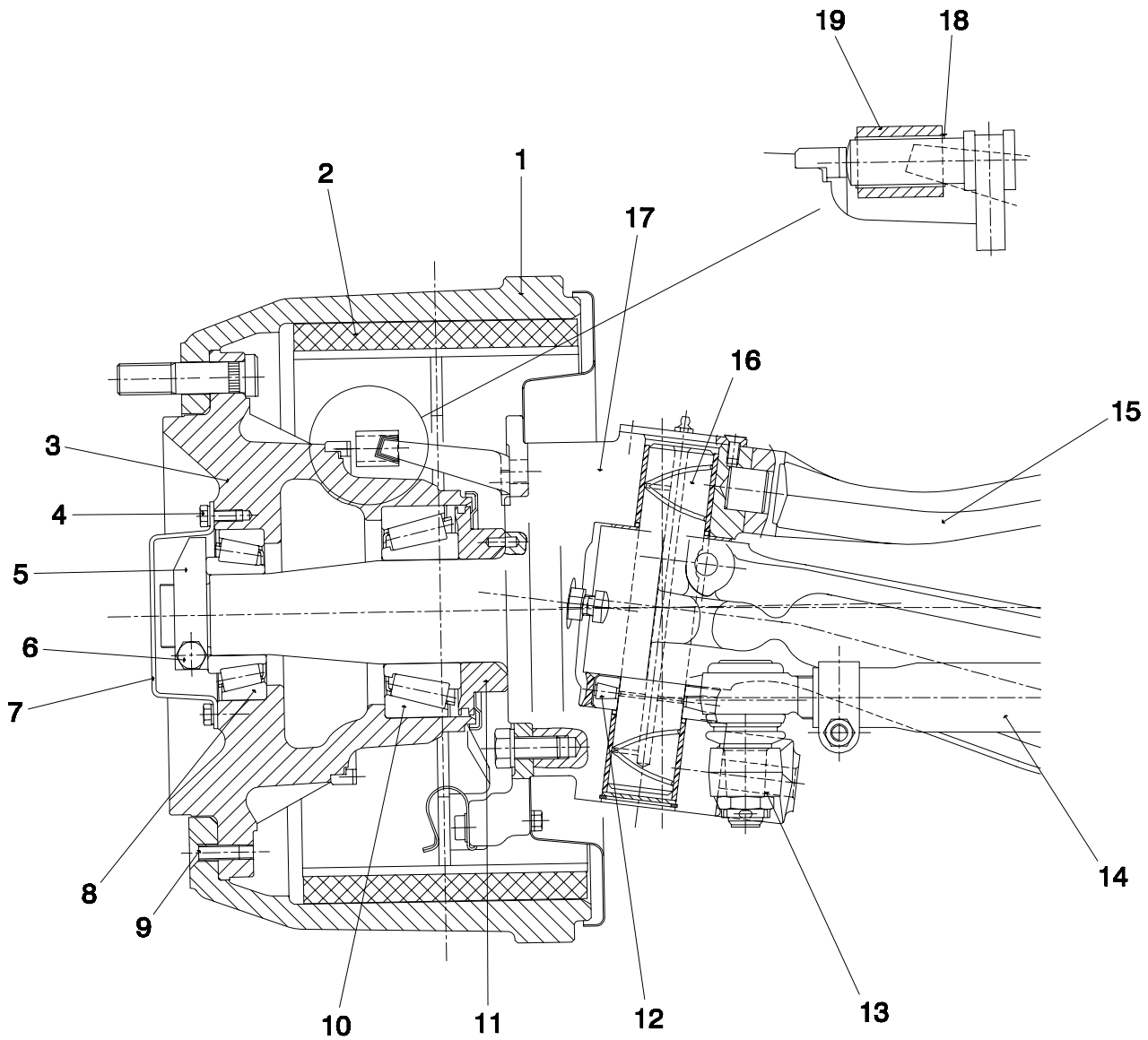
DESCRIPTION

The front axle is constructed in high tensile pressed steel, with double "T" end section where the stub axles are joined. The stub axle articulation takes place through taper pins built in the axle body, and through four bronze driven roller bearings in the overhang holes of the stub axle.

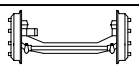
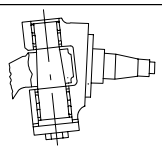
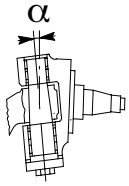
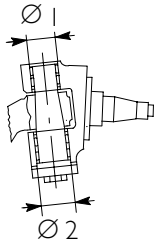
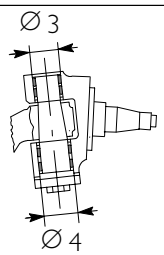
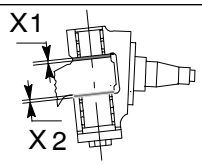
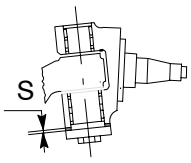
The wheel hubs are supported by two "set right" taper roller bearings, oil lubricated, fitted on the stub axle shank. Adjustment is performed through threaded ring nuts.

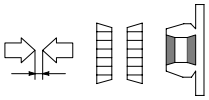
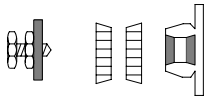
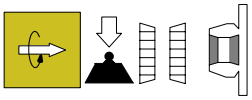
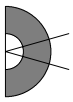
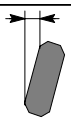
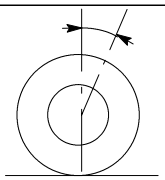
Figure 1



1. Brake drum – 2. Brake shoe – 3. Hub – 4. Hub cover fixing screw – 5. Bearing ring – 6. Bearing ring locking screw – 7. Hub cover – 8. Front taper roller bearing – 9. Brake drum fixing screw – 10. Rear taper roller bearing – 11. Bearing ring – 12. Kingpin axial taper roller bearing – 13. Ball joint – 14. Steering arm – 15. Axle – 16. Kingpin – 17. Stub axle – 18. ABS sensor (if any) – 19. ABS phonic wheel (if any)

CHARACTERISTICS AND DATA

	Type of axle		ASTRA 9820
	**SWIVEL AXLE PINS**		
	Inclination of swivel pin housings		7°
	Diameter of roller bearing housings on the swivel axle - upper housing Ø 1 - lower housing Ø 2	 mm mm	 52,5 ÷ 52,53 52,5 ÷ 52,53
	Outside diameter of roller bearings for swivel axle - upper bearings Ø 3 - lower bearings Ø 4	 mm mm	 52,67 ÷ 52,75 52,67 ÷ 52,75
	Swivel axle bearings	mm	0,14 ÷ 0,25
	Play between axle and upper facing of swivel axle X1 Clearance between axle and lower facing of swivel axle X2	mm mm	0,10 0
	Shims to adjust X1, X2		
ASTRA PARTS	> 0,25 mm S	mm	0,8 - 1,0 - 1,2

	Type of axle	ASTRA 9820
	**WHEEL HUBS**	
	Wheel hub bearings	2, taper rollers
	Wheel hub bearing end play	mm max 0,16
	Wheel hub play adjustment	using adjustment ring nut
	Rolling torque Bearing preloading	da Nm 0,50 max.
	Oil for wheel hub bearings	Tutela W 140/M DA
	Quantity per hub Litres (kg)	0,35 (0,32)
	**WHEEL GEOMETRY**	
	Camber angle (vehicle with static load)	1°
	Castor angle (vehicle with static load)	+ 3°

DIAGNOSTIC

Main possible faults:

1 - Wheels hard to steer;
2 - wheel shimmy;
3 - wheel rolling noise.

1 WHEEL HARD TO STEER

Front axle not perfectly aligned – YES → Re-align correctly and tighten leaf spring U-bolt nuts to the specified torque.

NO

Incorrect wheel toe-in – YES → Re-adjust front wheel toe-in.

NO

Incorrect tyre pressure – YES → Inflate tyres to specified pressure.

NO

Insufficient lubrication of kingpin – YES → Lubricate accurately.

NO

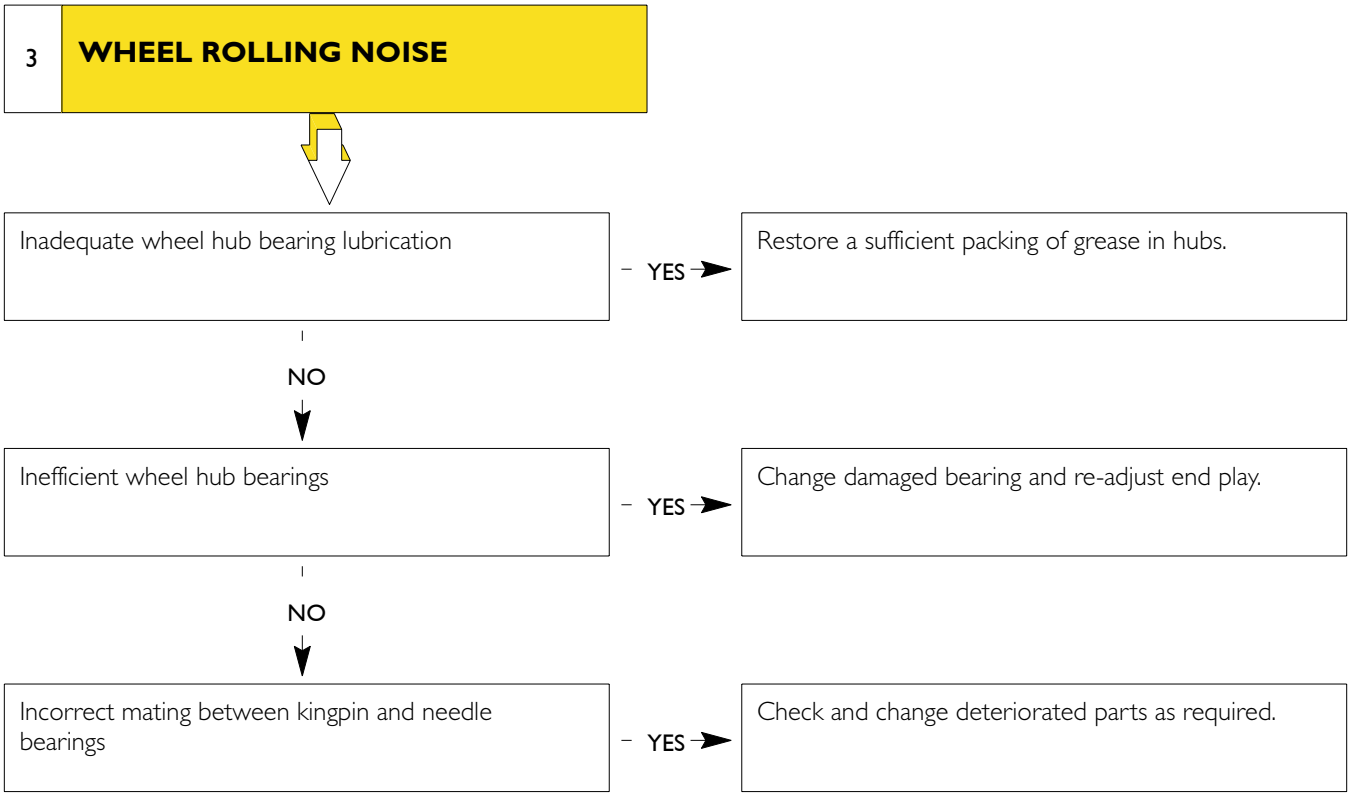
Incorrect steering knuckle to axle mating – YES → Re-adjust accurately to specified limits.

NO

Parts concerned with steering knuckle rotation on kingpin inefficient – YES → Check all parts and replace as required.

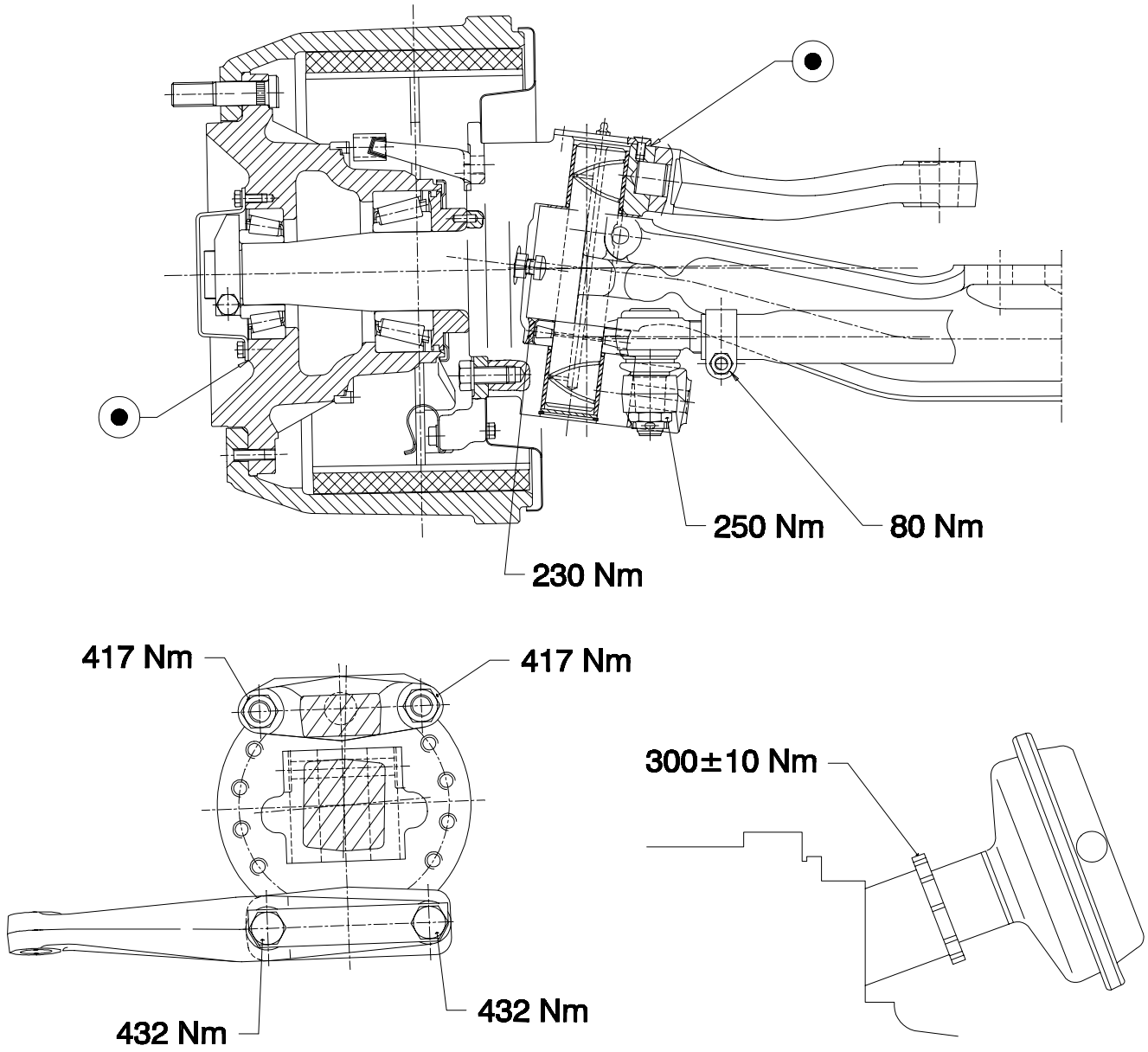
2 WHEEL SHIMMY

Wheel caster incorrect	YES →	Check axle assembly, repair and change distorted parts as required.
NO ↓		
Front axle not perfectly aligned	YES →	Re-align correctly and tighten leaf spring U-bolt nuts to the specified torque.
NO ↓		
Incorrect wheel toe-in	YES →	Re-adjust correctly.
NO ↓		
Inefficient steering linkage ball joint	YES →	Change defective parts.
NO ↓		
Incorrect wheel hub bearing play	YES →	Re-adjust end play after changing parts as required.
NO ↓		
Wheels incorrectly centered: rim not centered, distorted tyre fitted to wrong rim	YES →	Change the faulty rim.. Deflate and centre tyre on rim.
NO ↓		
Wheels incorrectly balanced	YES →	Carry out wheel balancing.


3
WHEEL ROLLING NOISE
Inadequate wheel hub bearing lubrication
YES
Restore a sufficient packing of grease in hubs.
NO
Inefficient wheel hub bearings
YES
Change damaged bearing and re-adjust end play.
NO
Incorrect mating between kingpin and needle bearings
YES
Check and change deteriorated parts as required.

TIGHTENING TORQUE

Figure 2



● Assemble applying LOCTITE 510

TOOLS

TOOL NO.	DESCRIPTION
99305111	Device for axle testing
99321024	Hydraulic truck to remove and re-fit in place the wheels
99322215	Stand for axle testing
99347068	Puller for drag link kingpins
99389819	Dynamometric wrench
99395026	Tool for testing hubs rolling torque (to be used with 99389819)
99370593	Stand
0/72068	Tool for stripping down and refitting stub axle bushings

REMOVING AND REFITTING THE AXLE

Removal

To remove the axle proceed as follows:

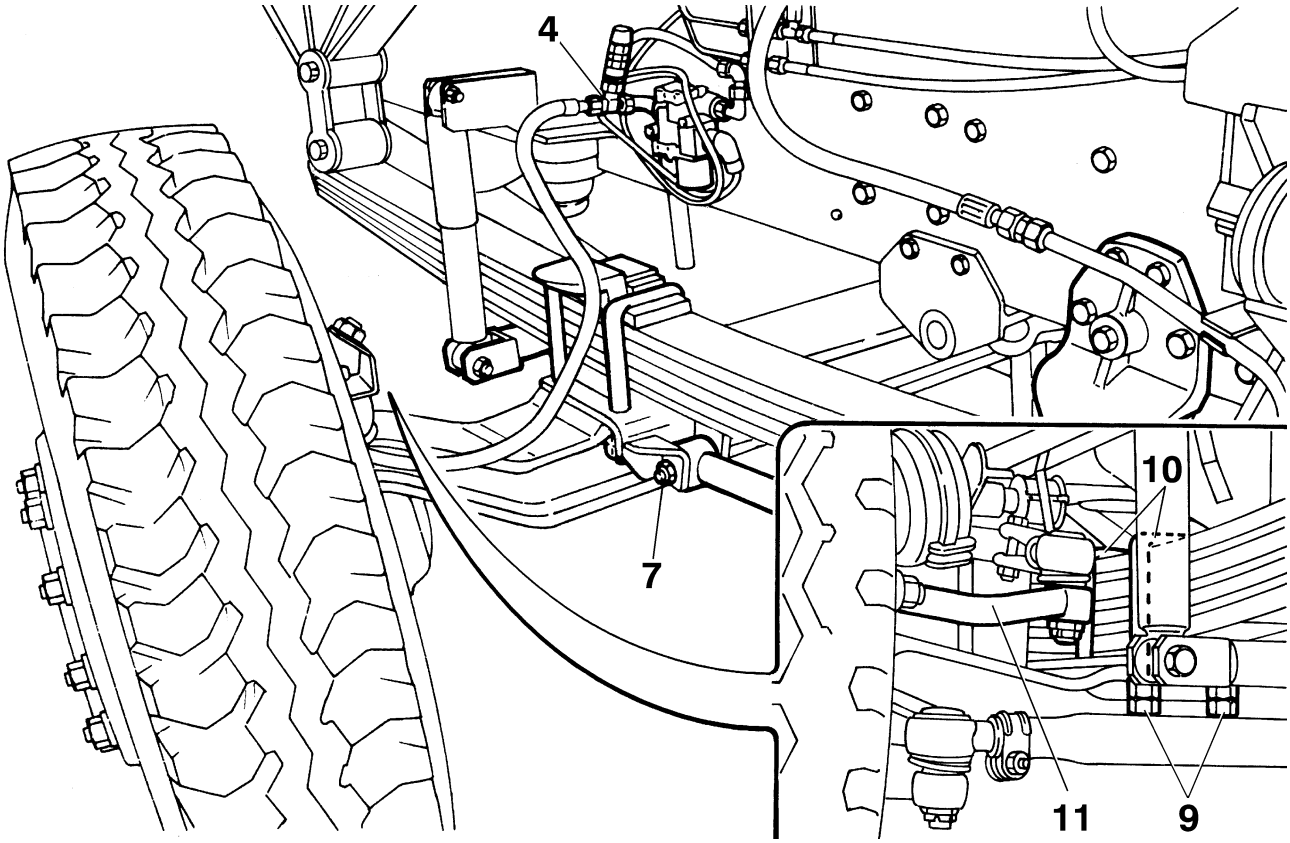
- ❑ place the vehicle on a flat ground and suitably lock the rear wheels;
- ❑ loosen both front wheel fastening nuts;
- ❑ using a hydraulic jack lift the front of the vehicle and rest it on two stands;
- ❑ remove both front wheels;
- ❑ disconnect ABS transmitter electrical cables from both sides (only vehicles provided with ABS);
- ❑ disconnect brake air delivery pneumatic connections (4) from both sides,
- ❑ disconnect the steering rod unscrewing the joint fitting securing nut (11);
- ❑ remove the bolts (7) fixing the stabilizer bar to the axle and rotate it downwards;
- ❑ set a hydraulic jack fitted with tool 99370617 under the axle;
- ❑ unscrew the nuts (9) from both sides, lift the leaf spring fixing brackets (10), lower the axle and take away the leaf spring.

Refitting

To refit, follow the removal operations in reverse order.

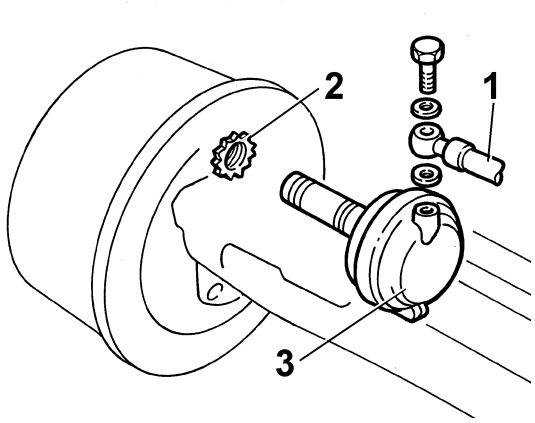
When refitting, check front wheel toe-in as described in Section 15.

Figure 3



DISASSEMBLING

Figure 4



Disassemble the brake drum (1) from the hub, and then remove the cover. Loosen block locking bolt (6) and the block (5); then take out the hub (3) and the outer bearing (8). Use a universal puller if required; take out the inner bearing (10) and the spacer (11) complete with grease guard seals from stub axle (17).

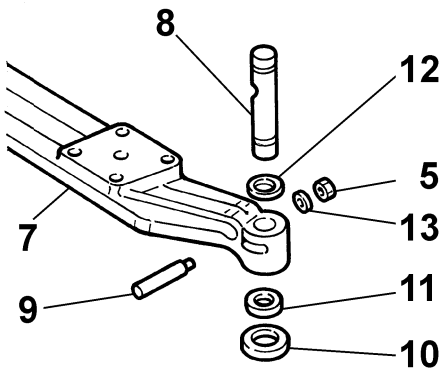
Continue disassembling removing the diaphragm-type brake booster connecting pipe (1), loosen the ring nut (2), then remove the diaphragm-type brake booster and take out the wedge acting on brake shoes.

Remove brake block fixing screws and take away the entire brake block. Disconnect the track rod (14) and levers thereof from stub axle.

Remove the upper plate, the seeger ring and the plate.

Loosen nut (5) and remove the lockpin (9) from the kingpin. Use a beater to take out the kingpin (8) from its housing and remove it. Should this operation be difficult, use a press to remove the kingpin (8).

Figure 5



CHECKING DISASSEMBLED PARTS

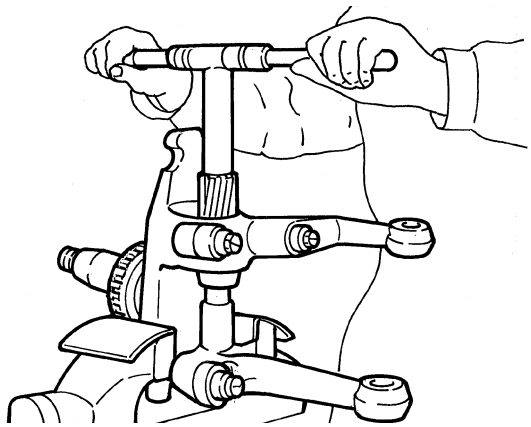
Clean disassembled parts accurately.

Check clearance between pin and stub axle bushing. Should the clearance value found be higher than 0.25 mm, check whether wearing affects the pin only (replace it) or also the bushing. If the bushing is worn, replace it.

To replace bushings use a press and tool 0/72068.

Ream, if required, after fitting the bushings (Figure 7).

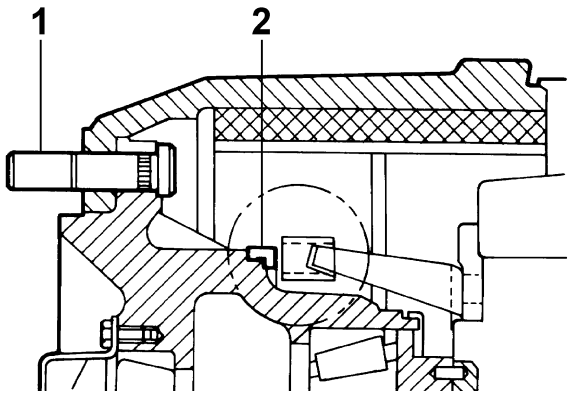
Figure 6



When replacing the wheel studs (1) check whether stud head supporting surface is free from slags and burrs. Fit studs applying a load not exceeding 2500 kg and check whether there is no clearance between hub surface and screw under-head.

To replace ABS phonic wheel, heat ring (2) to 150 °C and fit it down accurately.

Figure 7

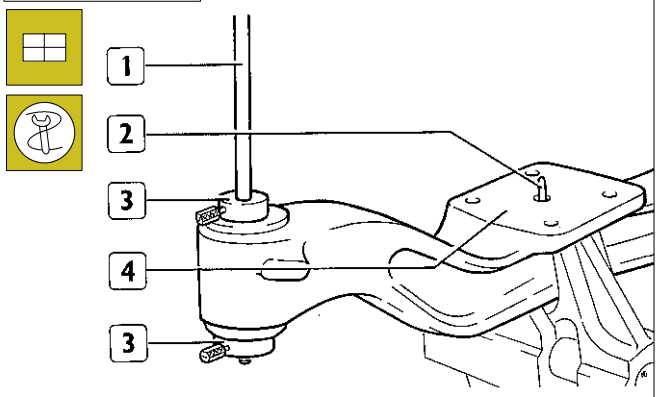


AXLE BODY CHECKS AND MEASUREMENTS

Leaf spring contact surfaces check using gauge 99305111

Set the two rods (1) with the cones (3) in the kingpin holes; press down the cones and lock them in position with the screws on the rod.
Insert the two set screws (2) in the seats on the leaf spring contact surface.

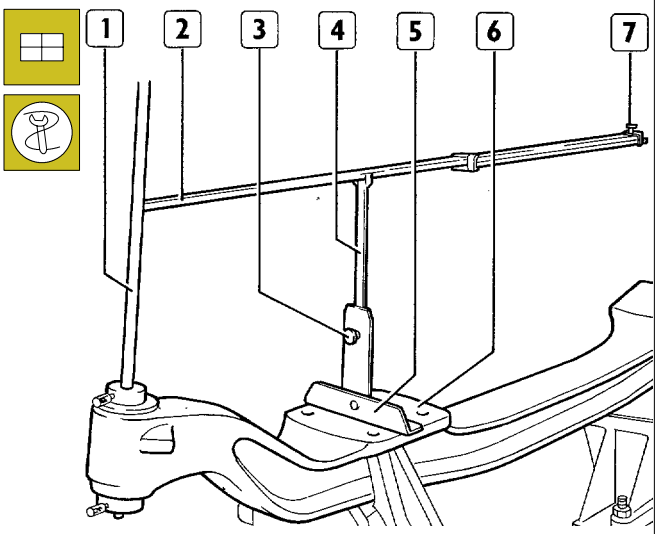
Figure 8



Set the bases (5, figure 10) with goniometers on the surfaces (6) and insert the set screws.

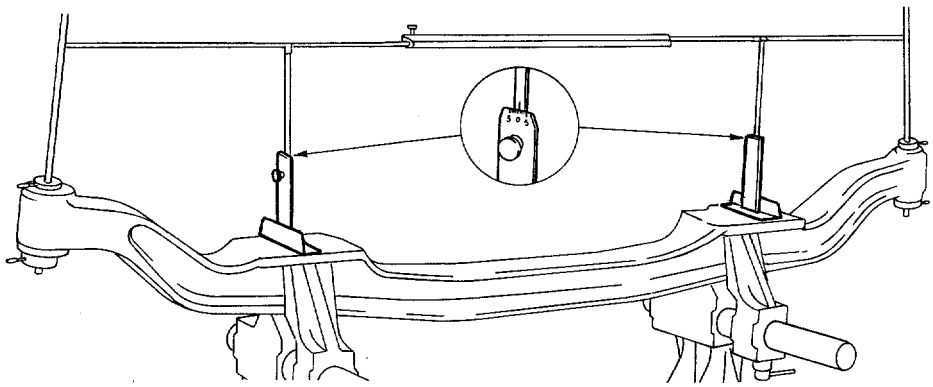
Before placing the bases with the goniometers, make sure that there is no paint or roughness on the contact surfaces.

Figure 9



Set the sliding bar (2) on the goniometer rods (4), adjusting the length so that the shaped ends remain inserted in the rods (1) Lock the clamp screw (7) and the screws (3) that fasten the goniometer to the rods (4)

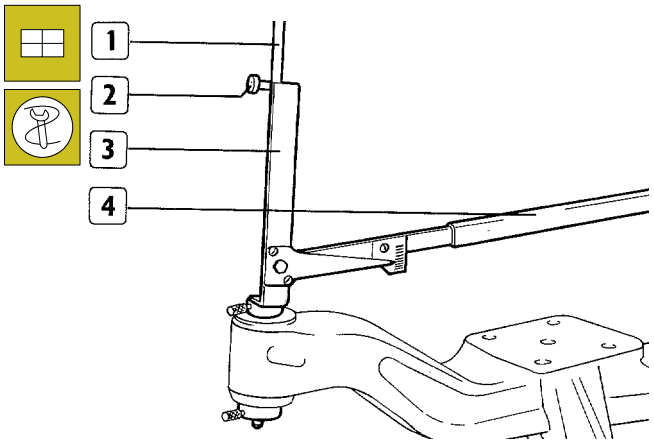
Figure 10



Check for deviation angles on the goniometer scaled sections indicated by the arrows.
The goniometer indicators do not indicate any angular displacement when the planarity of the leaf spring contact surface with reference to the stub axle pin holes is correct.
Remove the sliding bar and the bases with goniometer.

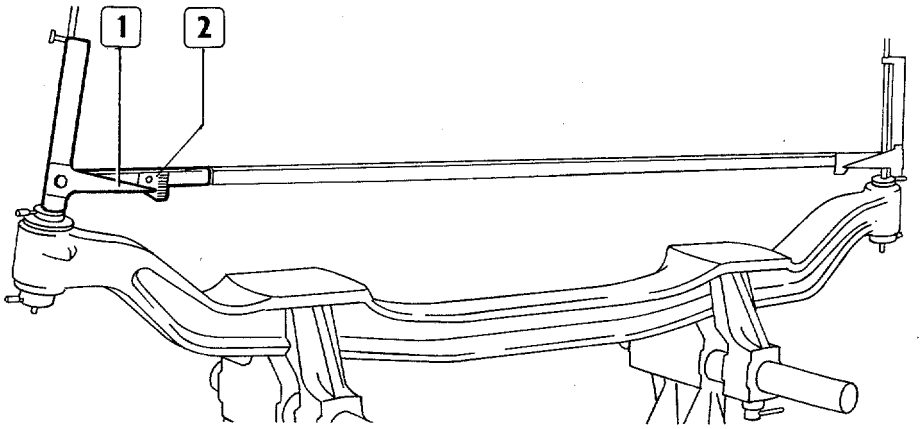
Checking inclination of kingpin boss bores with gauge 99305111

Figure 11



Set the supports (3) with goniometers on the rods (1) and slightly turn the screws (2) without locking them.
Insert the coupling track rod (4) and tighten the screws (2) that fasten the supports in the rods (1)

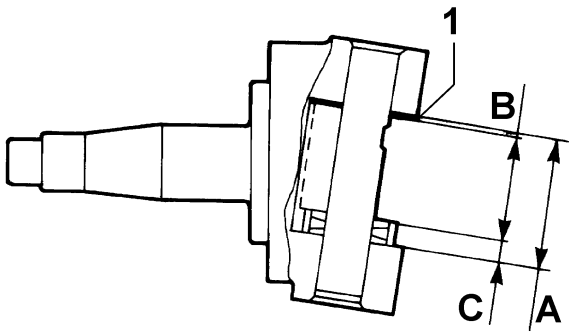
Figure 12



Read the kingpin holes camber angle value in the relevant scaled sectors (2) according to the indicators (1).

REFITTING

Figure 13



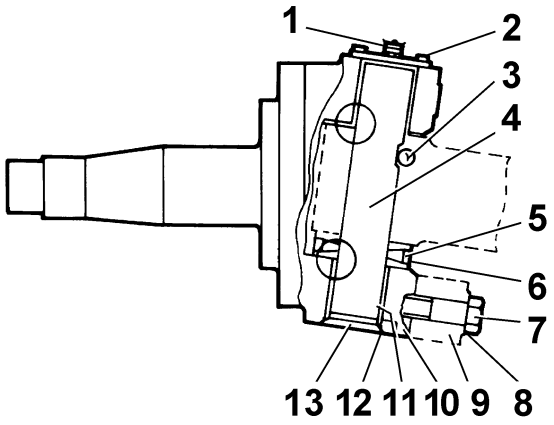
Before refitting the kingpin, it is essential to find the thickness of the shims (1) to be inserted between stub axle overhang holes and axle eye. Proceed as follows (Figure 14):

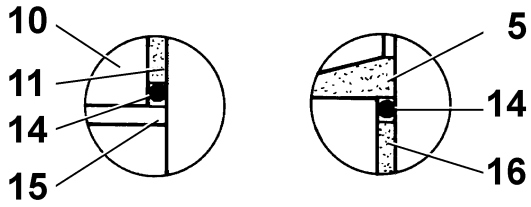
- ❑ find the distance between the two stub axle bushing housings (value "A").
- ❑ find axle eye thickness (value "B") and thrust bearing thickness (value "C").

Shims to be inserted between axle and stub axle shall be equal to:

S = A - (B + C) - 0.10 [mm]

Figure 14





1. Screw – 2. Cover – 3. Kingpin taper lockpin – 4. Kingpin – 5. Taper roller bearing – 6. Bearing protection – 7. Screw – 8. Catch – 9. Lever – 10. Bracket – 11. Bushing – 12. Seeger ring – 13. Cap – 14. O-ring – 15. Shim – 16. Bushing

Insert the O-rings (14) laying on bushings (11 and 16) into kingpin housing. Grease the O-rings and the bushings.

Couple axle kingpin inserting in the lower part the thrust bearing complete with dust cover, and in the upper part the previously selected shims.

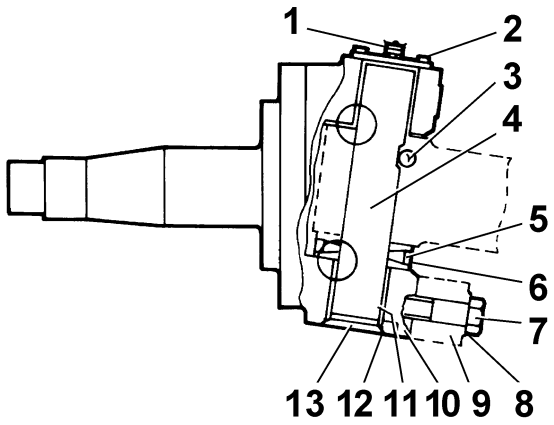
Insert the central pin so as to make the notch and the axle hole coincide to fit the taper pin (3).

Insert taper lockpin (9, Figure 6) and tighten the nut (5, Figure 6) to 80 Nm; then use a hammer to beat the non-threaded side to fit down the pin into its housing perfectly.

Tighten the nut again to 122.5 Nm torque.

Direct the chamfer towards the kingpin when inserting the lockpin.

Figure 15



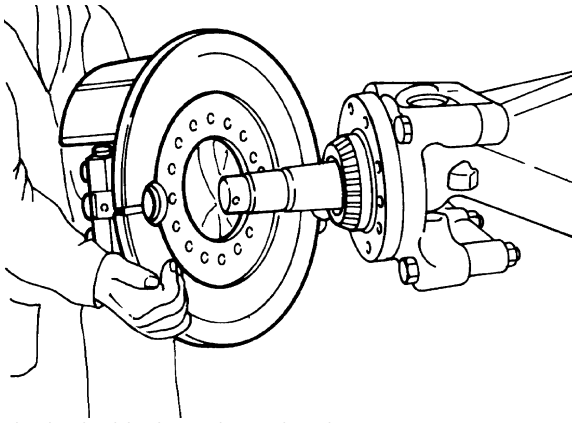
After refitting, use a thickness gauge to check whether clearance between axle and stub axle is 0.05/0.25 mm.

Lift the stub axle with a hydraulic jack to facilitate checking.

Fit the plate (2).

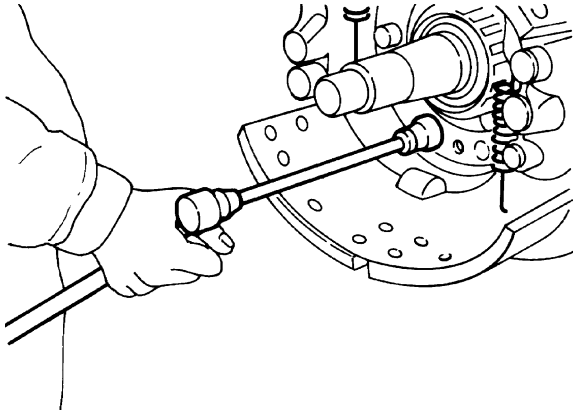
Insert cap (13) and lock it with the seeger ring (12). On the lower side of the stub axle, tighten the screws (7) of the drag link levers (9) to 432 Nm torque and lock them with the safety catch (8).

Figure 16



Fit the brake block on the stub axle.

Figure 17



Tighten the screws to 230 Nm torque.

See the "Brake" section for setting the brake block.

Fit the spacer ring (11, Figure 1) with the grease seals taking care to insert the pin.
Heat the bearing (10, Figure 1) to 80°C and insert it on the stub axle until coming in touch with the spacer.

Prepare the wheel hub separately.

Fit down bearing outer rings on hub internal shoulders. Fit the ten knurled studs (1) into the holes, and check whether every stud head touches the bottom of its relevant housing.
Fill hub internal compartment with approx. 1 kg of Agip MU/3 grease or equivalent in compliance with MIL NLGI-3 Specification.
Smear with the same type of grease the inner bearing needles and fit the hub on the stub axle.

Do not cause damages to the grease guard seals during this operation.

Mount the outer bearing (8, Figure 1) smearing the needles with a slight coat of grease; screw and tighten the block (5, Figure 1) until feeling a slight resistance of the hub when it is turned manually.
When tightening the block it is necessary to rotate the hub and strike slightly the bearings to enable their correct positioning.
Unscrew the block, 20° - 30°.
Tighten block locking bolt (6, Figure 1) to 130 - 144 Nm torque.
Check axial clearance, it must be falling between 0.044 and 0.220 mm.
Fit hub cover (7, Figure 1) and the gasket after filling with grease.
Fit brake drum (1, Figure 1) on the hub screwing the fixing screws.
Fit the diaphragm-type brake booster and connect brake air ducts.
Fit wheels and tighten the nuts to the prescribed torque.

After fitting a new stub axle or overhaul interventions on the forecarriage, check steering mechanical stop adjustment on both parts as described in Section 15.

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FRONT DRIVE AXLE

SECTION 12.1

SECTION 12.1

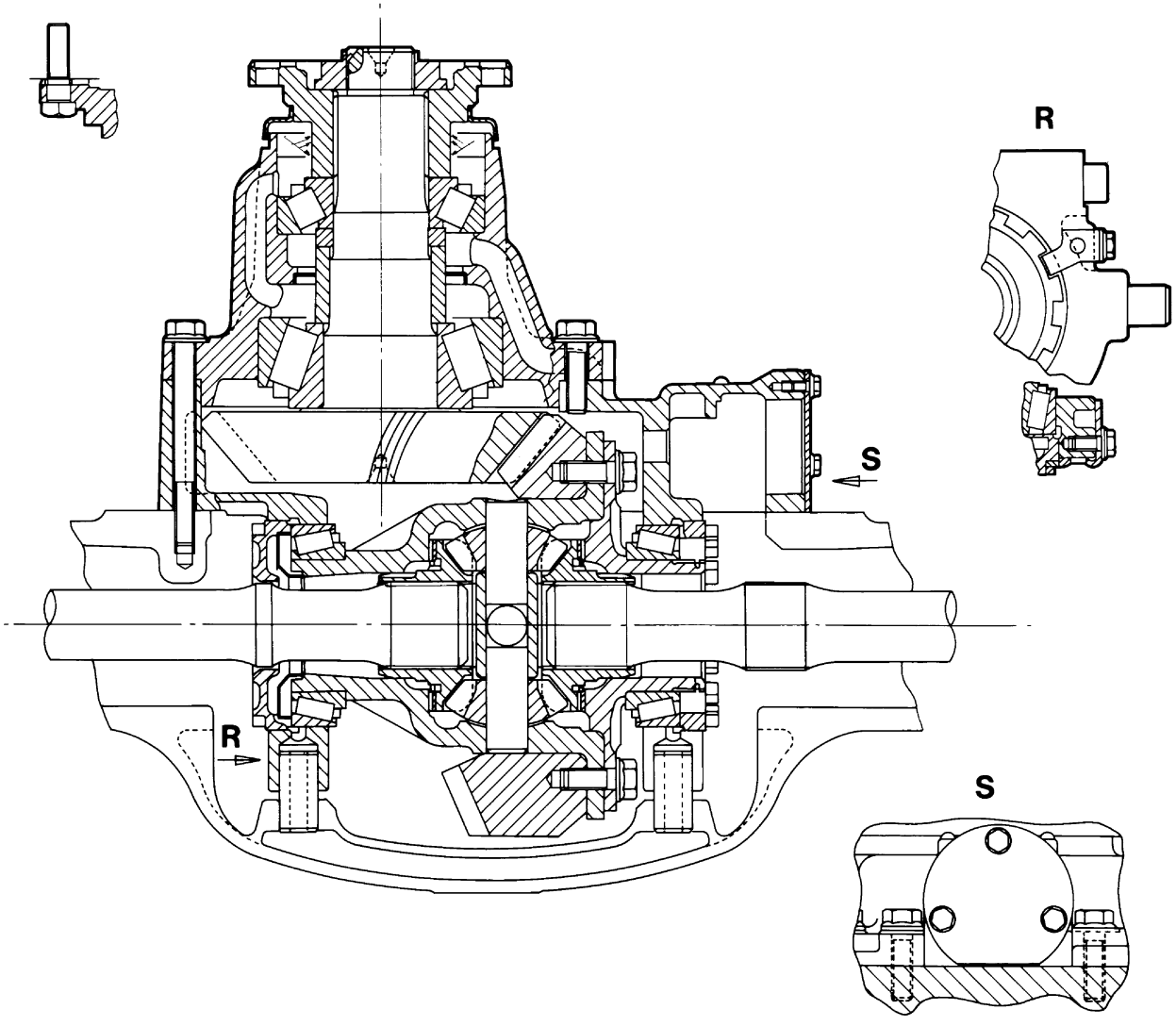
Front drive axle

DESCRIPTION

The axle is double reduction bearing type.
The first reduction is obtained from the pinion-ring bevel gear unit, the second through an epicyclic unit in the wheel hubs.
The differential housing, with ring bevel gear, is supported by two taper roller bearings that can be adjusted through two threaded ring nuts.

The pinion is supported by two taper roller bearings and adjustment is through adjustment rings.
The half shafts coming from the differential transmit the rotation to the epicyclic gears by means of constant velocity joints.
Two flanges fitted to the end of the axle casing permit the stub axles movement.

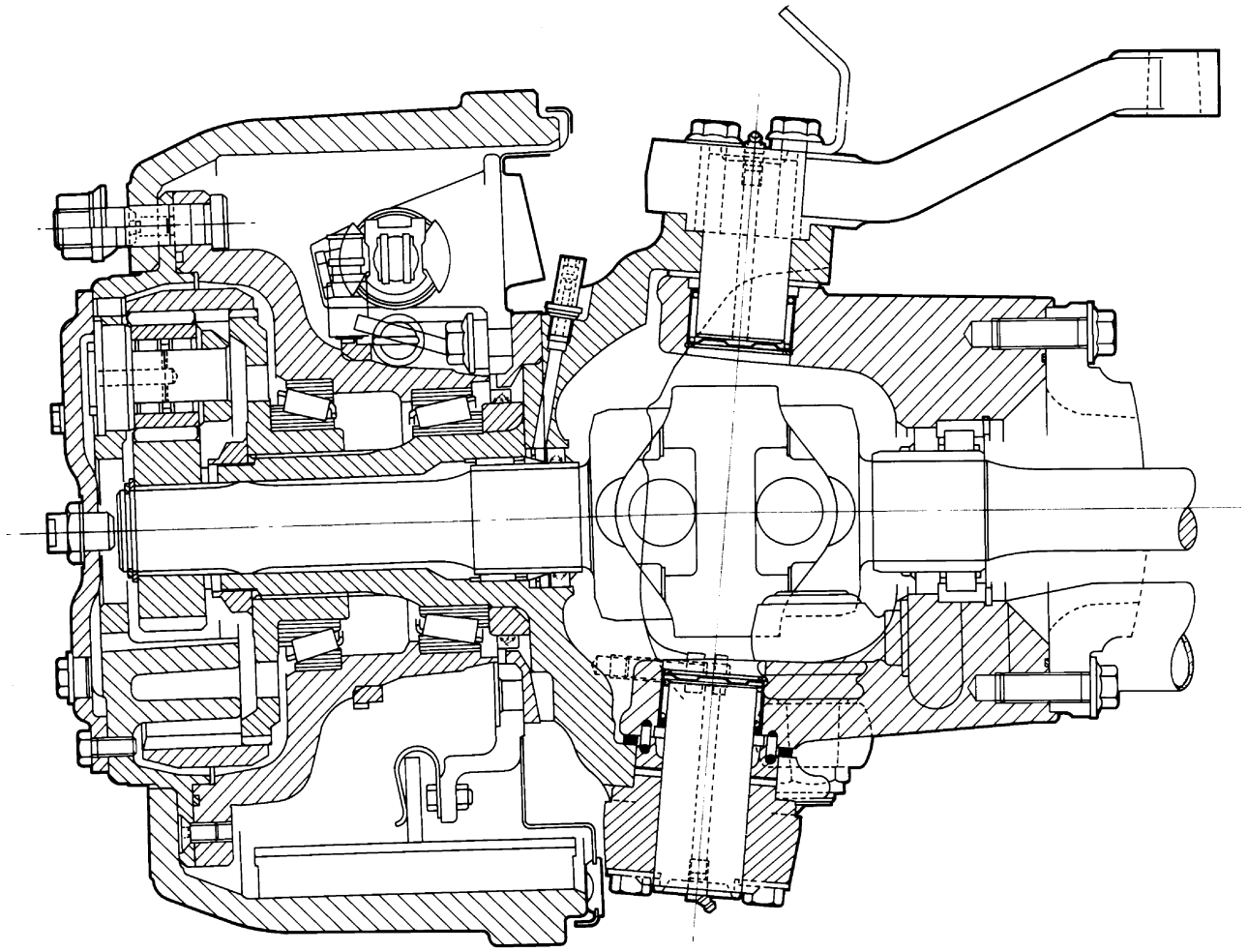
Figure 1



39386

DIFFERENTIAL LONGITUDINAL PICTORIAL SECTION

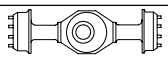
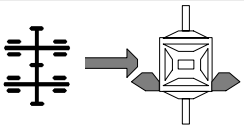
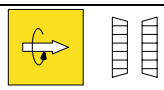
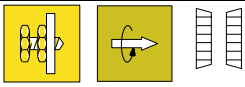
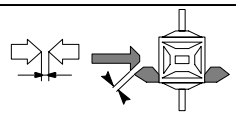
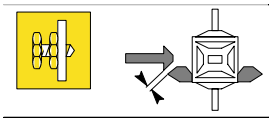
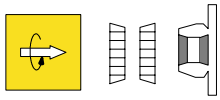
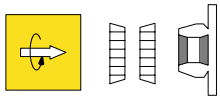
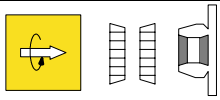
Figure 2



39387

LONGITUDINAL PICTORIAL SECTION OF WHEEL HUB AND EPICYCLIC REDUCTION GEAR

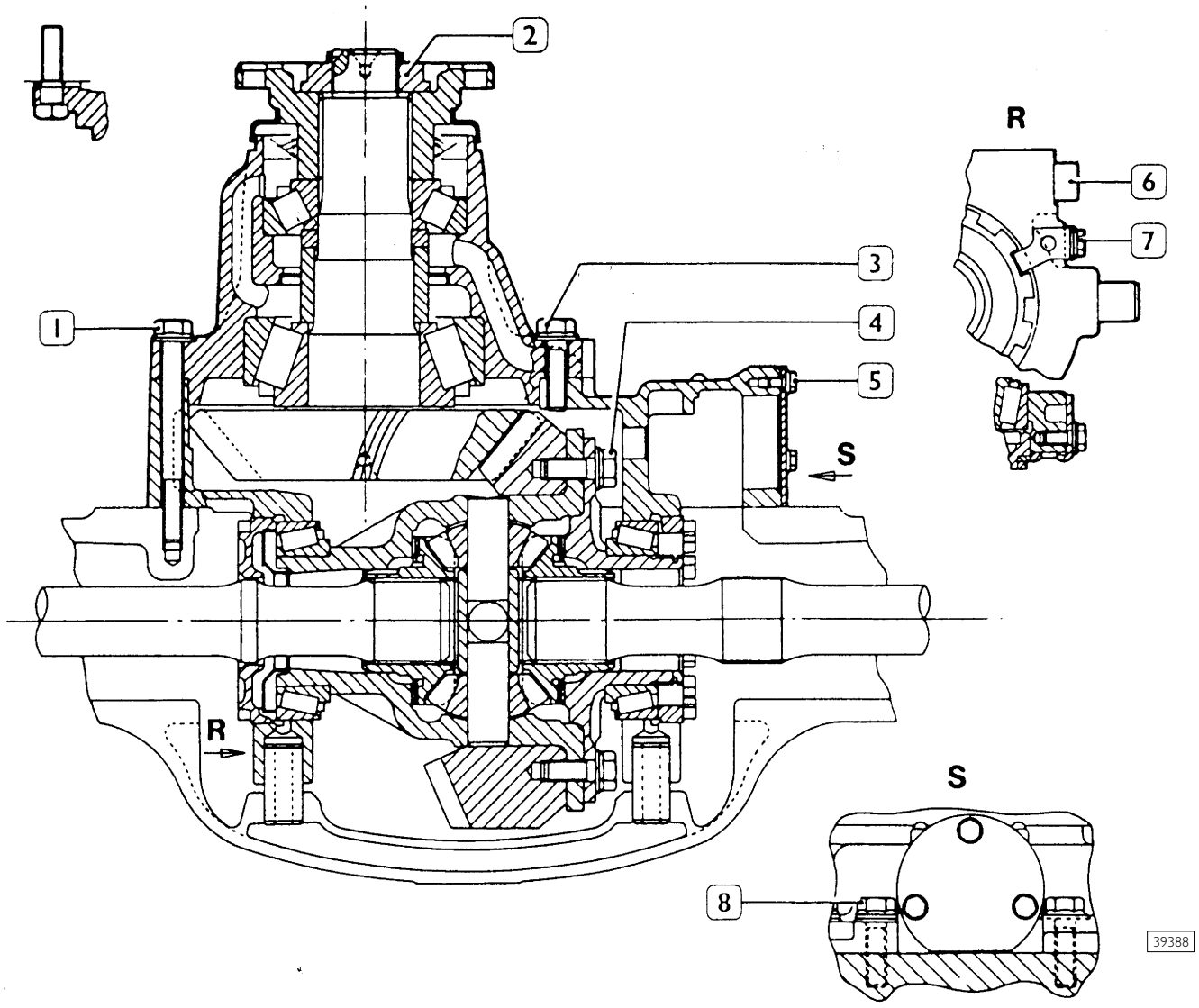
SPECIFICATIONS AND DATA

 Axle type: Bearing with double reduction	**ASTRA 5985/2D (IVECO D 1385 AG001)**
 Bevel drive pinion bearings	2 taper roller
 Final bevel gear ratio	21/40 (1,905) 19/33 (1,737) 23/36 (1,565) 28/37 (1,321) 27/32 (1,185)
 Epicyclic reduction gear ratio on the wheels Epicyclic reduction gear ratio on the wheels	3,2
 Bevel pinion bearings rolling torque without seal ring Nm	6÷8
 Bevel pinion bearings rolling torque adjustment	through adjustment rings
 Thickness of adjustment rings for bevel pinion bearings mm	10 – 10,02 – 10,04 – 10,06 – 10,08 – 10,10 – 10,12 – 10,14 – 10,16 – 10,18 – 10,20 – 10,22 – 10,24 – 10,26 – 10,28 – 10,30 – 10,32 – 10,34 – 10,36 – 10,38 – 10,40 – 10,42 – 10,44 – 10,46 – 10,48 – 10,50 – 10,52 – 10,54 – 10,56 – 10,58 – 10,60
 Thickness of adjustment rings for bevel pinion fitting with reference to the ring bevel gear mm	0,2 – 0,3 – 0,5 – 1
 Backlash between pinion and ring bevel gear mm	0,18÷0,23
 Adjustment of backlash between pinion and ring bevel gear	Through ring nuts
 **WHEEL HUBS**	
 Wheel hub bearings	Two with taper rollers
 Rolling torque of wheel hub bearings: new bearings with surface protection Nm	3 + (7,5÷9)
 Rolling torque of wheel hub bearings: Run-in bearings and new lubricated seal rings Nm	3 + (4÷5)
 Rolling torque of wheel hub bearings: Run-in bearings and seal rings Nm	3 + (3÷4)
 Half-shaft end play mm	0,5 ÷ 1

(*)	Oil for wheel hub bearings	5 (4,5)
(*)	Quantity per hub Litres (kg) Bevel drive pinion bearings	0,75 (0,68)
	WHEEL GEOMETRY	
	Wheel camber angle (vehicle with static load)	—
	Wheel caster angle (vehicle with static load)	1° 30'
	Wheel toe-in (vehicle with static load)	B = A - (0 ÷ 3 mm)
	KING PINS	
	King pin camber	5°
X1	Thickness of adjustment rings between axle and stub axle upper shim X1 mm	1,75 – 2,00 – 2,25 – 2,50 – 2,75 – 3,00 3,25 – 3,50

(*) For the correct type of fluid, see section 2 - HYDRAULIC FLUID AND LUBRICANTS TABLE

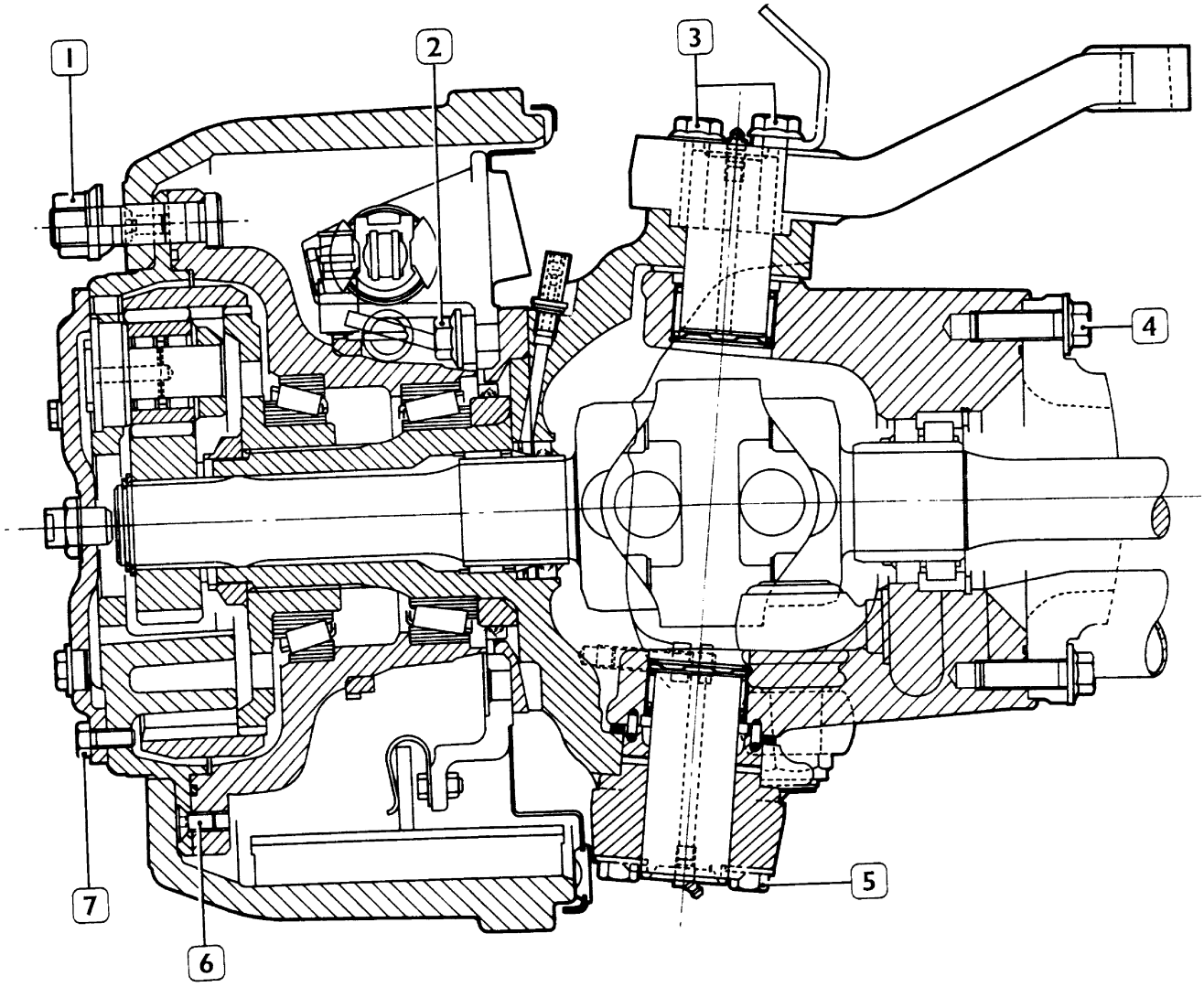
Figure 3



DRIVING TORQUES

	COMPONENT	TORQUE	
		Nm	Kgm
1	Differential housing to axle casing fastening screw	180 ± 10	18 ± 1
2	Bevel pinion locking nut	700 ± 50	70 ± 5
3	Bevel pinion support to differential housing fastening screw	180 ± 10	18 ± 1
4	Ring bevel gear to gear housing fastening screw	180 ± 10	18 ± 1
5	Screw with flange	14 ± 2	1,4 ± 0,2
6	Bearing supports fastening screw ◊	180 ± 10	18 ± 1
7	Self-locking screw for safety plate	51 ± 5	5,1 ± 0,5
8	Screw with toothed flange	180 ± 10	18 ± 1
	◊ Apply LOCTIT AVX		

Figure 4



DRIVING TORQUES

	COMPONENT	TORQUE	
		Nm	Kgm
1	Wheel fastening nut	650	65
2	Brake support fastening screw	360	36
3	Fastening screw for steering drop arm pin	230	23
4	Stub axle support fastening screw	360	36
5	Fastening screw	230	23
6	Support fastening screw	25	2,5
7	Cover fastening screw	49	4,9

TOOLS

TOOL NO.	DESCRIPTION
99305121	Hot air operated equipment
99322205	Rotary stand for unit overhaul
99322215	Stand for axle testing
99322225	Unit holder (to be mounted on stand 99322205)
99345049	Counter block for pullers
99345053	Counter block for pullers
99347068	Puller for drag link pivots
99348001	Puller with locking device
99348004	Universal puller for internal diameters 5 - 70 mm
99354207	Wrench (94.5 mm) for wheel hub bearing adjustment nut
99355025	Wrench for differential gearcase bearing adjustment ring nut
99355081	Wrench (60 mm) for differental bevel pinion nut (to be used with 99370317)
99357111	Pliers for brake shoe return spring
99370006	Handle for interchangeable beaters
99370007	Handle for interchangeable beaters
99370258	Beater to remove - fit in place the roller bearings in the kingpin axle fork (to be used with 9937006)
99370317	Lever and relevant extension bar
99370509	Hook to remove differental gearcase half box
99370616	Support to hold differential during removal/re-fitting in place
99370617	Support to hold axles during removal/re-fitting in place
99370133	Tool to lock differential cap angle
99374093	Beater to fit in place bearings outer tracks (91-134) (to be used with 99370007)
99374094	Beater to fit in place bearings outer tracks (134-215) (to be used with 99370007)
99374233	Element to fit in place the differential bevel pinion gasket
99374369	Beater to fit the roller bearing in the stub axle (to be used with 99370006)
99373371	Element to fit in place roller bearings and seal ring on axle fork (to be used with 99370006)
99374377	Element to fit in place the internal wheel hubgasket
99374390	Element to fit the seal ring in the stub axle (to be used with 99370006)
99389819	Dynamometric wrench 0 to 10 kgm connection 1/4"
99389821	Dynamometric wrench 0 to 70 kgm connection 3/8"
99395026	Tool to check hubs rolling torque (to be used with dynamometric wrench)
99395027	Tool to find proper differential bevel pinion adjustment shims (to be used with 99395603)
99395603	Dial gauge (0-5 mm)

DIAGNOSTICS

Main axle faults:
1 - Wheel hubs noisy
2 - Noise
3 - Noise at release
4 - Noise during acceleration
5 - Cornering noise

1 WHEEL HUBS NOISY

Insufficient lubrication – YES → Check there are no leaks from gaskets or the axle casing and top up oil to correct level.

NO

Wheel hub bearings inefficient – YES → Remove the hub and replace inefficient parts.

NO

Bad adjustment of wheel hub bearings – YES → Adjust bearings

NO

Half-shaft splines to fit planetary gears of epicyclic gears are worn – YES → Overhaul and replace worn or damaged parts

2 NOISE

Lubricating oil level low – YES → Check there are no leaks from gaskets or axle casing and top up to correct level

NO

Half shaft splines to fit the differential crown wheels damaged – YES → Overhaul the axle and replace worn or damaged parts.

Bad adjustment of hub bearings		YES →	Adjust the bearings backlash.
NO ↓			
Bad adjustment or wear on differential gears or bearings		YES →	Locate the trouble and overhaul the unit.

3 NOISE AT RELEASE

Improper fitting backlash between pinion and ring bevel gear		YES →	Remove the gear housing inspection cover and adjust backlash between pinion and ring bevel gear.

4 NOISE DURING ACCELERATION

Insufficient lubrication		YES →	Check that there are no leaks from the gaskets or the casing and top up to the correct level.
NO ↓			
Gear housing bearings badly set or deteriorated		YES →	Overhaul the unit.
NO ↓			
Bad tooth contact between pinion and ring bevel gear		YES →	Adjust the contact.

5 CORNERING NOISE

Improper backlash between planetary gears and crown wheels.		YES →	Overhaul or replace the unit.

REMOVING - REFITTING THE FRONT DRIVE AXLE

Removal

To remove the front drive axle proceed as follows:

- ❑ place the vehicle on a flat ground and suitably lock the rear wheels;
- ❑ loosen both front wheel fastening nuts;
- ❑ using a hydraulic jack lift the front of the vehicle and rest it on two stands;
- ❑ remove both front wheels;
- ❑ disconnect ABS transmitter electrical cables from both sides (only vehicles provided with ABS);
- ❑ disconnect brake air delivery pneumatic connections (4) from both sides,
- ❑ disconnect the steering rod unscrewing the joint fitting securing nut (11);
- ❑ undo the screws fixing the propeller shaft flange (6), and secure temporarily the shaft to the chassis to avoid interference during next operations;
- ❑ remove the bolts (7) fixing the stabilizer bar to the axle and rotate it downwards;
- ❑ set a hydraulic jack fitted with tool 99370617 under the axle;
- ❑ unscrew the nuts (9) from both sides, lift the leaf spring fixing brackets (10), lower the axle and take away the leaf spring.

Refitting

To refit, follow the removal operations in reverse order.

When refitting, check front wheel toe-in as described in Section 15.

Figure 5

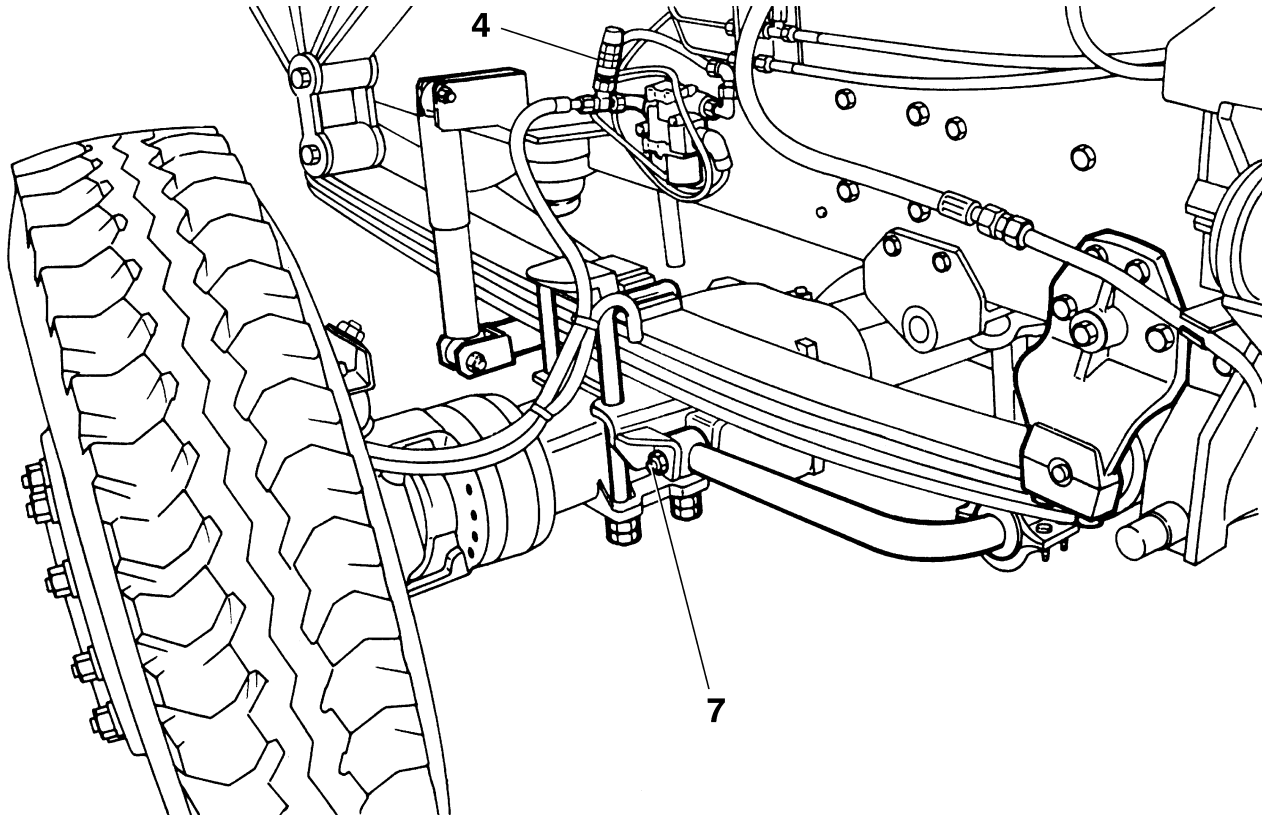
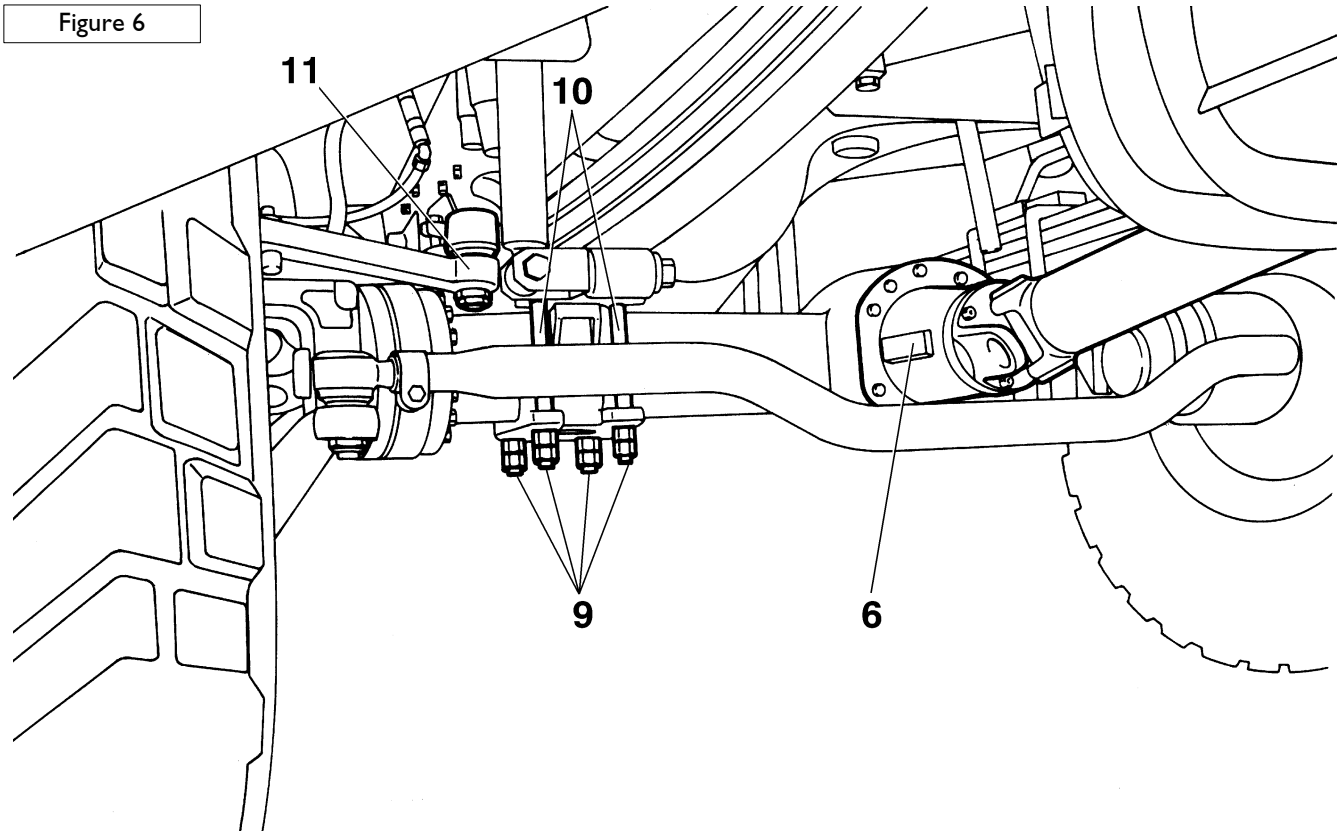
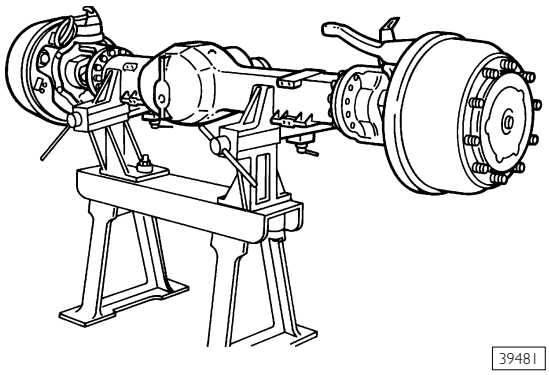


Figure 6



REPAIRING THE AXLE AND WHEEL HUBS

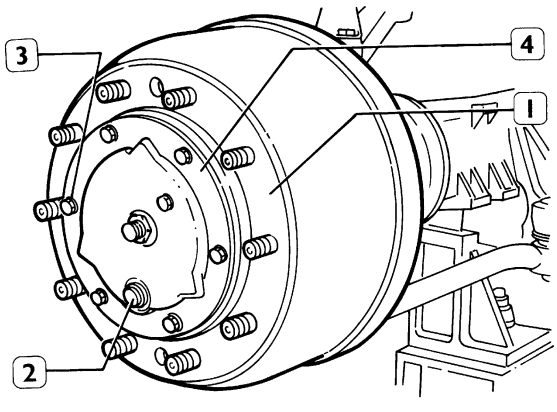
Figure 7



39481

Set the axle on stand 99322205 for overhauling.

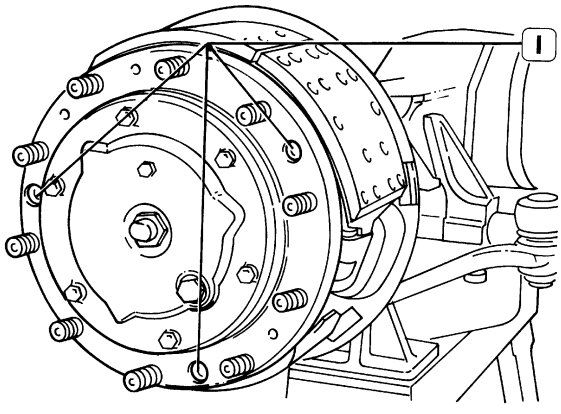
Figure 8



39482

Set the wheel hub (1) so that the oil drainage plug (2) is turned downwards.
Unscrew and drain the oil from the unit into a container.
For easier drainage, remove a screw (3) from the cover (4).
Unscrew the cap on the axle housing and drain the differential unit oil into a suitable container.
After the oil has been drained off, screw the plugs into the drainage holes by hand.

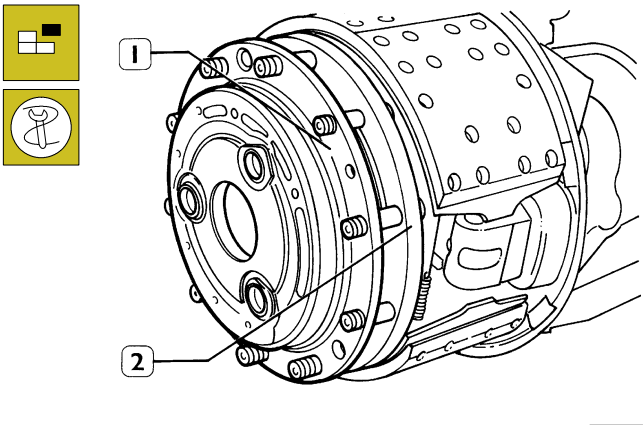
Figure 9



39483

Loosen the three hexagonal socket head screws (1) and remove them.

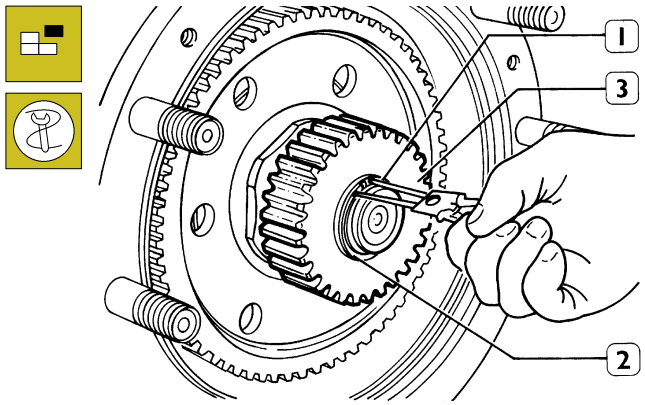
Figure 10



39484

Using a suitable tool separate the planetary gear support (1) from the hub (2) then remove it, taking care that the crown wheel integral with the planetary gears does not slip out.

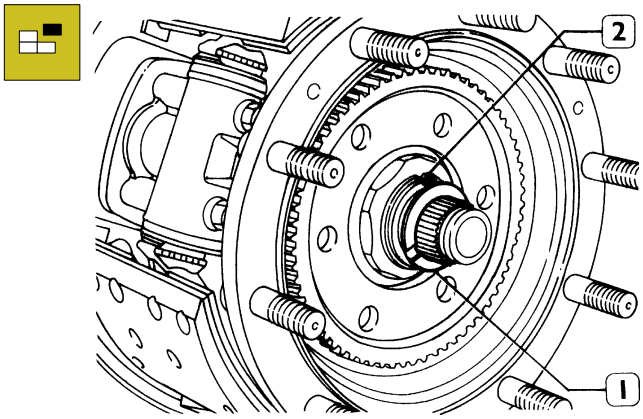
Figure 11



39485

Move the half-axle outwards.
Remove the circlip (2) and the spacer, remove the gear (3)

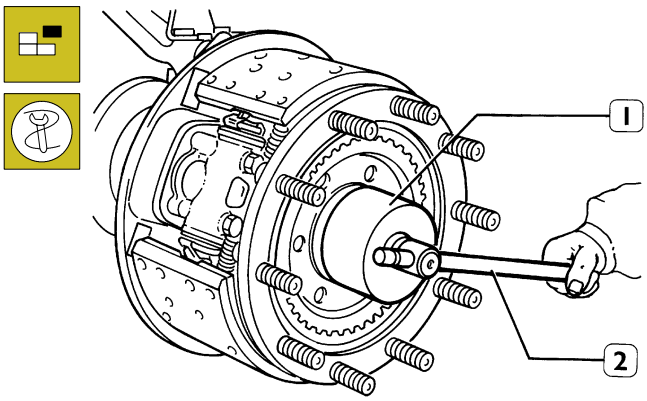
Figure 12



39486

Withdraw the shim ring (1).
Use the appropriate tool to remove the nut dent (2)

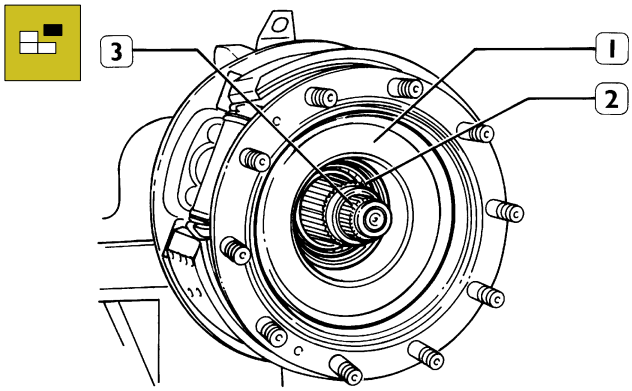
Figure 13



39487

Using wrench 99354207 (1) unscrew the nut (2, figure 12).
Remove the crown wheel gear carrier (56, figure 25) together with the bearing inner ring located behind it.

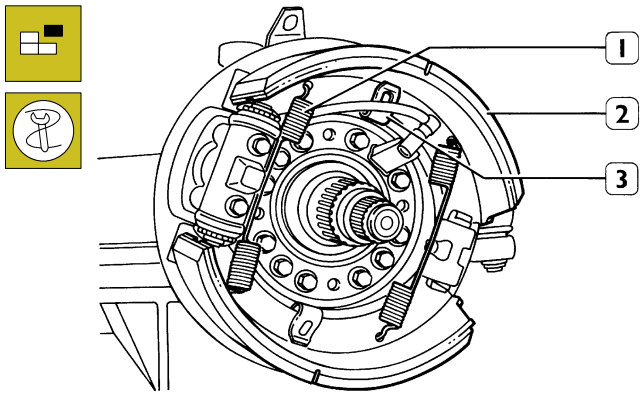
Figure 14



39488

Remove the wheel hub (1) and bearing (2) from the stub axle (3).

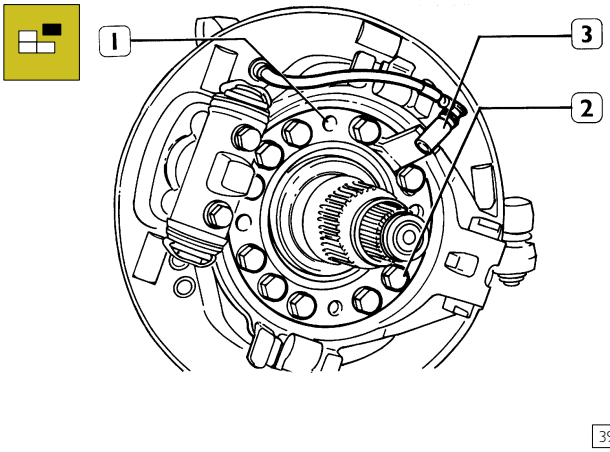
Figure 15



39489

Using the relevant pliers, release the shoe return springs (2).
Always release first the spring where the shoe (1) rests on the adjustment unit.
Withdraw both shoes from the stop brackets (3) moving them up and down.

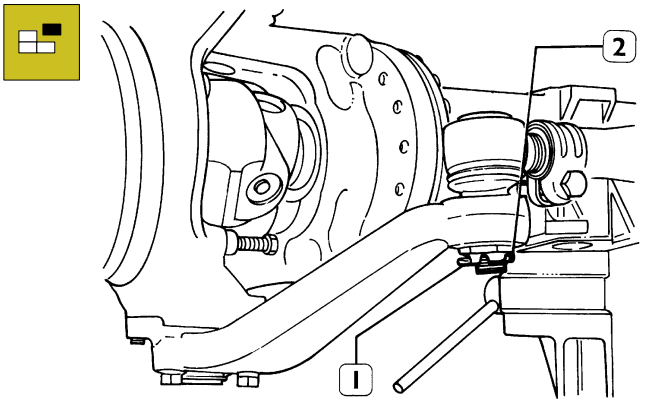
Figure 16



39490

Release the screws (2) from the brake carrier (1) and remove it together with the guards. Withdraw the ABS brakes sensor (3).

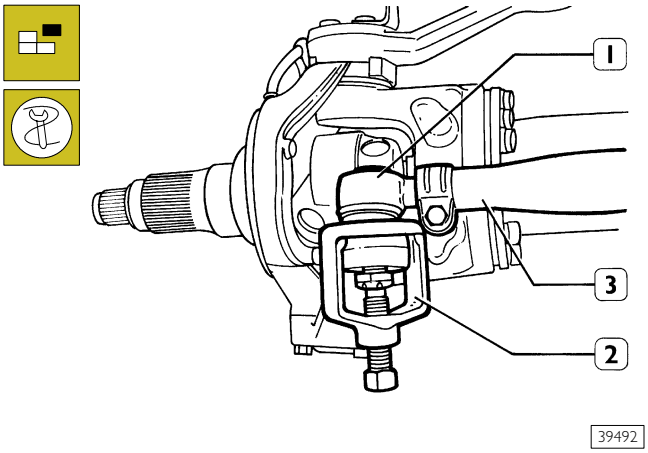
Figure 17



39491

Remove the split pin (1) and unscrew the nut (2) by a few threads without removing it completely.

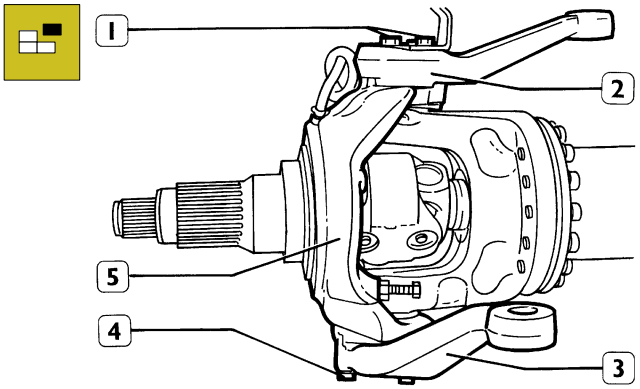
Figure 18



39492

Apply puller 99347068 (2) and remove the stub axle kingpin. Remove the track rod (3).

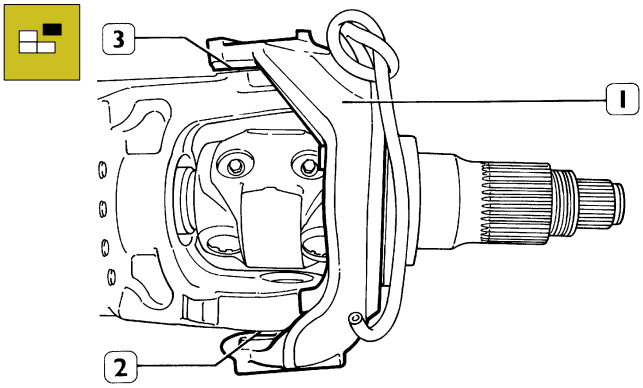
Figure 19



39493

Unscrew the screws (1-4) that fasten the pin (2) and lever (3). Withdraw pin (2) and lever (3) from their housings on the stub axle (5).

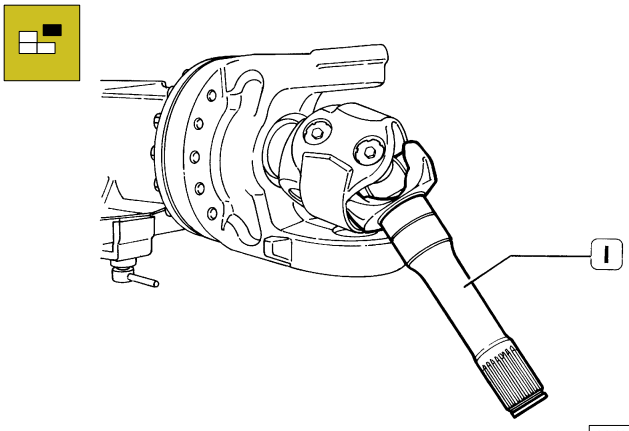
Figure 20



39494

Remove the stub axle (1) and set aside spacer rings (3) and (2).

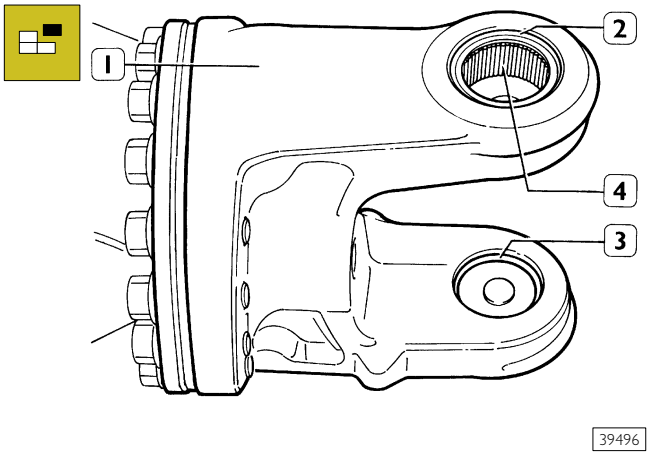
Figure 21



39495

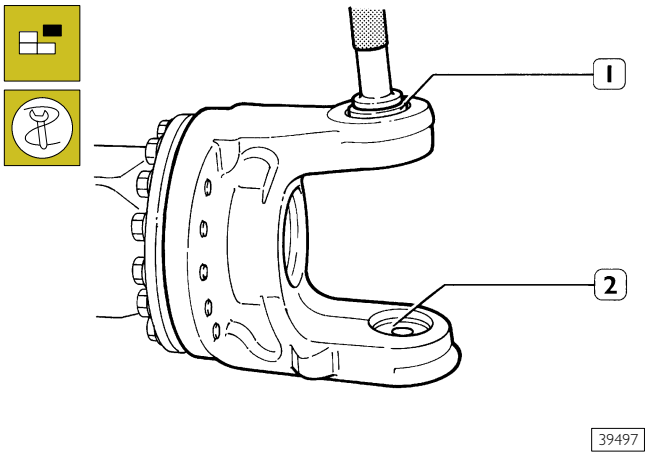
Remove the half-axle (1)

Figure 22



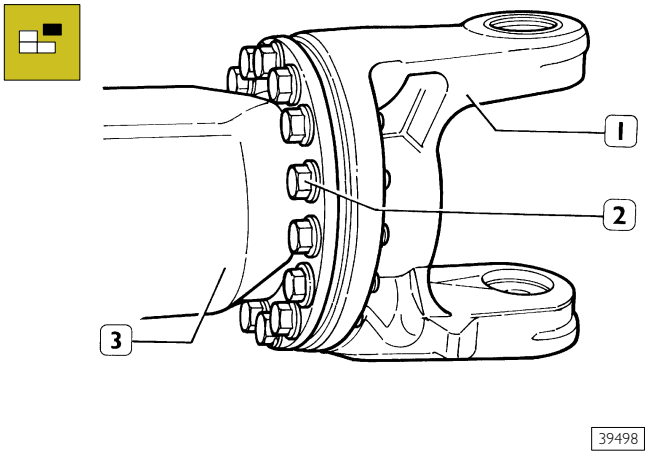
Remove the seal ring (2) and check rings (3) from the fork (1).

Figure 23



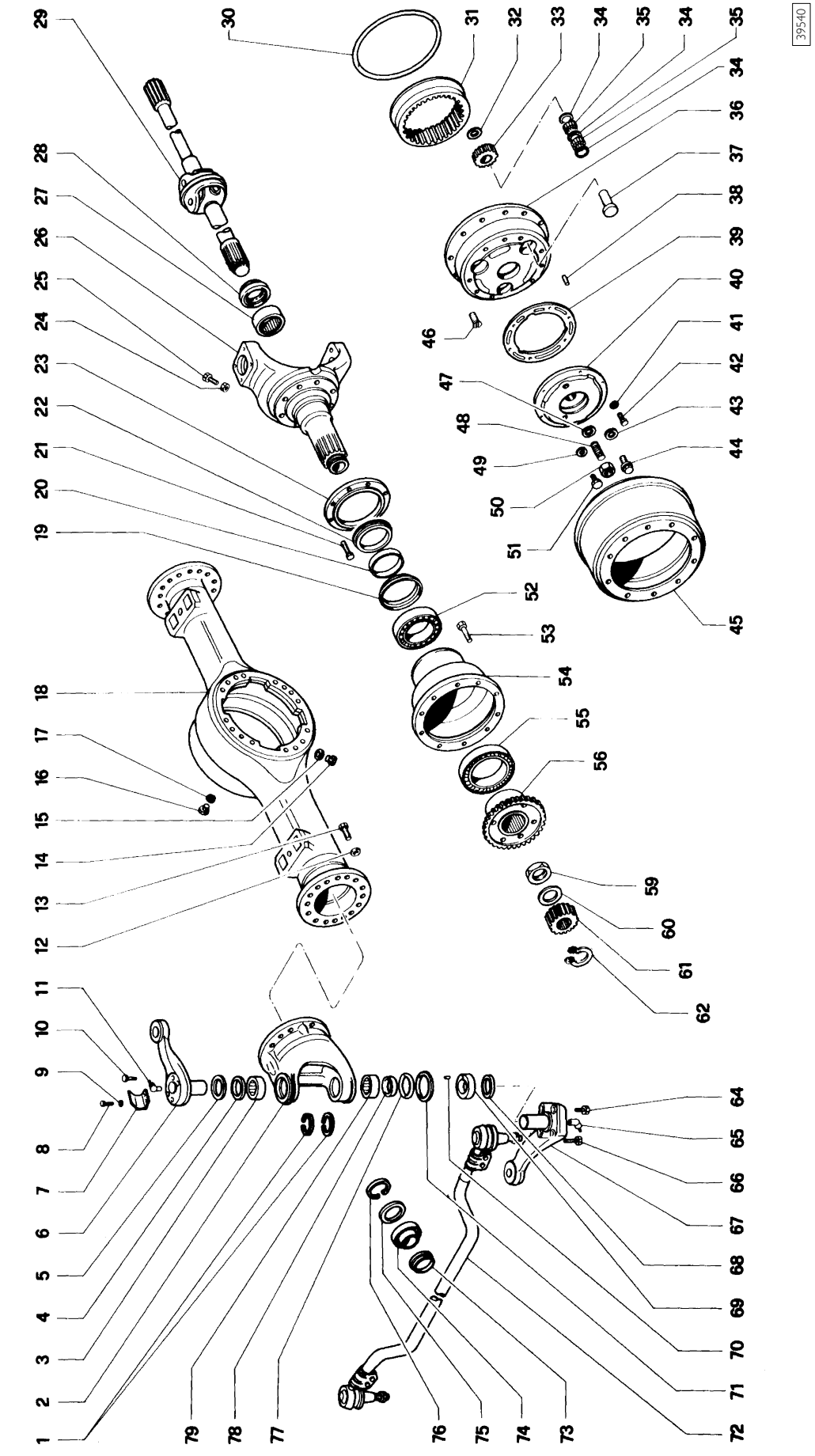
Remove the gasket (1)
Remove the bearings (4, figure 22) from their seats using handle 99370006 and beater 99370258.

Figure 24



Release the screws (2) then remove the fork (1) from the axle casing (3).
Repeat the same operations for the hub on the other side.

Figure 25

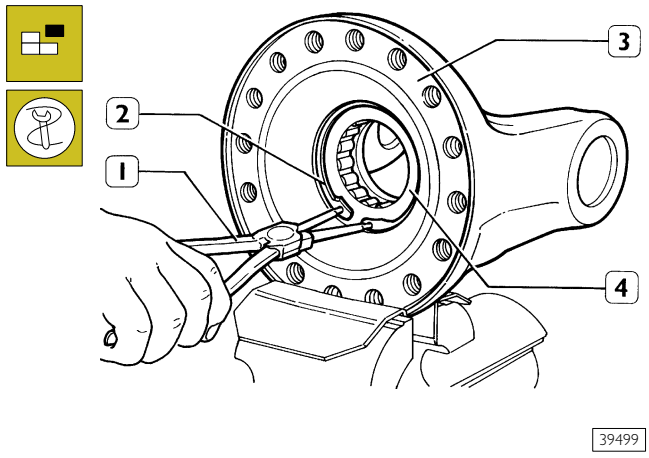


FRONT DRIVE AXLE AND LATERAL REDUCTION UNIT COMPONENTS

1. Split rings - 2. Fork support - 3. Roller bearing - 4. Seal ring - 5. Adjustment ring - 6. Steering drop arm - 7. Bracket - 8. Arm fastening screw - 9. Washer - 10. Arm fastening screw - 11. Greasing nipple - 12. Washer - 13. Fo support fastening screw - 14. Oil drain plug - 15. Sealing washer - 16. Oil inlet plug - 17. Sealing washer - 18. Axle casing - 19. Seal ring - 20. Sliding ring - 21. Brake support fastening screw - 22. Shim - 23. Baffle ring - 24. Adjustment nut - 25. Steering stop screw - 26. Stub axle - 27. Needle bearing - 28. Seal ring - 29. Half-axle with constant velocity joint - 30. Seal ring - 31. Crown wheel - 32. Shim washer - 33. Crown wheels - 34. Shim r 35. Bearing needles - 36. Planetary gear carrier - 37. Bearing pin - 38. Dowel pin - 39. Gasket - 40. Crown wheels carrier cover - 41. Washer - 42. Cover fastening screw - 43. Sealing washer - 44. Oil inlet plug - 45. Brake dru 46. Crown wheelscarrier fastening screw - 47. Sealing washer - 48. Spacer screw - 49. Sealing washer - 50. Lock nut - 51. Oil level plug - 52. Taper roller bearing - 53. Wheel fastening screw - 54. Wheel hub - 55. Taper roller bearing - 56. Ring bevel bearing carrier greasing nipple - 59. Wheel hub fastening nut - 60. Support ring - 61. Planetary gears - 62. Circlip - 64. Arm fastening screw - 65. Greasing nipple - 66. Arm fastening screw - 67. Conne arm - 68. Supporting ring - 69. Spacer ring - 70. Stop pin71. Safety ring - 72. Track rod - 73. Seal ring - 74. Needle bearing - 75. Support ring - 76. Circlip -77. Seal ring - 78. Seal ring - 79. Needle bearing

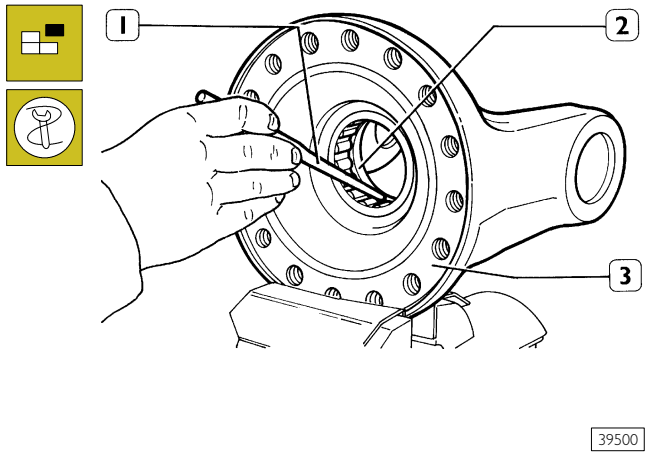
Removing the fork support

Figure 26



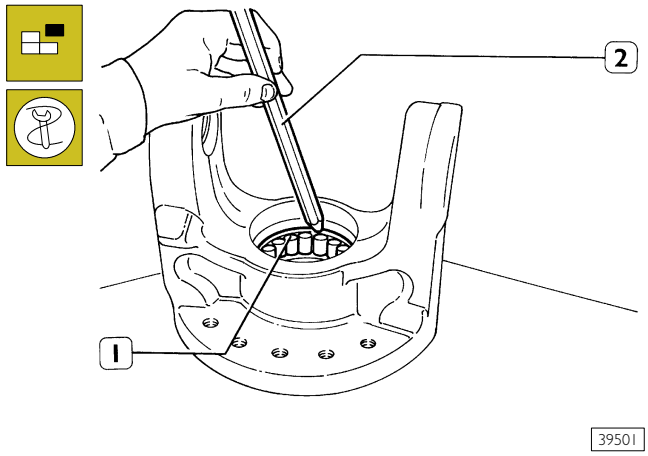
Using the specific pliers (1) remove the check ring (2) and support ring (4) under the fork support (3).

Figure 27



Using a beater (1) eject the seal ring (2) from the fork support (3).

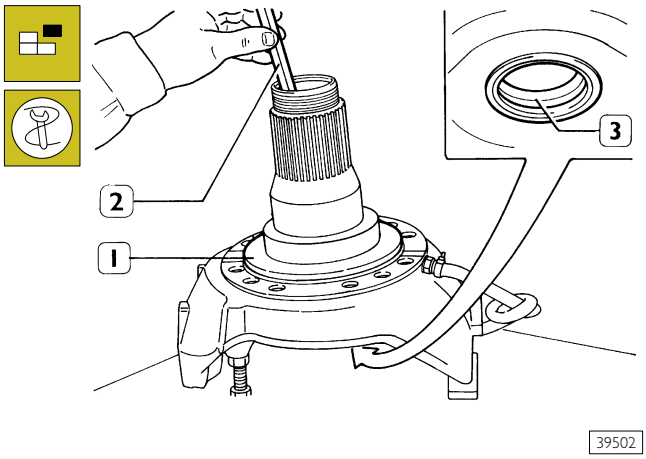
Figure 28



Remove the roller bearing (1) using the suitable beater (2).

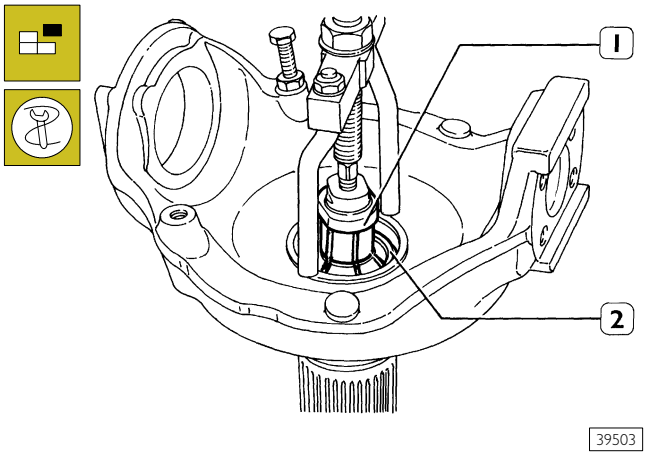
Removing the stub axle

Figure 29



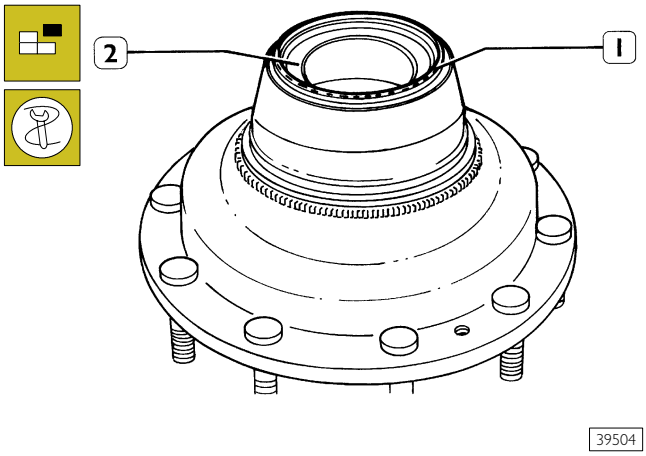
Using the suitable beater (2), remove the seal ring (3) from the stub axle (1).

Figure 30



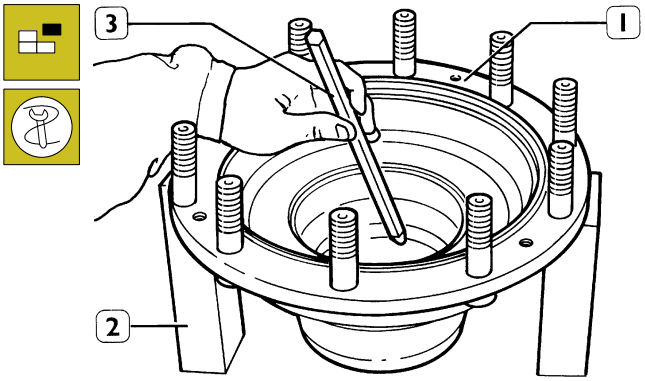
Remove the split ring. Using puller 99348004 (1), remove the bearing (2).

Figure 31



Remove the seal ring (1). Use the appropriate beater to remove the bearing outer ring (2).

Figure 32

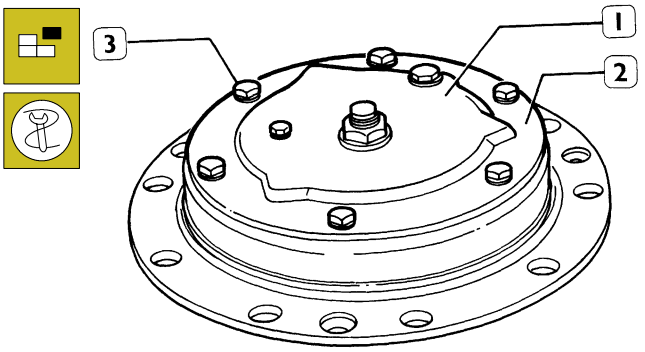


39505

Place the wheel hub (1) on two stands (2) and using a beater (3) remove the bearing outer ring with its gasket.

Removing the epicyclic reduction gear

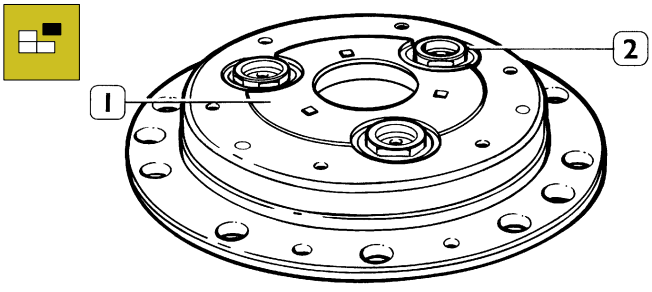
Figure 33



39506

Remove the screws (3), then with a beater, separate the cover (1) from the planetary gear carrier (2).

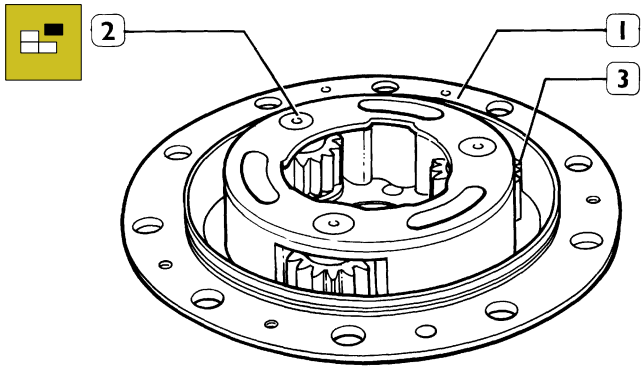
Figure 34



39507

Turn over the carrier (1) holding the pins (2) in their seats.

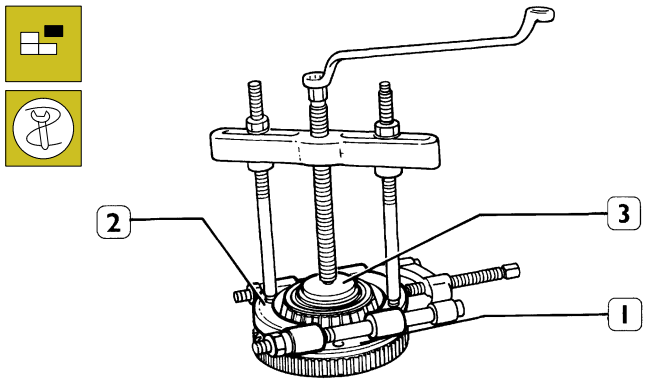
Figure 35



39508

Withdraw the pins (2) from the carrier (1) together with the gears (3) and the shims.

Figure 36



39510

Using puller 99348001 and counteracting block (3) 99345049, remove the bearing from the ring bevel gear carrier(1)

CLEAN-OUT AND CHECKS

After the unit has been dis-assembled, dip all the parts, except the bearings, in a washing tank containing a soda and water solution heated to a temperature of 80 - 85 °C to dissolve all the lubricant residue.
Use a metal brush and scraper to remove any deposits, residue from gaskets, Loctite or sealant that has remained between the connecting plates, taking care not to damage them.
Wash again and dry the parts with compressed air.
At the bench, with an electric metal brush, remove any Loctite or sealant remaining in the screw threads.
To clean the bearings properly, place them in a petrolium bath and use a brush to remove any lubricant residue.
Dry the bearings with compressed air making sure that the air jet does not cause the bearings to rotate.
Lubricate the bearings with the same type of oil as for the epicyclic unit.
Keeping the bearings pressed with one hand and at the same time turning them slightly in both directions, check that there is no roughness or noise as they slide.
Carefully check that the rollers and their cages, the outer tracks and raceways are not worn.
Check all the parts to decide whether they can be re-used or must be replaced. Special attention must be given to the axle casing, the fork supports and the stub axles; make sure there are no signs of cracking or other faults.
Any parts that show signs of wear must be replaced.
Check the wheel fastening bolts; if any strain or damage to the threads is seen, replace, using the press to remove them and fit in place the new parts. After fitting, check that the orthogonality tolerance does not exceed 0.3 mm.

CHECKING THE AXLE CASING CAMBER ANGLE AND CASTER ANGLE

To find the camber angle, device **99305111** is used, following this procedure:

- Set the two supports (1, figure 37), together with the centering cones (5), in the stub axle housings and lock the cones on their supports;
- Set up the gauge and read the camber values on the relevant goniometers (2).

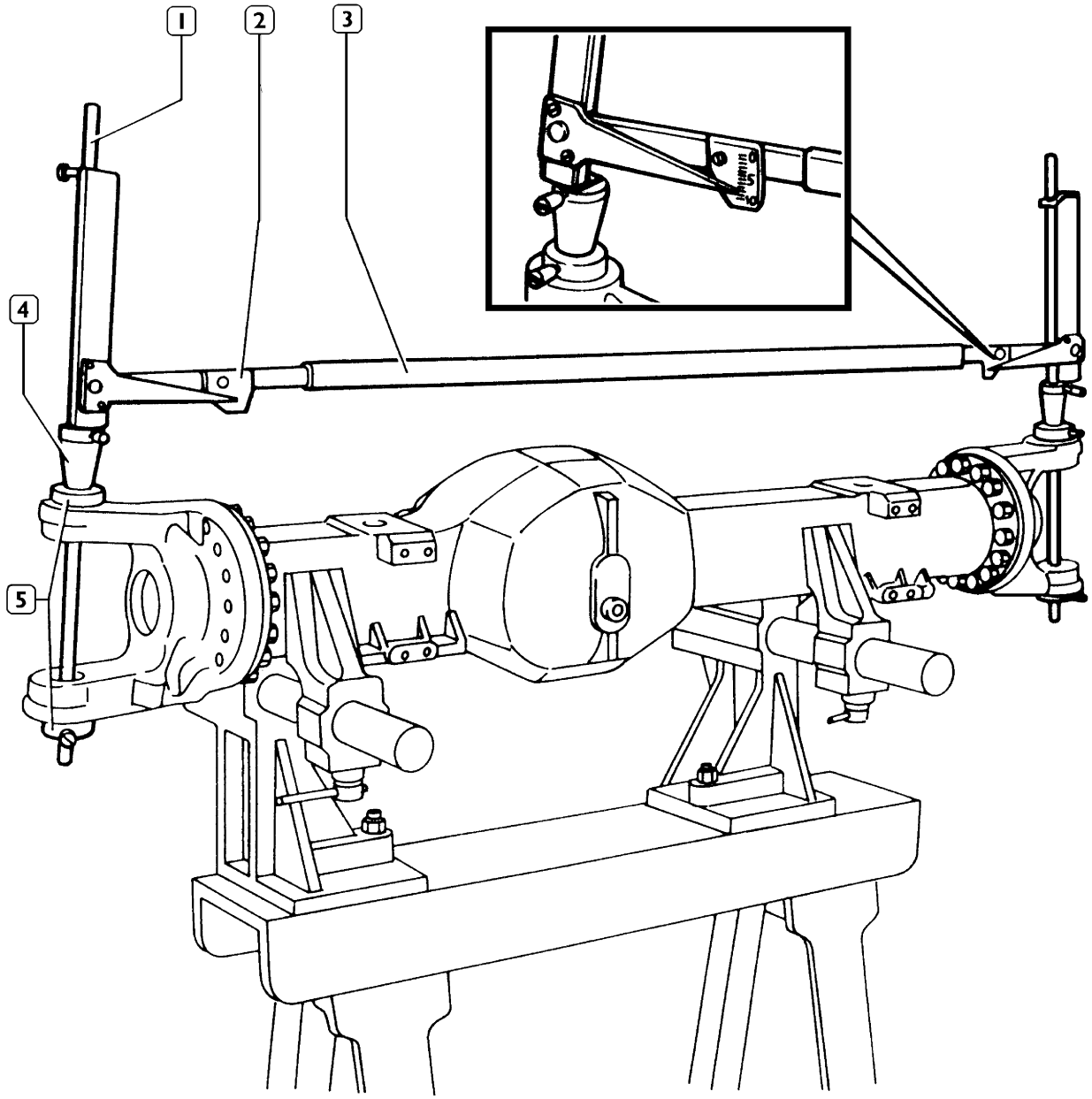
The camber angle of the holes must be 5°

Check the flatness of the contact surfaces for the leaf springs. Device 99305111 is used to find the caster angle, following the procedure described below:

- Insert the two centering pins (4, figure 38) on the leaf spring contact surfaces;
- Using the centering pins, set up the two goniometers (2) on the leaf spring contact surfaces;
- Set up the cross bar (1) on the supports (3) and goniometers (2) then read the relevant caster values on the goniometers.

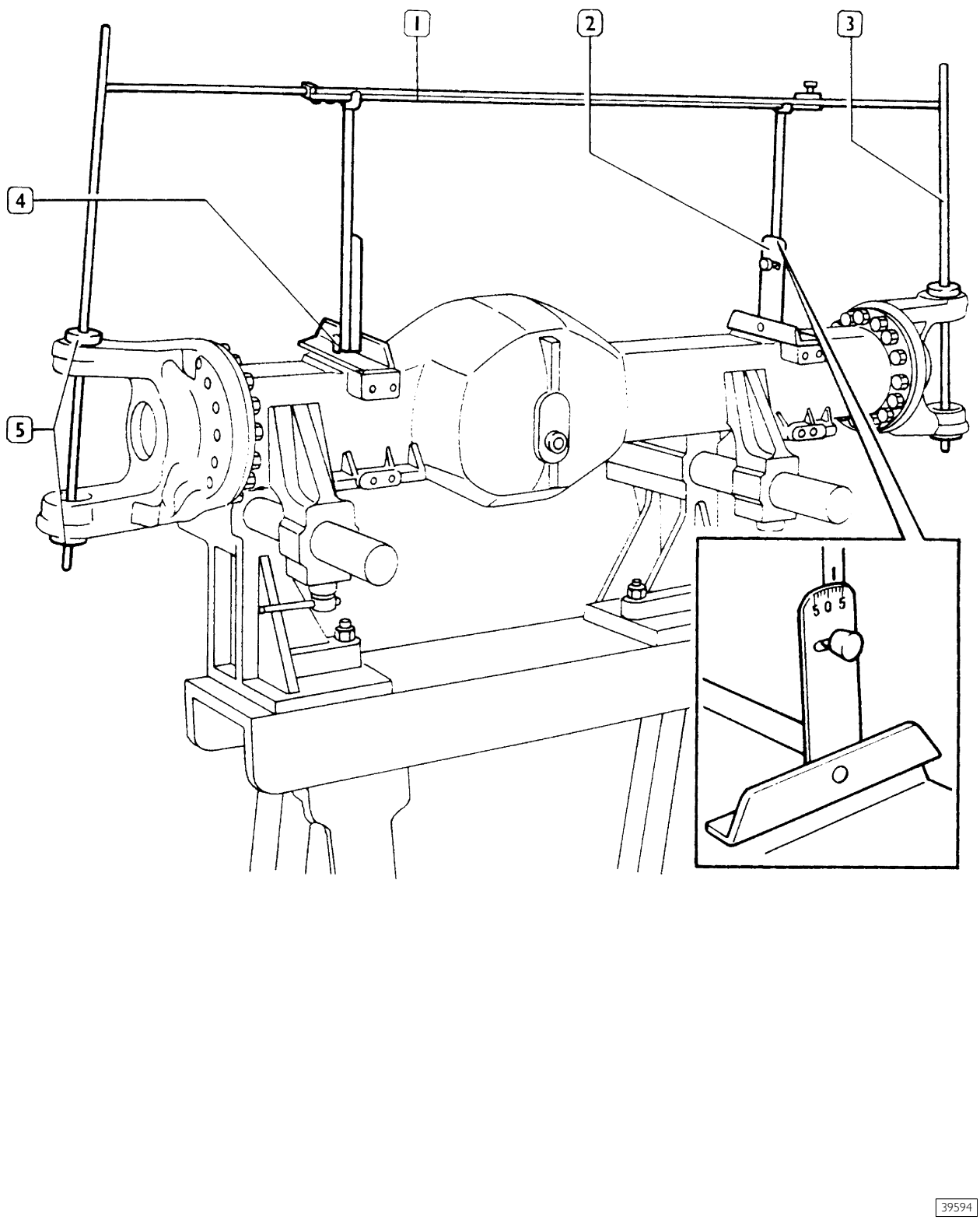
The axle caster angle must be 1° 30'

Figure 37



CAMBER ANGLE CHECK
1. Support - 2. Goniometer - 3. Cross bar - 4. Centering cones - 5. Spacer

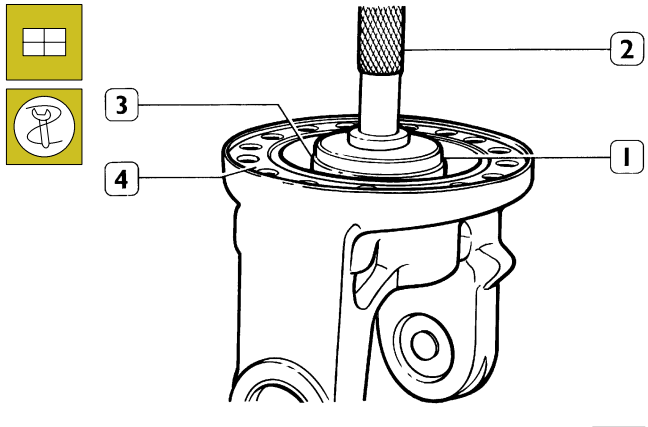
Figure 38



CASTER ANGLE CHECK
1. Cross bar - 2. Goniometer - 3. Support - 4. Centering pin - 5. Spacer

Fitting in place the fork support

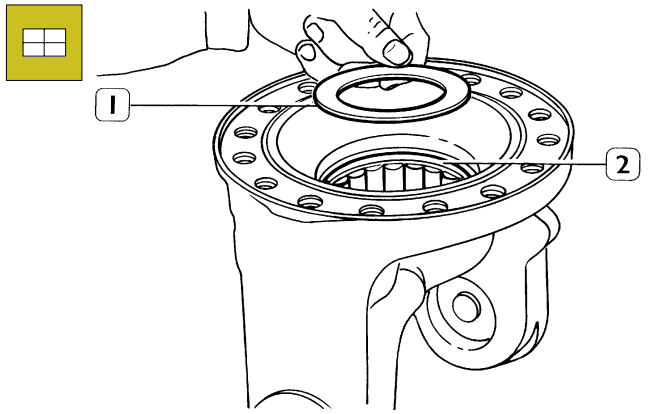
Figure 39



39511

Using beater 99374370 (1) and handle 99370006 (2) fit the roller bearing (3) in its housing in the fork support (4).

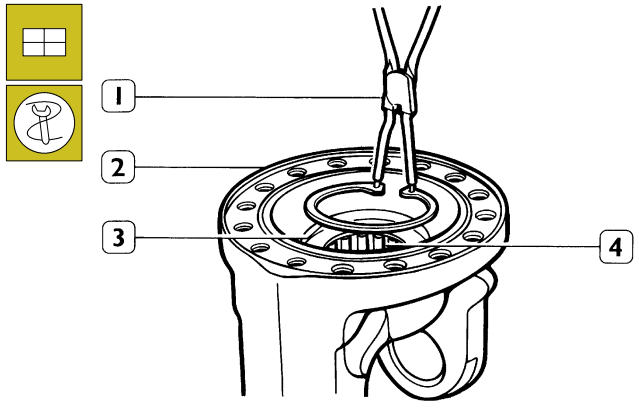
Figure 40



39512

Fit the spacer (1) in the fork support housing (2).

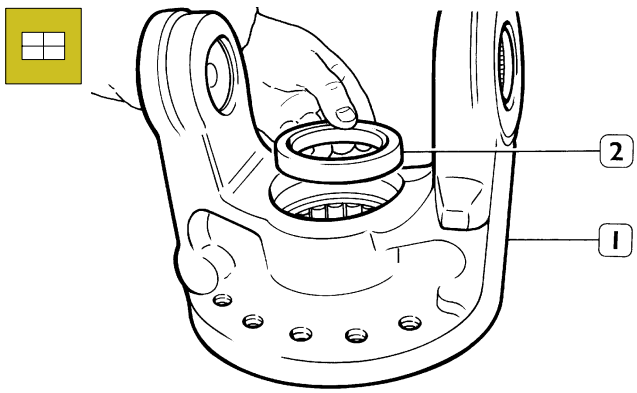
Figure 41



39513

Using the specific pliers (1), fit in place the check ring (3) in the fork support housing (2).

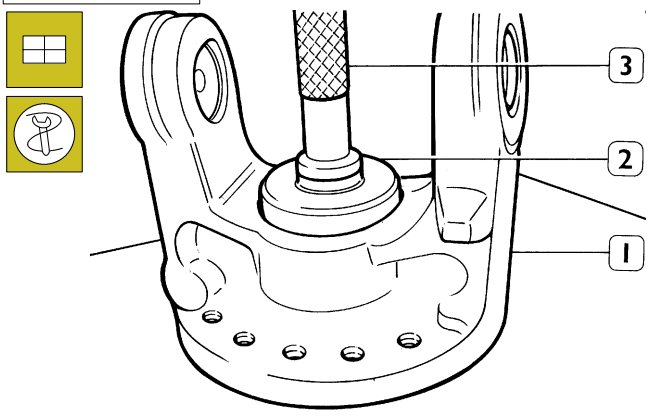
Figure 42



39514

Turn over the support (1) and fit in place the sealing gasket (2)

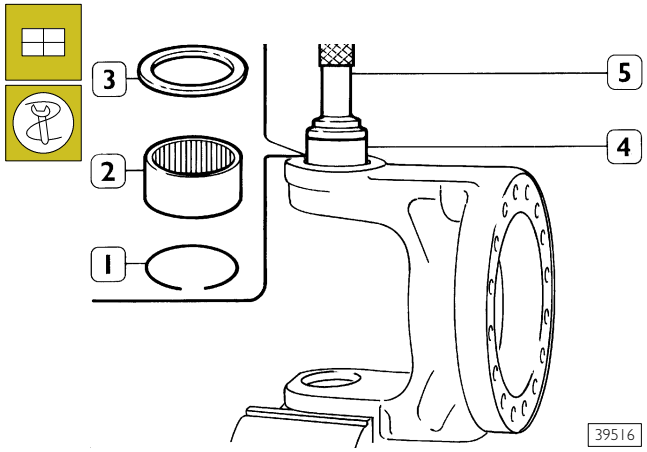
Figure 43



39515

Using connection device 9937437 (2) and handle 99370006 (3), fit the gasket in the fork support housing (1).

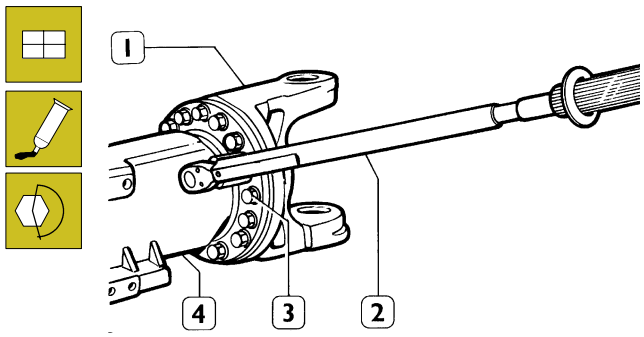
Figure 44



39516

Fit in place the split ring (1). Using beater 99370258 (4) and handle 99370006 (5) fit the split ring (1) to contact the needle bearing (2); fit in place the seal ring (3). Repeat the same operations for the other side.

Figure 45

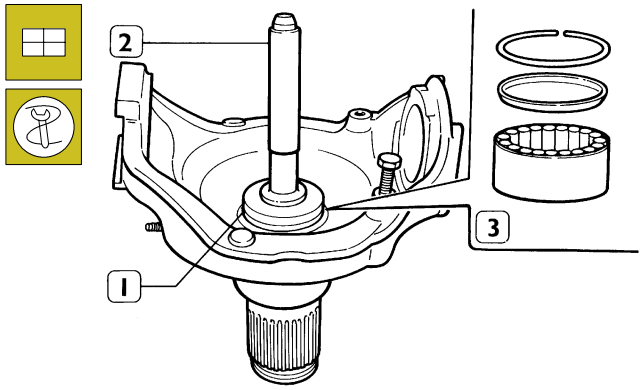


39517

Spread Loctite AVX on the coupling surfaces of the fork support (1) and the axle casing (4), then fit in place the support,taking care that the boss for the steering mechanical end of stroke is in its correct position.
Align the holes for the fastening screws.
Spread Loctite AVX on the screw threads (3) and screw them to make contact, working on them in progressive order.
Use a dynamometric wrench to tighten the screws to the prescribed torque.

Fitting in place the stub axle

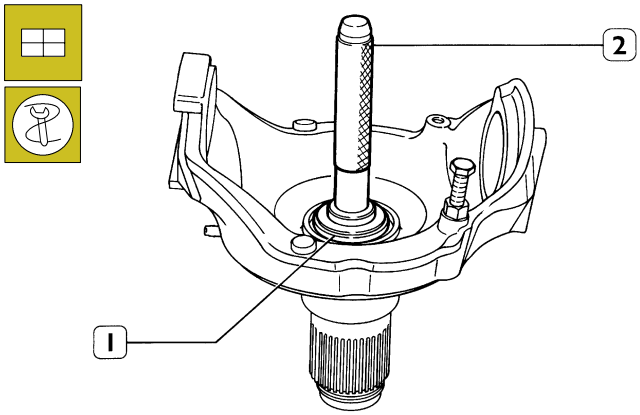
Figure 46



39518

Using beater 99374369 (1) and handle 99370006 (2) fit in place the roller bearing (3) with the cap and split ring.

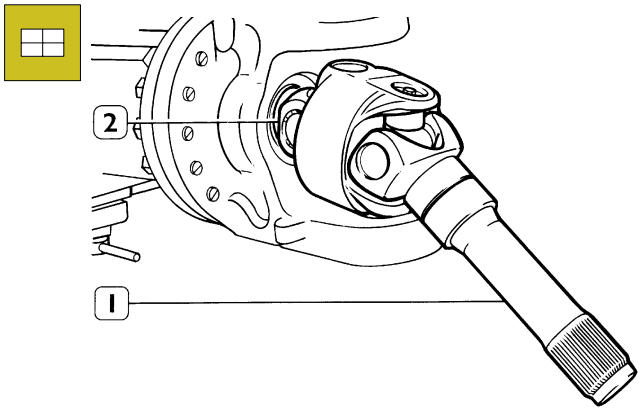
Figure 47



39518

Using beater 99374390 and handle (2) fit the seal ring (1) in the stub axle housing.

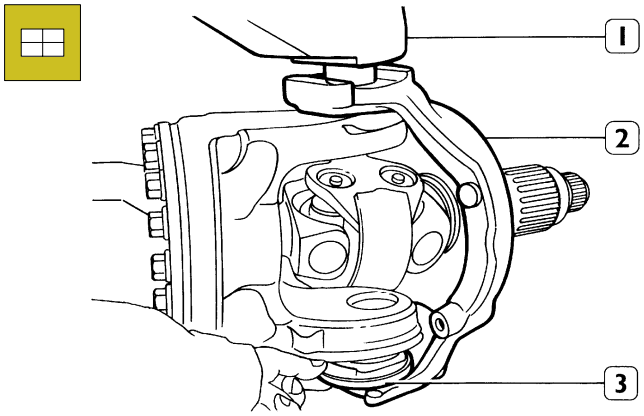
Figure 48



39519

Lubricate the bearing inner ring (2) then insert the half-shaft (1) taking care not to damage the seal ring.

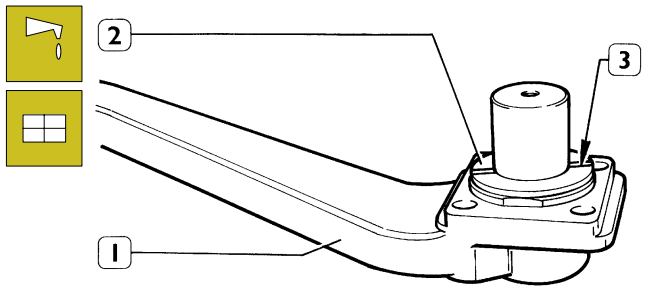
Figure 49



39520

Fit in place the stub axle (2) and momentarily insert the upper pin (1) and shim (3).

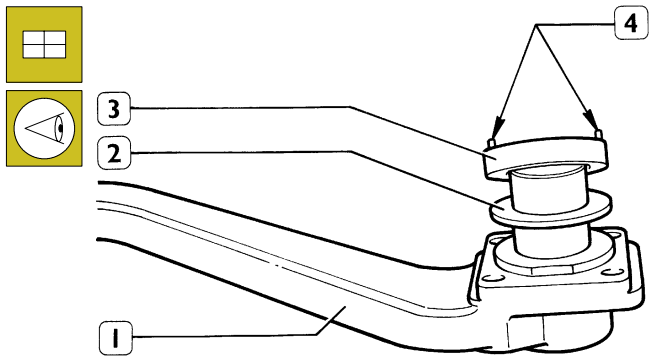
Figure 50



39521

Grease the collar (2) and fit it in place on the steering (1) in the position indicated by the arrow (3).

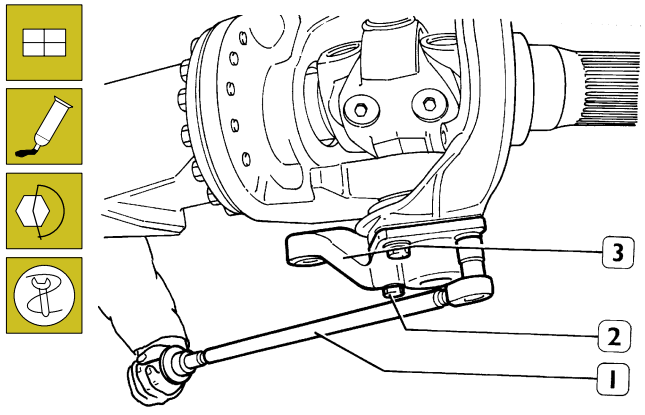
Figure 51



39522

Fit in place the spacer (3) positioning the pins (4) as shown; fit in place the seal ring in the safety ring and insert it between the fork support and the stub axle.

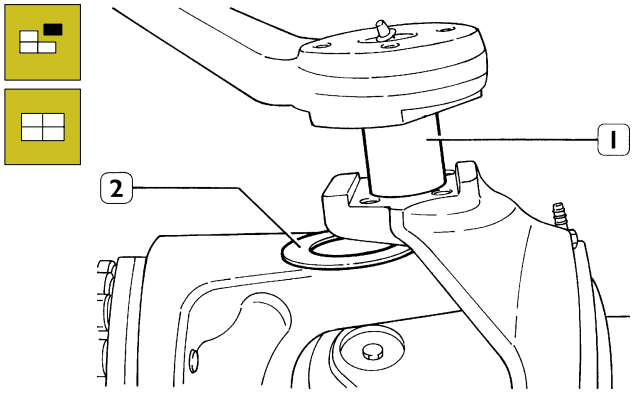
Figure 52



39523

Fit in place the arm (3) in the stub axle.
Spread Loctite AVX on the screw threads (2) then tighten them with a dynamometric wrench (1) to a torque of 230 Nm (23 Kgm)

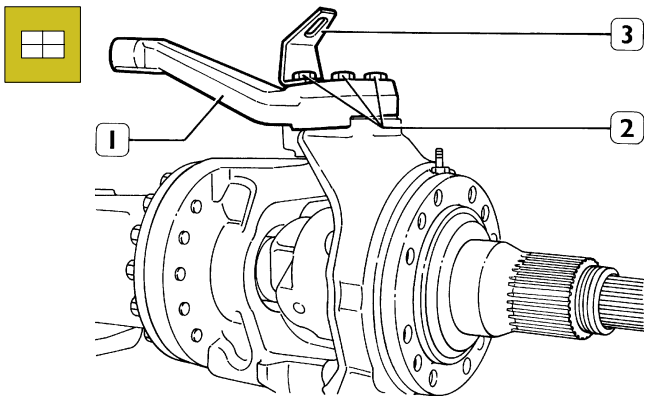
Figure 53



39524

Partially withdraw the upper pin (1) and insert the adjusting ring (2).

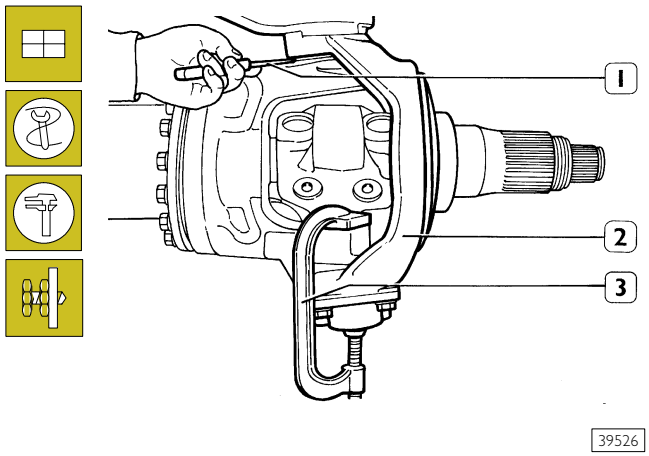
Figure 54



39525

Insert the upper pin (1).
Fit in place the brake air hoses coupling bracket (3) and lock it withscrews (2).

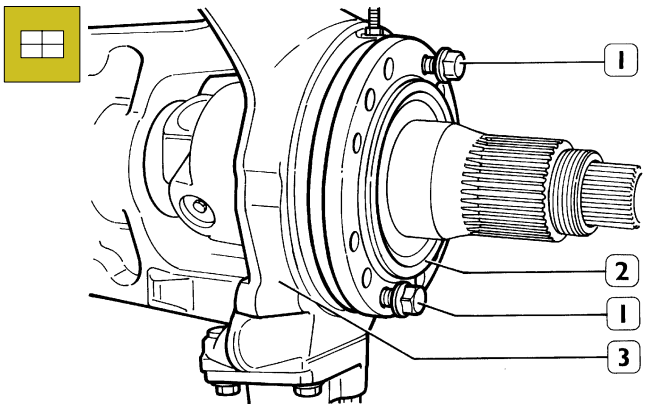
Figure 55



39526

Fit a vice (3) to lift the stub axle (2); check there is no backlash using a feeler gauge (1).
If backlash is found, replace the ring with another of an adequate thickness to eliminate the backlash.
Remove the upper pin fastening screws, apply Loctite to them and re-fit them in place, tightening to a torque of 230 Nm (23 kgm).

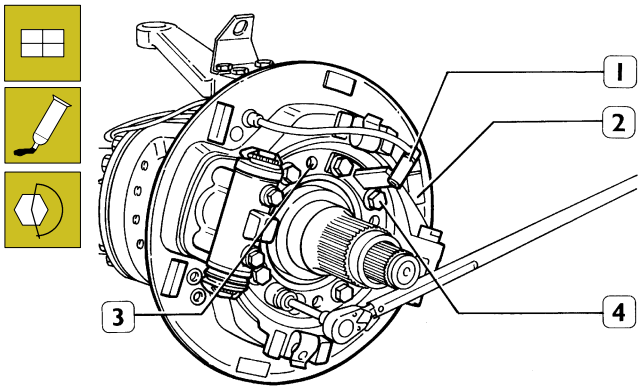
Figure 56



39527

Using two screws (1), fit the flange (2) on the stub axle (3) with the oil drainage notch downwards.

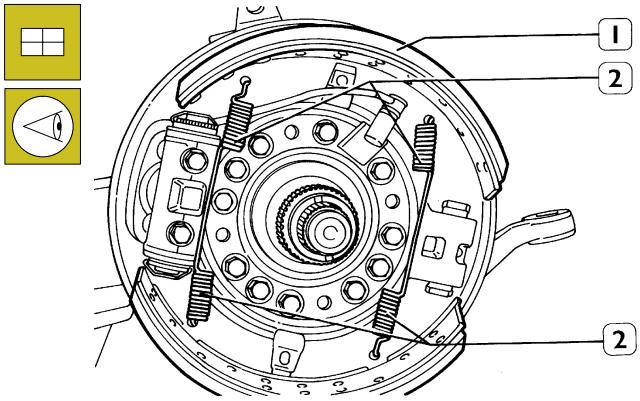
Figure 57



39528

Fit in place the brake housing (3) and its guard (2) on the stub axle; use Loctite AVX on the screws (4) and tighten them to a torque of 360 Nm. Fit in place the ABS sensor (1).

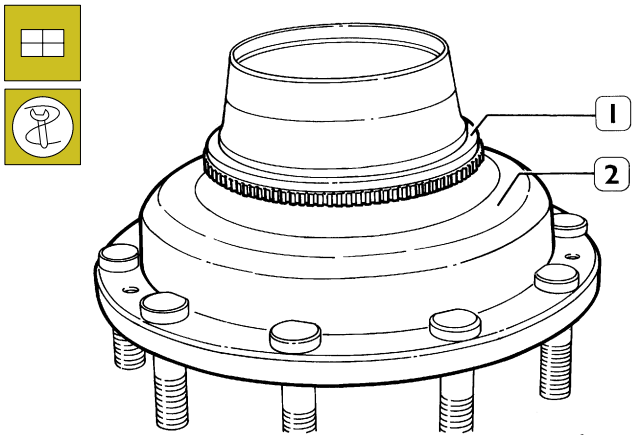
Figure 58



39529

Fit in place the shoes (1) so that the embossed arrow is in the forward driving direction; latch the return springs (2).

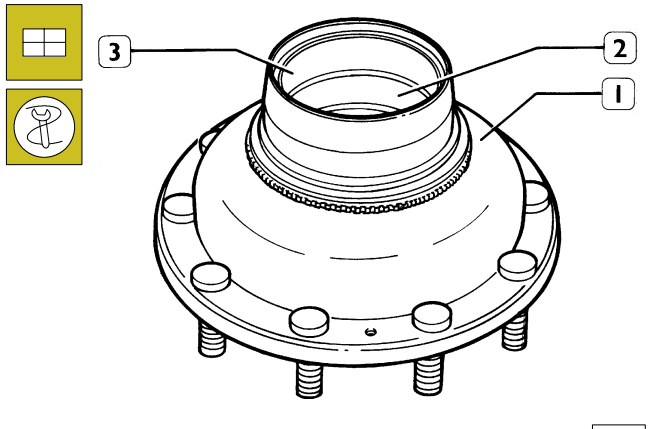
Figure 59



39530

Slightly heat the phonic wheel (1) and fit it in place on the wheel hub (2)

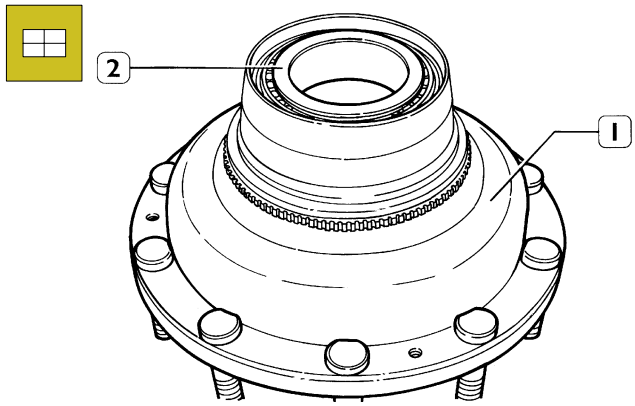
Figure 60



39531

Use beater 99374094 to fit in place the bearing outer rings (2 and 3) on the wheel hub (1).

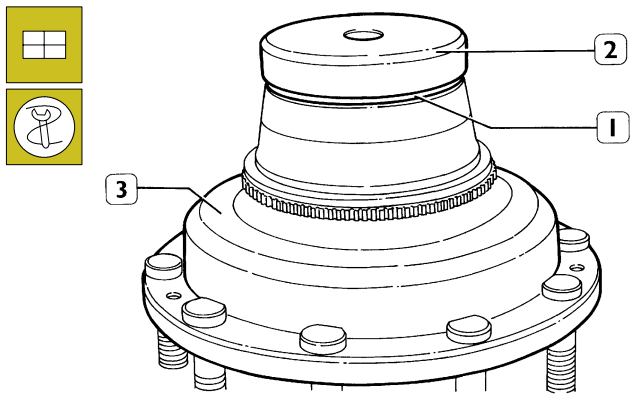
Figure 61



39532

Insert the outer bearing inner ring (2) on the wheel hub (1)

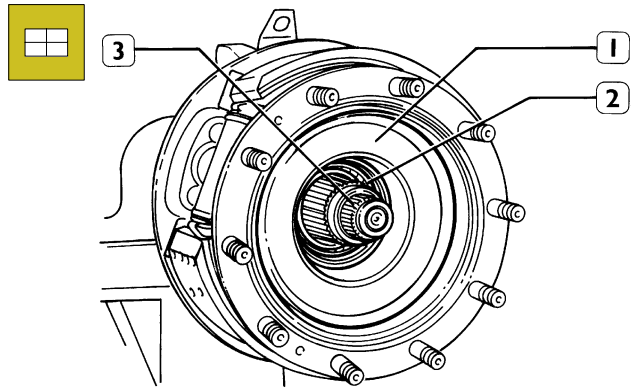
Figure 62



39533

Using element 99374377 (2) fit in place the sealing gasket (1) on the wheel hub (3).

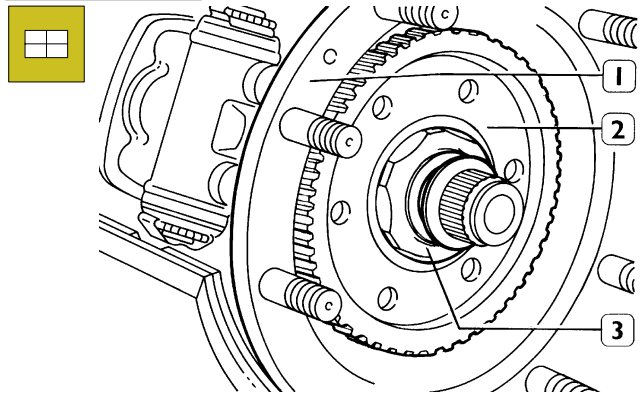
Figure 63



39488

Fit in place the wheel hub (3) on the stub axle shank (2)

Figure 64

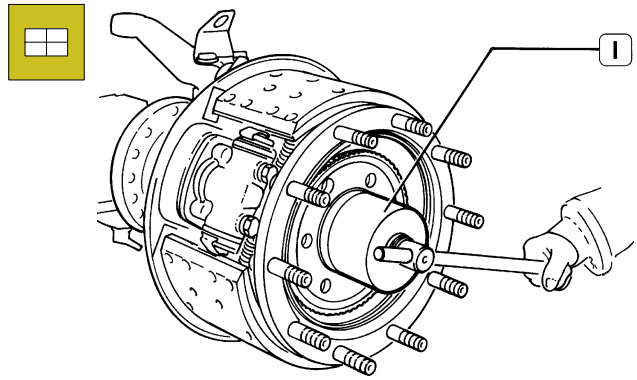


39534

Fit in place the ring bevel gear-carrier (2) on the hub (1) together with the relevant bearing, screw it to contact the nut (3).

The oil passage milling on the ring bevel gear carrier (2) must be set in a perpendicular position in the lower part.

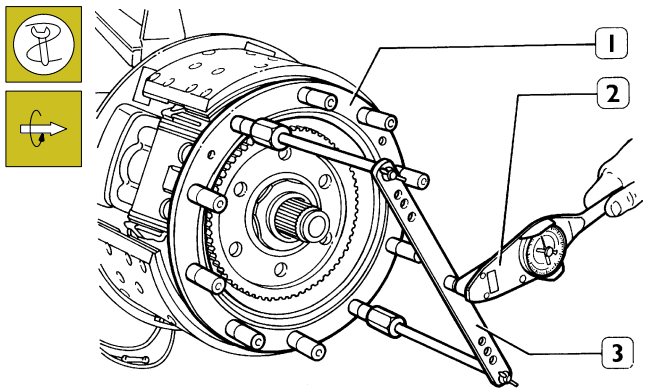
Figure 65



39535

Using wrench 99345207 (1) lock the wheel hub nut until the assembly rotates with difficulty.
Use a teflon hammer on the hub to settle the bearings in position.

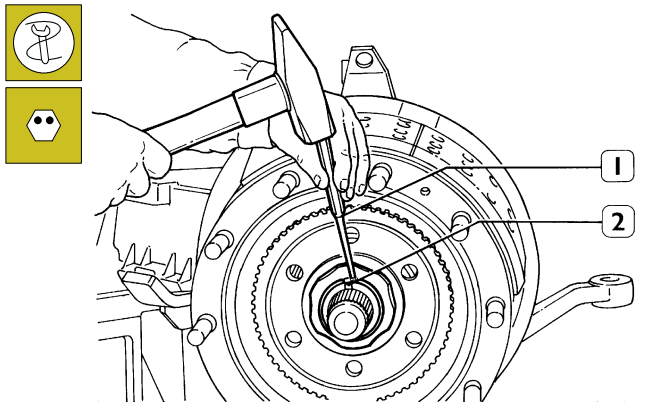
Figure 66



39536

Apply tool 99389819 (3) to the wheel hub (1) and use a dynamometric wrench (2) to rotate it.
Set the dynamometric wrench indicator (2) to zero then make one wheel hub turn at about 25 ÷ 30 r.p.m.
Find the rolling torque on the instrument scale indicator.
This value should correspond to that given in the SPECIFICATIONS AND DATA table on page 5.
If the values do not coincide, loosen or tighten the nut to obtain the required value.

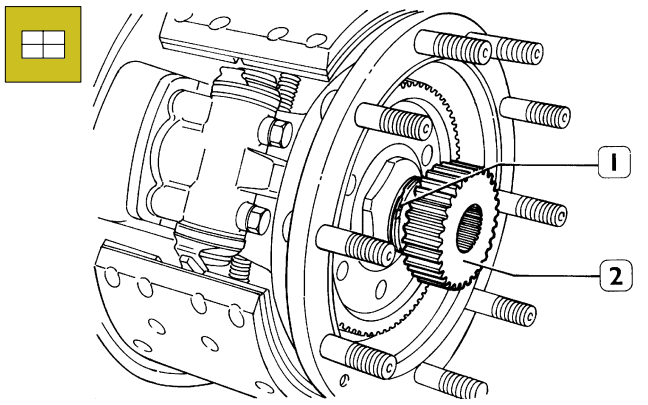
Figure 67



39537

Fit the shoulder ring (1) and the circlip (2) on the half shaft, using the appropriate pliers.

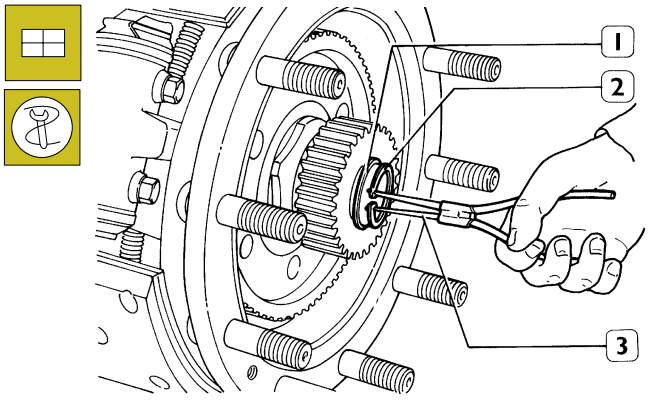
Figure 68



39538

Fit in place the shoulder ring (1), then the planetary gear (2)

Figure 69

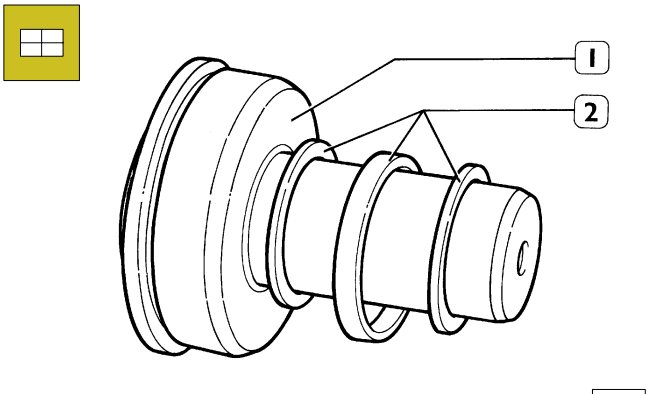


39539

Fit the shoulder ring (1) and the circlip (2) on the half shaft, using the appropriate pliers.

Fitting in place the epicyclic reduction gear support

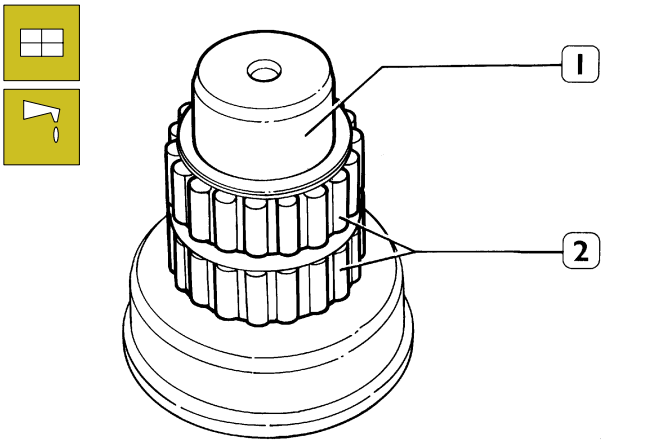
Figure 70



39541

Fit the shim rings (2) on the pin (1)

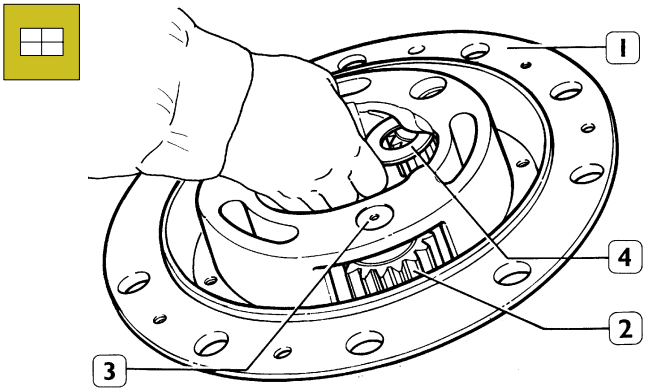
Figure 71



39542

Grease and fit in place the rollers (2) on the pin (1)

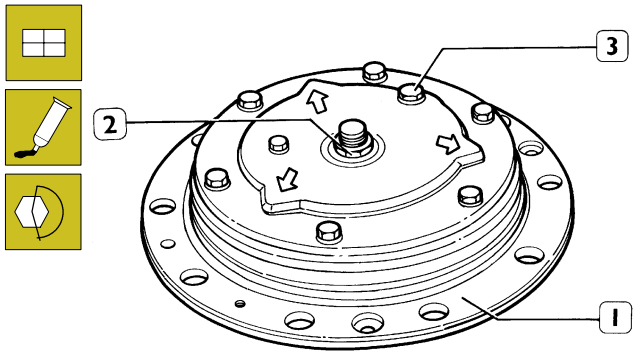
Figure 72



39543

Insert the gears (2), the spacer washers (4) and pins (3) into the support (1)

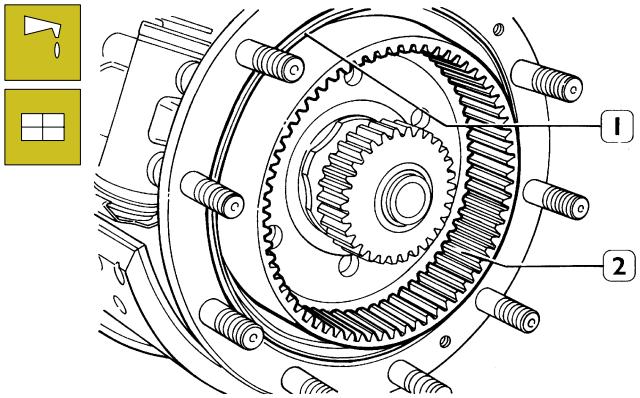
Figure 73



39544

Spread sealant on the two coupling surfaces of the support cover (1), fit in place the seal gasket and place the cover so that the spaces indicated by the arrows coincide with the pins.
To make this operation easier, before fitting the gasket, position the pins according to the seats on the cover, then fit in place the gasket.
Tighten the fastening screws to a torque of 25 Nm (2.5 kgm).
Loosen nut (2) and unscrew some threads of the screw (3)

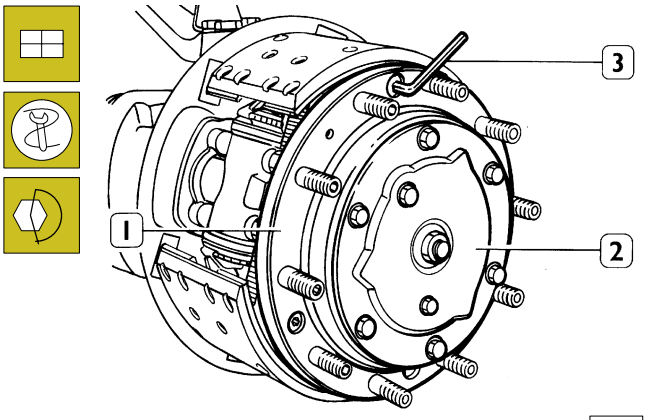
Figure 74



39545

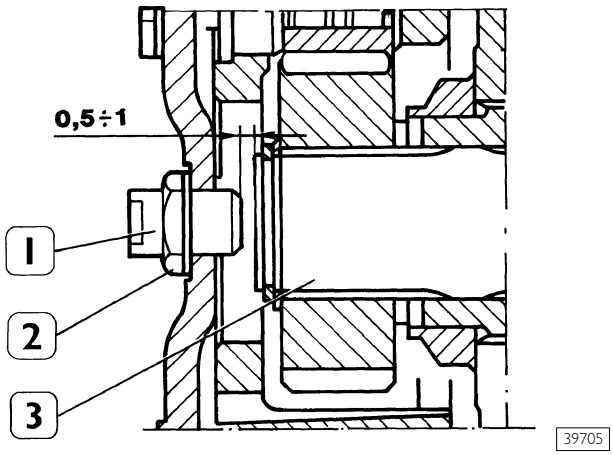
Fit in place the ring bevel gear (2) with the outer chamfer toward the operator. Grease the split ring (1) and fit it in its housing.

Figure 75



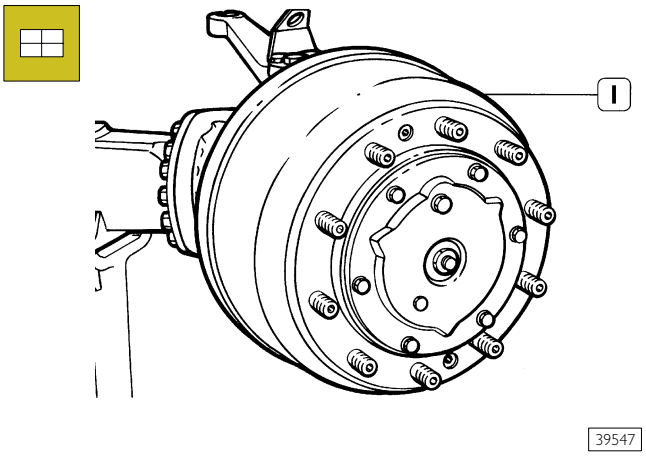
Fit in place the planetary gear carrier (2) on the wheel hub (1). Using a socket wrench (3) screw down the three hexagonal socket head screws and tighten them to a torque of 25 Nm (2.5 kgm).

Figure 76



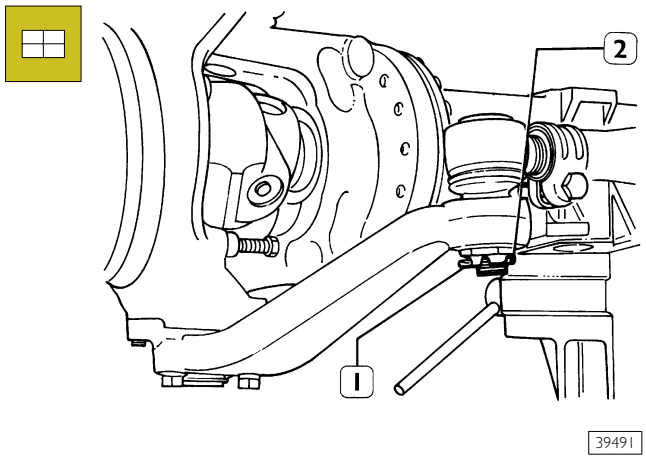
Tighten the screw (1) to bring it into contact with the half axle (3), then unscrew by 1/3 ÷ 1/2 a turn to obtain the assembly clearance (0.5 ÷ 1 mm).
Lock the nut (2)
The washer must be replaced whenever the half-axles end play is adjusted.

Figure 77



Fit in place the brake drum (1) on the wheel hub and lock it with the two screws.

Figure 78



Fit in place the track rod, tighten the nut (1) to the prescribed torque, fit the split pin (2) and bend it.

GREASING THE STUB AXLE PINS

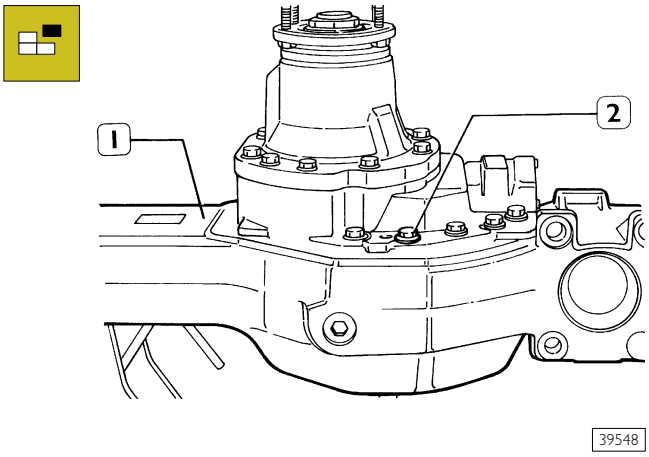
Using a suitable grease pump, fill the grease nipples.
Continue with the grease pump until the pressure of the grease, after the needle bearing housings are filled, overcomes the sealing edges of the rings and seeps out through the spaces between the stub axle post and the fork support.
Remove the excess grease.

EPICYCLIC UNITS LUBRICATION

Through the inlet hole on the cover, fill the epicyclic unit with approx 0.75 lt (0.68 kg) of prescribed oil.

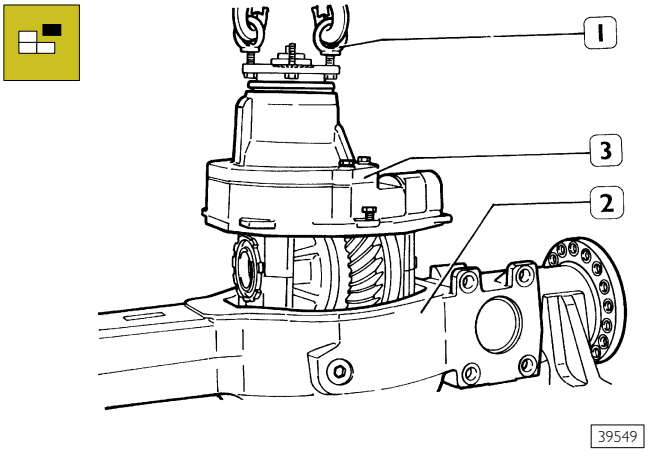
REMOVING THE DIFFERENTIAL (with axle on stand 99322215)

Figure 79



Set the axle casing (1) as shown in the figure and withdraw the half shafts.
Unscrew the differential housing fastening screws (2).

Figure 80



Fasten two eye-bolts (1) to the differential output flange.
Using suitable lifting equipment and ropes remove the differential (3) from the axle casing (2).

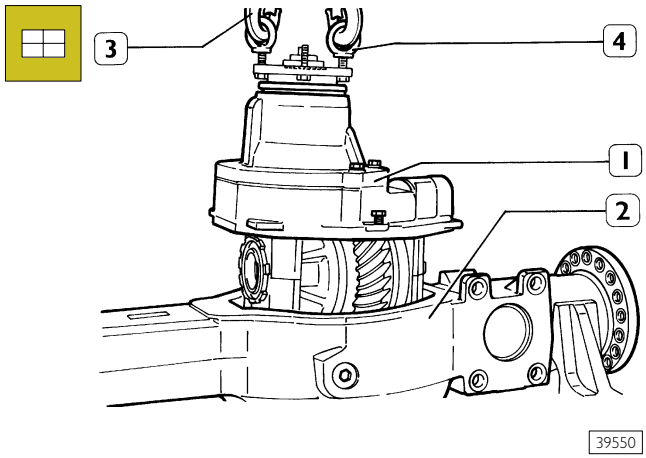
Axle casing check

The axle casing alignment must be checked since any deformation will cause straining and noise (see page 18).

RE-FITTING IN PLACE THE DIFFERENTIAL (with axle on stand 99322215)

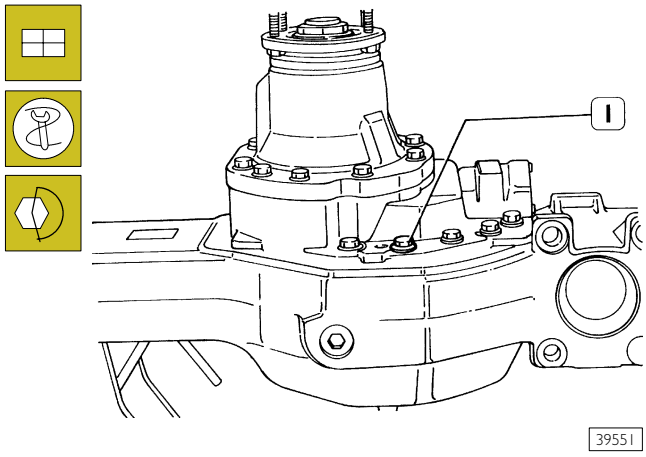
To keep in place the seal ring between the axle casing and the differential housing, moisten it with a little grease. Spread Loctite 573 on the coupling surfaces of the axle casing (2) and the differential housing (1).

Figure 81



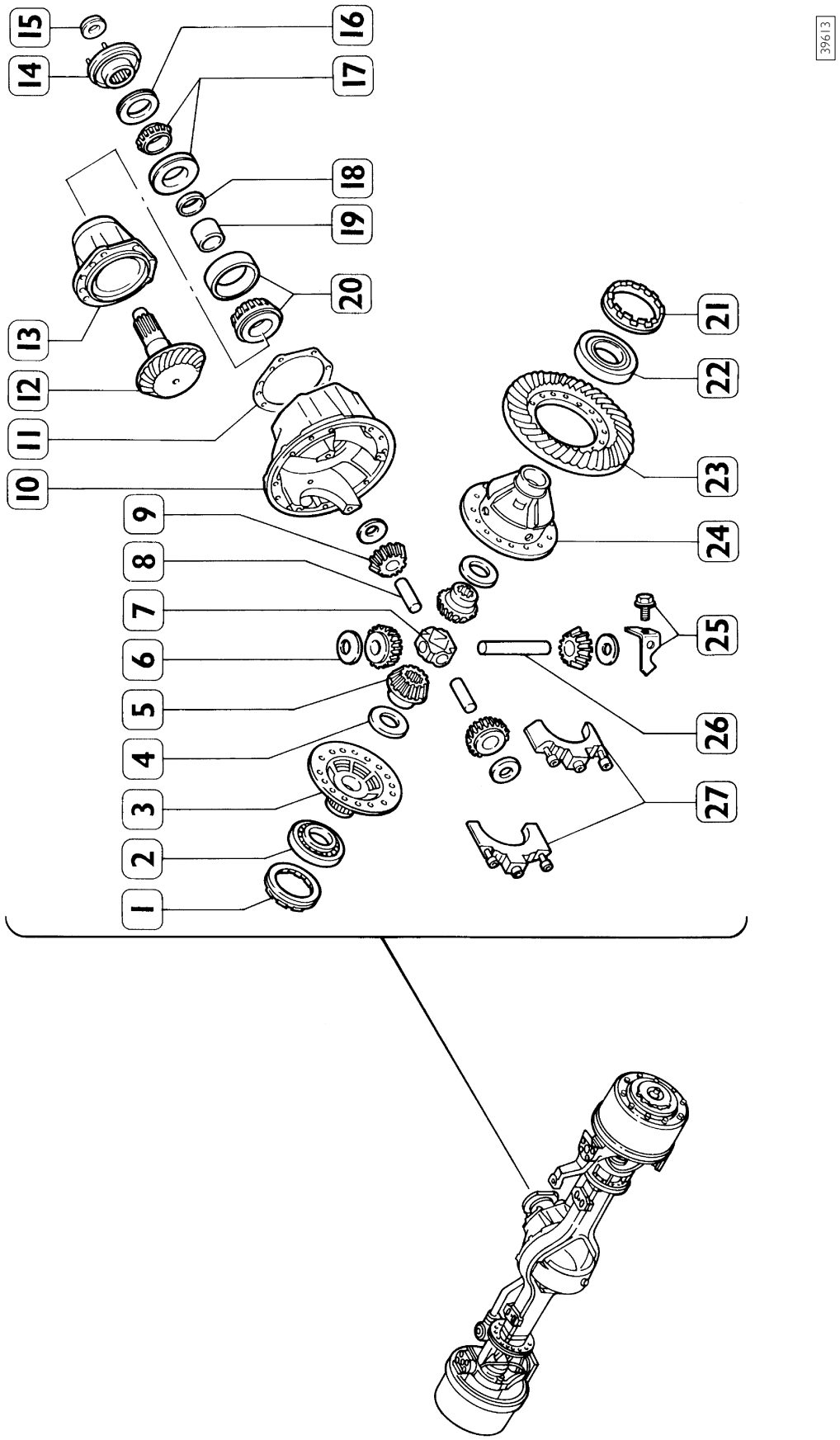
Using mobile hydraulic lifting equipment and ropes with hooks (3-4) place the differential housing (1) in the axle casing (2).

Figure 82



Insert the screws (1) and tighten them with a dynamometric wrench to the prescribed torque.

Figure 83

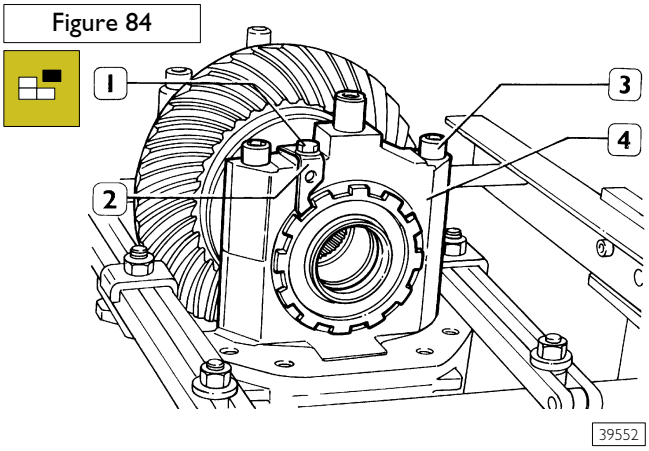


DIFFERENTIAL COMPONENTS

1. Ring nut - 2. Bearing - 3. Gear housing cover - 4. Shoulder washer - 5. Crown wheel - 6. Washer - 7. Spider - 8. Short pin - 9. Planetary gear - 10. Differential housing - 11. Adjusting shim - 12. Pinion - 13. Pinion support - 14. Flange - 15. Nut - 16. Seal ring - 17. Bearing - 18. Adjusting ring - 19. Spacer - 20. Bearing - 21. Ring nut - 22. Bearing - 23. Crown wheel - 24. Gear housing - 25. Plate and screw - 26. Long pin - 27. Caps

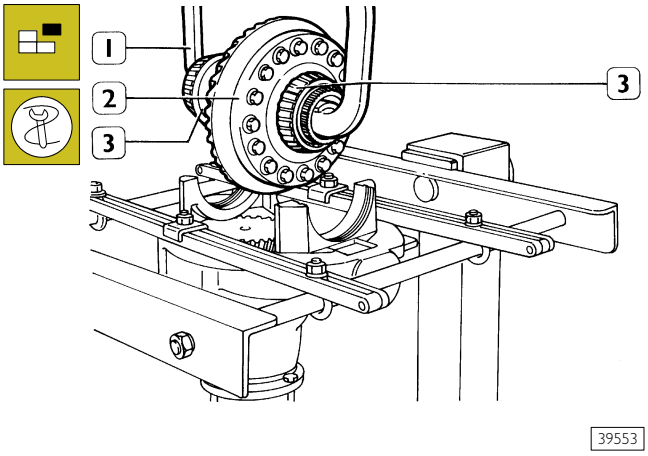
REPAIRING THE DIFFERENTIAL
Removal

Figure 84



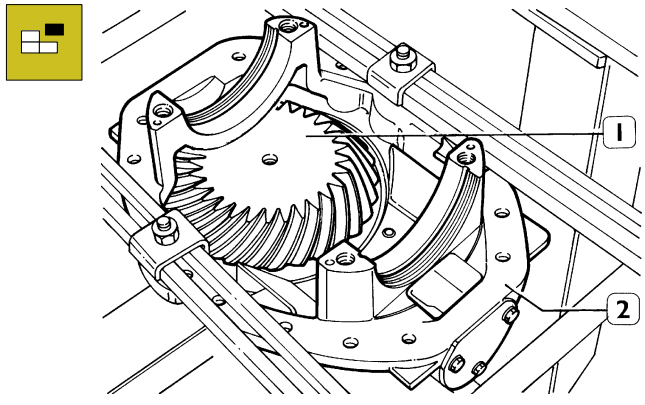
Remove screw (1) and take away the safety plate (2). Remove screws (3) and take away the caps (4). Remove the ring nuts.

Figure 85



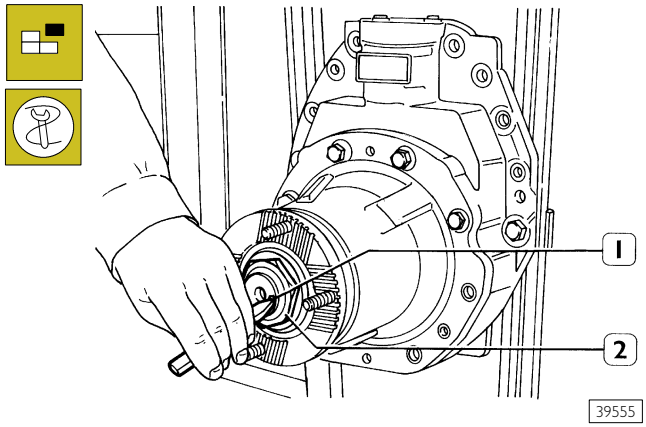
By means of the hook (1) lift the gear housing (2) with the relevant bearings (3).

Figure 86



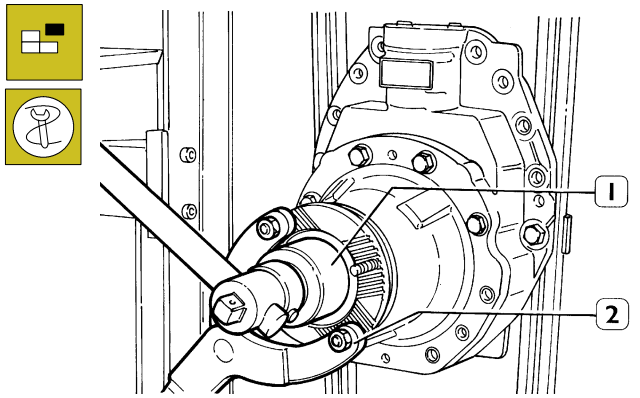
View of pinion (1) from inside the differential housing (2)

Figure 87



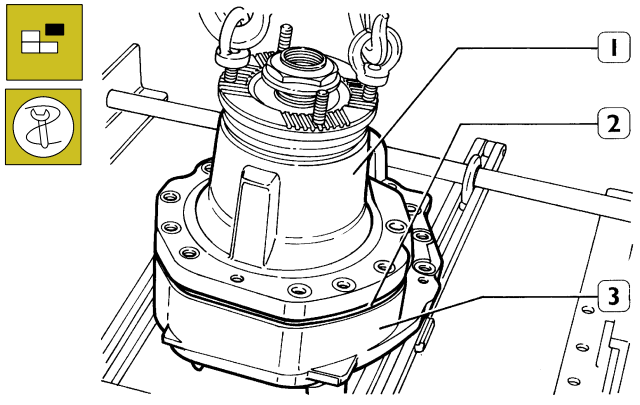
Using the appropriate beater, remove the dents (1) and unscrew the nut (2) as described below.

Figure 88



Lock the coupling flange rotation with lever 99370317 (2) and using socket wrench 99355081 (1) loosen the flange fastening nut.

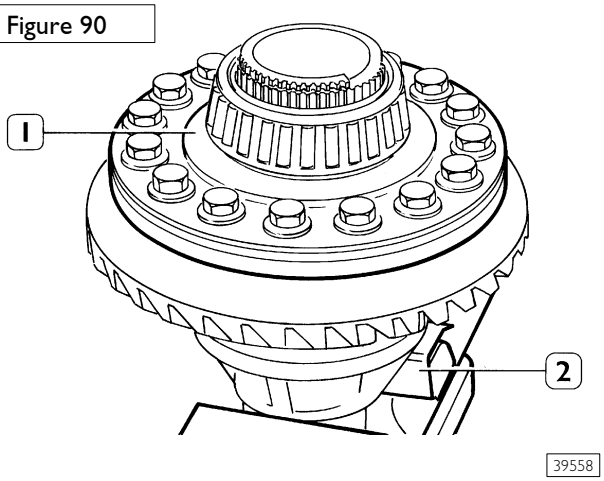
Figure 89



Remove the screws that fasten the bevel gear carrier to the differential housing.
Withdraw the carrier (1) with the bevel gear from the differential housing (3); remove the pinion-crown wheel shims (2)

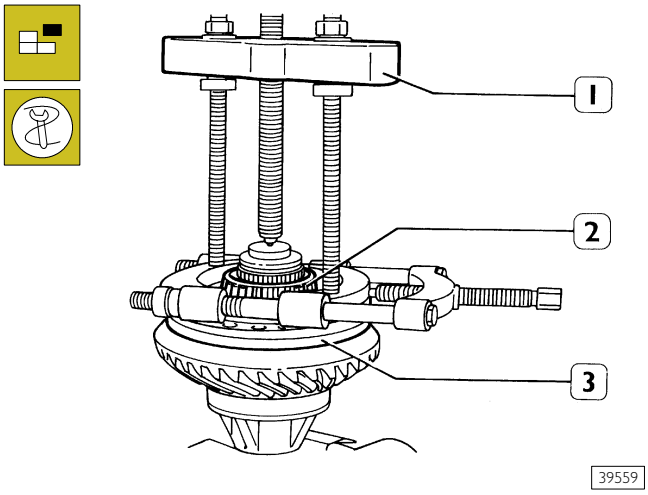
Removing the gear housing

Figure 90



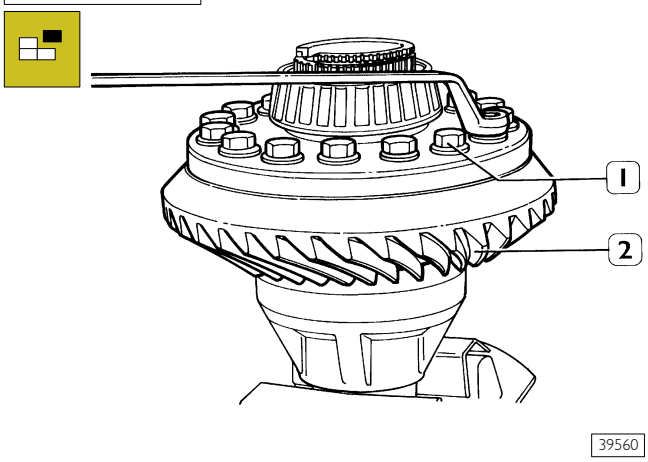
Set the gear housing (1) in a vice (2)

Figure 91



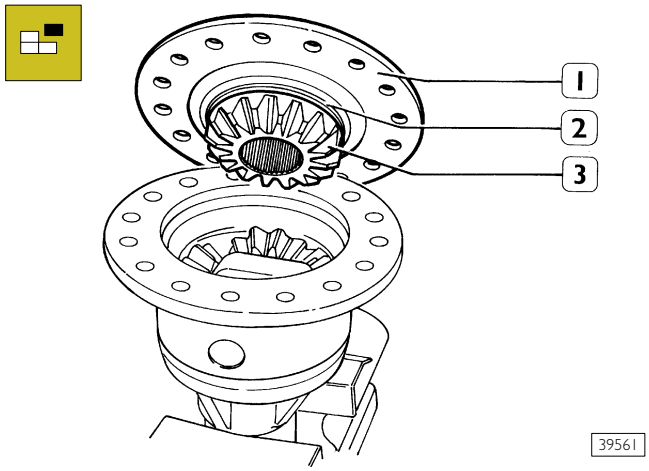
Using puller 9934801 (1) extract the bearing(2) on toothed side from the gear housing (3).

Figure 92



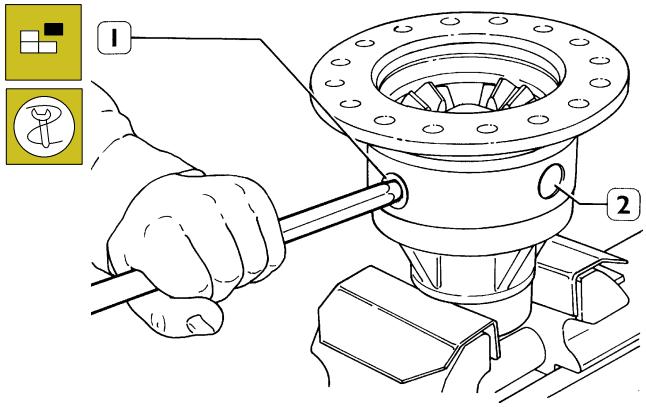
Remove the screws (1)
Use the suitable beater to release the bevel gear (2)

Figure 93



Remove the gear housing cover (1).
Take out the crown wheel (3) with its shoulder washer (2)

Figure 94



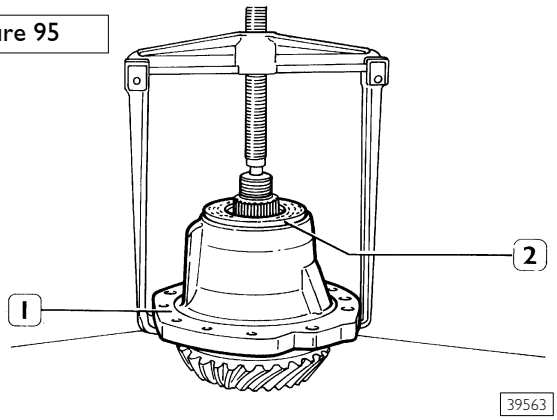
Use a beater to draw out the long pin (1), then the two short pins (2)

The exact position of the pins is indicated on the spider by a long stripe for the long pin and two short stripes for the short pins.

Remove the spider and the four planetary gear wheels with the shoulder washers.
Remove the crown wheel and shoulder washer

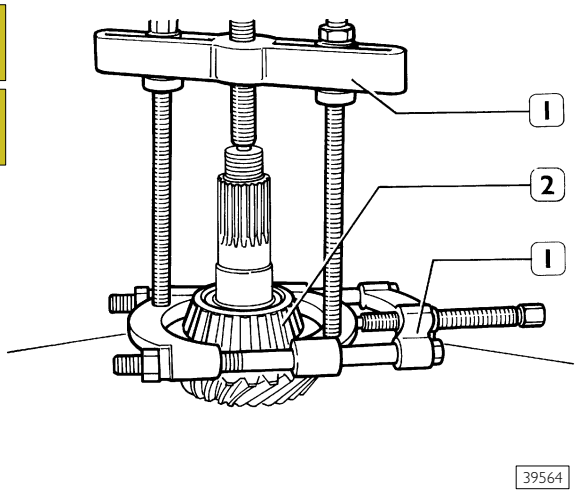
Removing the bevel pinion support

Figure 95



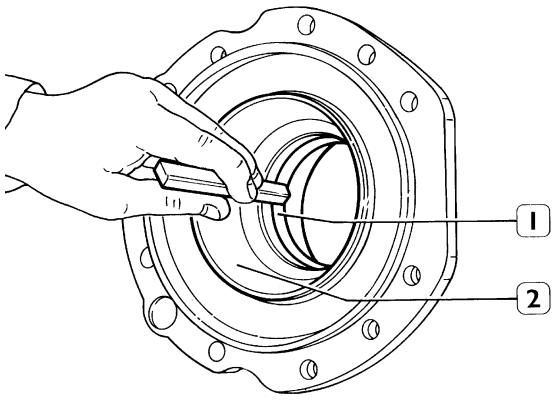
Using the suitable puller set up as shown in the figure, remove the bevel pinion, bearing and adjustment ring from the support (1)
Draw out the seal ring (2)

Figure 96



Using puller 99348001 (1) remove the bearing (2) from the bevel gear.

Figure 97



Using a beater, release the front and intermediate bearing outer rings (1 and 2) from the support.
Remove the oil baffle.

Checking the differential components

Carefully clean all the differential components.
Lubricate the bearings and rotate the roller cage freely, this rotation should be regular with no stiffening. Check the contact surfaces of the bevel gear and the stop plate of the half box to ensure that the crown wheel adheres properly. Any deformation of these surfaces will cause the vibration of the fastening screws jeopardizing the unit functioning.

Carefully clean all the threads to ensure accurate adjustments and exact driving torques.

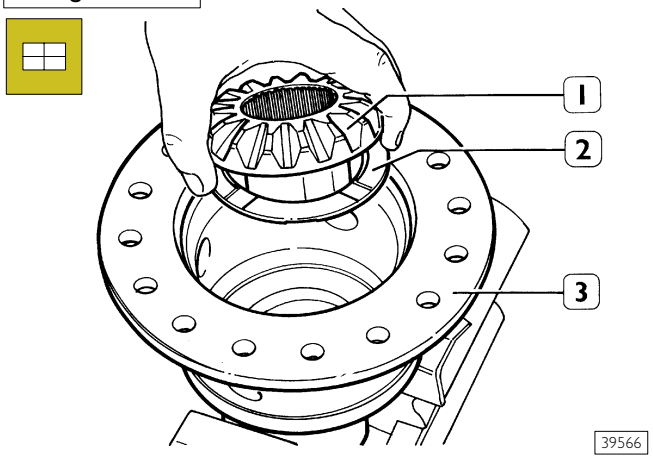
Check that the splined section for the flange connection onto the pinion is not worn. If it is, replace it.

If it is necessary to replace the crown or the pinion, both elements must be changed as they are supplied in pairs.

Check the planetary gears and their shoulder washers, the spider and the crown wheels with their shoulder washers.
All sealing elements and lock washers must be replaced with new ones.

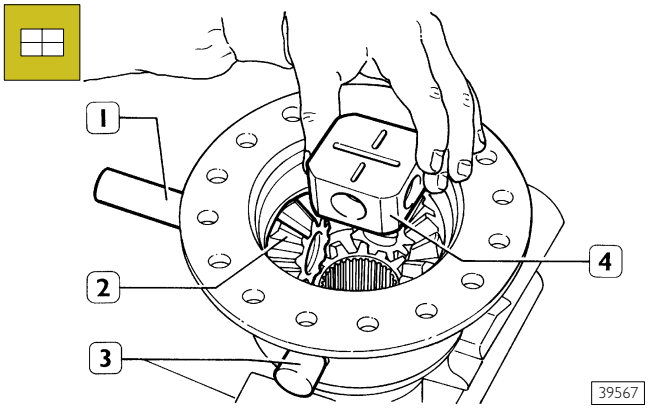
Fitting in place the gear housing

Figure 98



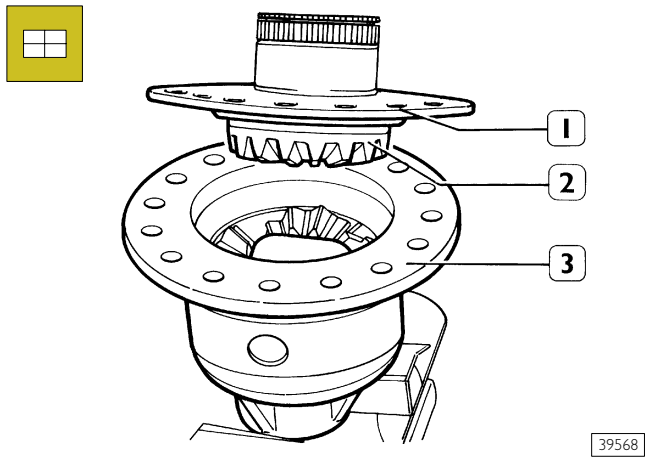
Set the gear housing (3) on a suitable support, fit the crown wheel (1) in its seat with its shoulder ring (2)

Figure 99



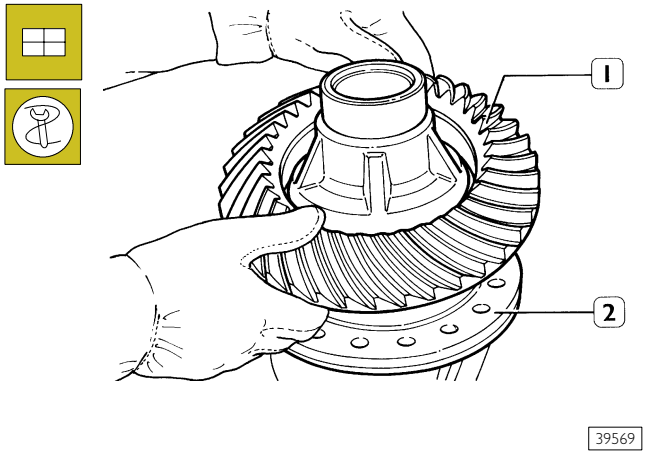
Fit in place the 4 planetary gears (2) and shoulder rings, then fit in place the spider (4). Insert the long pin (1) and two short pins (3).
The correct positions for the pins are marked on the spider (4) by a long stripe for the long pin and two short stripes for the short pins.

Figure 100



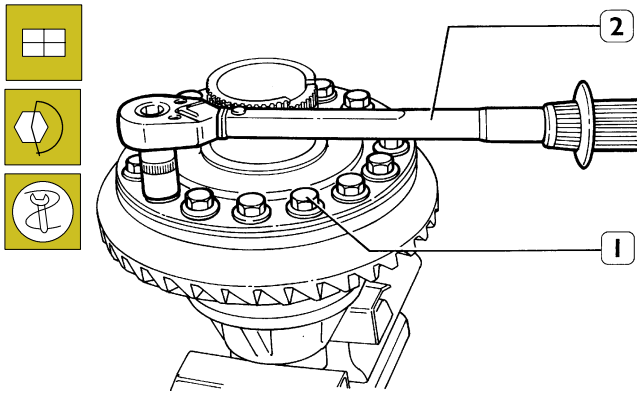
Set the crown wheel (2) with its shoulder ring on the planetary gears.
Fit in place the cover (1) on the gear housing (3) making sure that the fastening screw holes coincide.

Figure 101



Heat the bevel gear (1) to approx 80°C, fit it into its seat on the gear housing (2) and lock it immediately by means of two fastening screws.

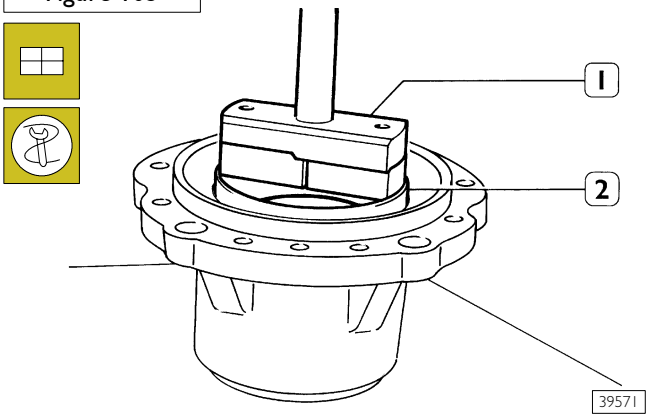
Figure 102



Fit in place the other screws (1) and tighten them with a dynamometric wrench (2) to a torque of 300 Nm.
Heat the support bearings and fit them in place on the gear housing.

Fitting in place the bevel pinion support

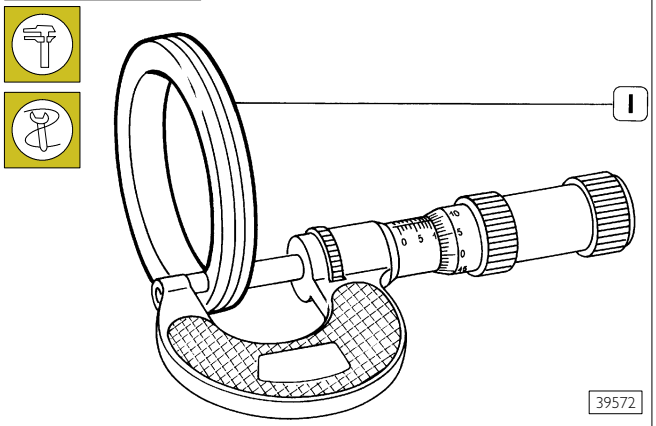
Figure 103



Fit a new oil baffle in the pinion support. Using beater 99374093 (1) drive completely into their seats the outer ring (2) for the front bearing and with beater 99374094 the outer ring for the rear bearing.

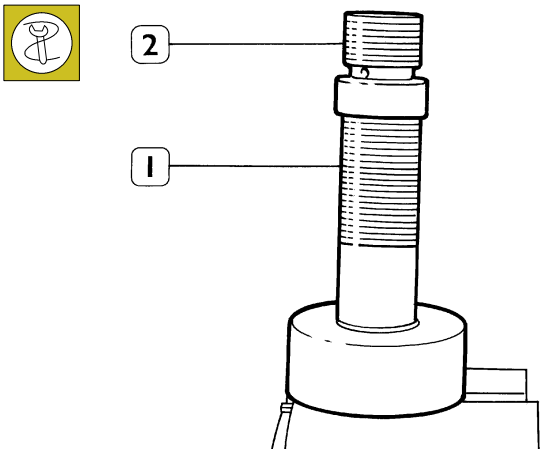
PROCEDURE TO DETERMINE THE ADJUSTMENT RING SHIM FOR THE BEVEL GEAR ROLLING TORQUE

Figure 104



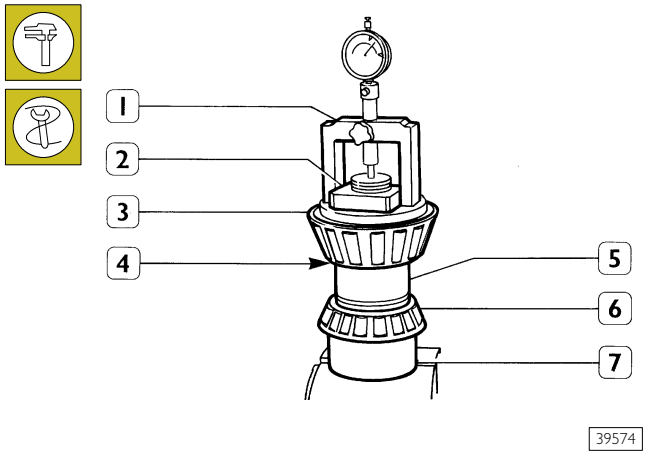
Measure the thickness of the adjustment ring (1) that has been removed and make a note of the value (value A).

Figure 105



Tighten tool 99395027 (1) and its extension bar (2) in a vice

Figure 106



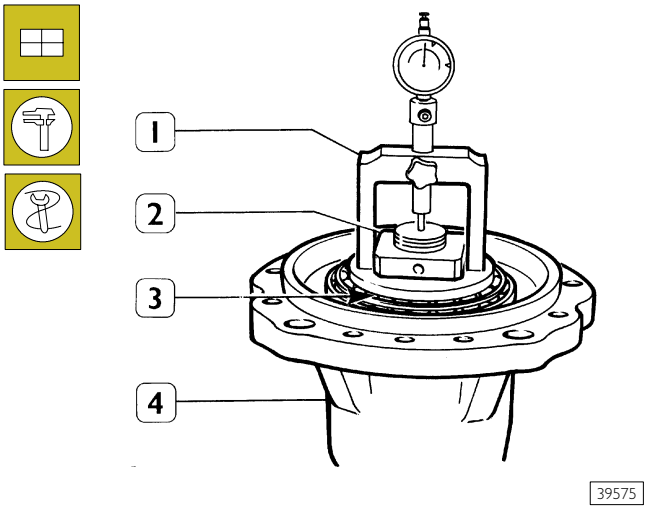
Onto tool 99395027, fit in place:

- ❑ pinion side bearing (6)
- ❑ spacer ring (5), the previously measured adjustment ring (4) and bearing (3).

Screw on the ring nut (2) and lock it tight.
On the bearing (3), set element (1) of tool 99395027 (1) equipped with a dial gauge and set the gauge to zero on the end of the tool (7).
Now remove from the tool (7):

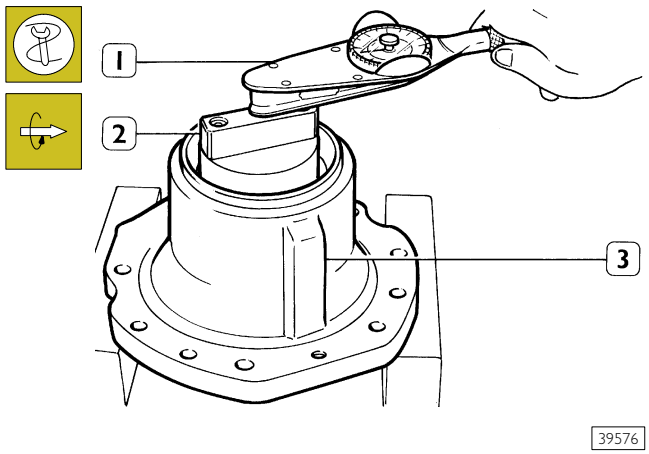
- ❑ element (1),
- ❑ ring nut (2),
- ❑ bearing (3),
- ❑ adjustment ring (4) .

Figure 107



Set the support (4, figure 105) on the bearing (6, figure 104) then fit in place the bearing (3).
Tighten the ring nut (2) by hand. Check the rolling torque as indicated in figure 108.

Figure 108



39576

Set the complete support (3) on two parallel bars; using the dynamometric wrench (1) mounted on the equipment (2) find the rolling torque that should result:

❑ 6 ÷ 8 Nm; if it is not so, operate on the ring nut (2, figure 106)

Once again place the part (1, fig. 107), with the dial gauge set to zero, on the bearing (3, fig. 107) to find any deviation (value B).

The adjusting ring thickness **S** is obtained from the following formula:

S = A - (± B) + C

where:

A = thickness of adjusting ring fitted to reset the dial gauge

B = deviation found

C = 0.05 mm coefficient that takes into account the bearings dilatation caused by the assembly interference on the bevel gear

First example:

A = 13.12 mm
B = + 0.13 mm
C = 0.05 mm

S = 13,12 - (+ 0.13) + 0.05 =
S = 13,12 - 0.13 + 0,05 = 13.04 mm.

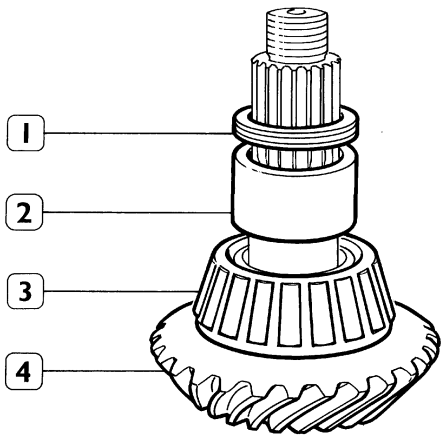
Second example

A = 13.12 mm
B = - 0.13 mm
C = 0.05 mm

S = 13.12 - (- 0,13) + 0,05 =
S = 13.12 + 0.13 + 0.05 = 13.30 mm.

Remove the parts from tool 99395027.

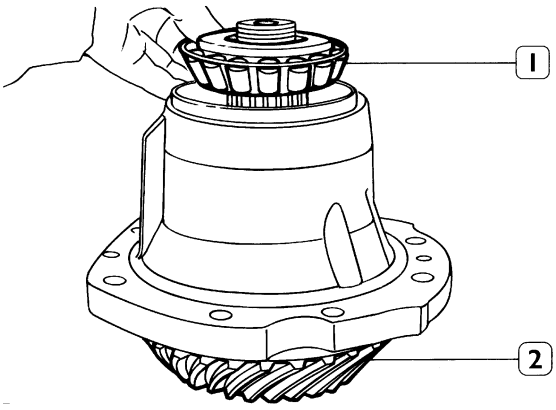
Figure 109



39577

Heat the bearing (3) and connect it to the bevel pinion (4).
Fit in place the spacer (2).
Fit in place an adjustment ring (1) that has the same thickness as previously noted and set it on the bevel gear.
Fit in place the support with the bearing outer rings on the bevel gear.

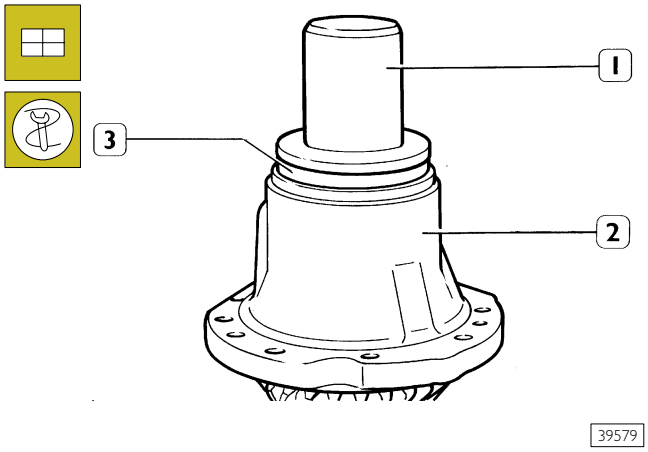
Figure 110



39578

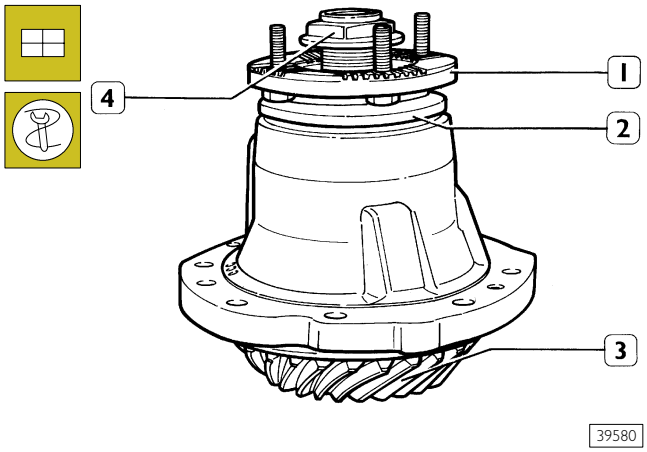
Heat the bearing (1) and using the beater, fit it into its seat on the bevel gear (2).

Figure 111



Using connecting device 99374233 (1) fit in place the new gasket (3) on the support (2). The gasket spares are supplied prelubricated and with grease between the lips.

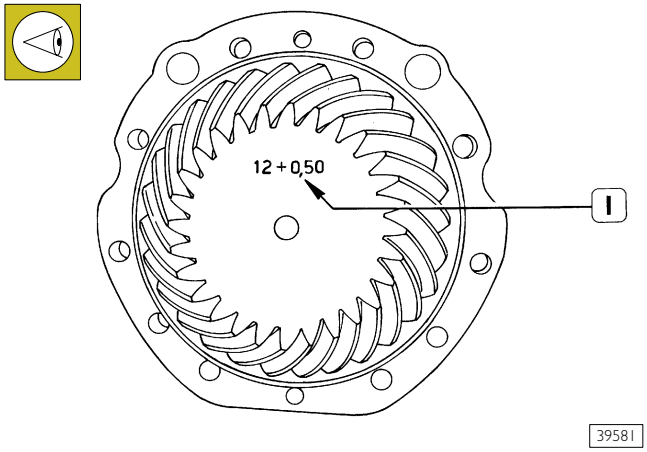
Figure 112



Set the coupling flange (1) and baffle (2) on the splined area of the bevel gear (3). Using a suitable beater fit it tightly. Tighten the nut (4) momentarily.

Fitting in place the differential housing

Figure 113



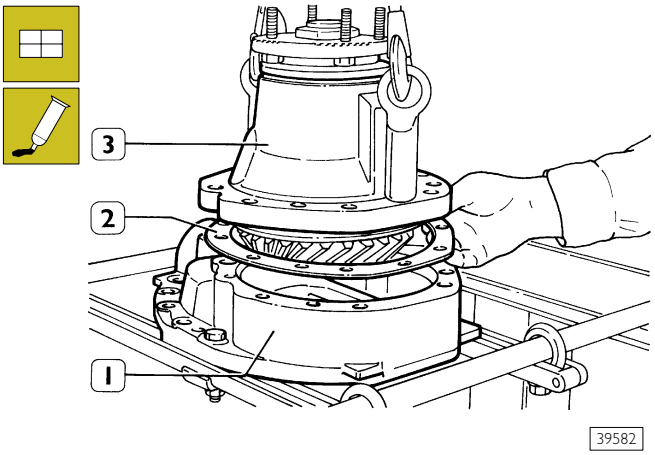
Before fitting in place the bevel gear carrier on the differential housing, check the value (1) engraved on the bevel pinion; consulting the table in figure 114 the thickness of the adjusting ring to be placed between the support and the housing is obtained.
Example:
if the reference value (1) engraved on the pinion is + 0.50, the thickness of the adjusting ring must be 1 mm.

Figure 114

Values engraved on the bevel gear	Total thickness of adjusting rings
0	0,5
0,1	0,6
0,2	0,7
0,3	0,8
0,4	0,9
0,5	1,0
0,6	1,1
0,7	1,2
0,8	1,3
0,9	1,4
1,0	1,5

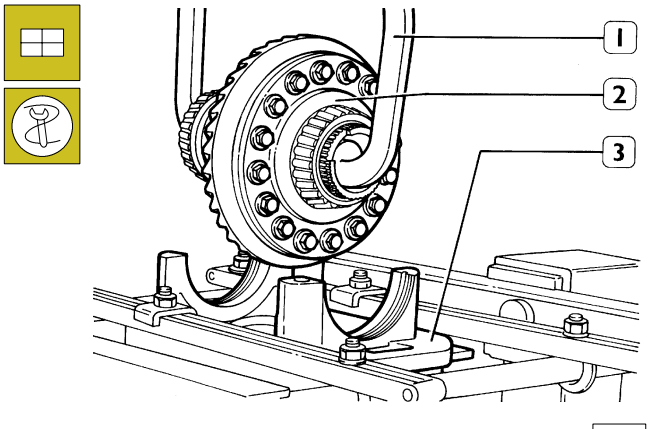
TABLE TO DETERMINE THICKNESS OF THE ADJUSTING RING SET IN THE BEVEL GEAR

Figure 115



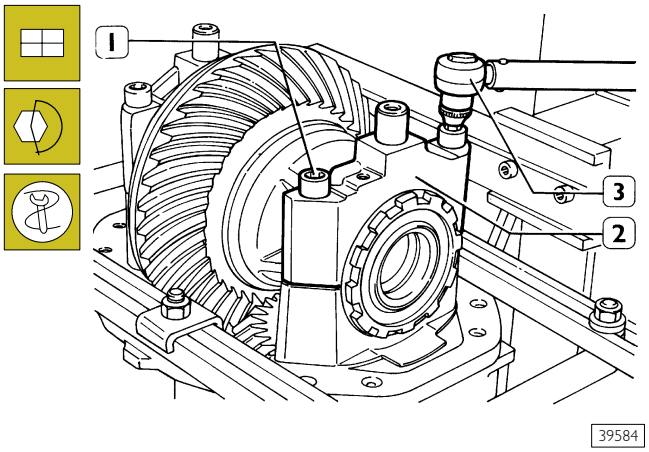
Carefully spread LOCTITE 573 on the contact surface (1); fit in place the adjusting ring (2) and using eye bolts and ropes fit the completed bevel gear support (3) on the differential housing.
Tighten the fastening screws to the prescribed torque.

Figure 116



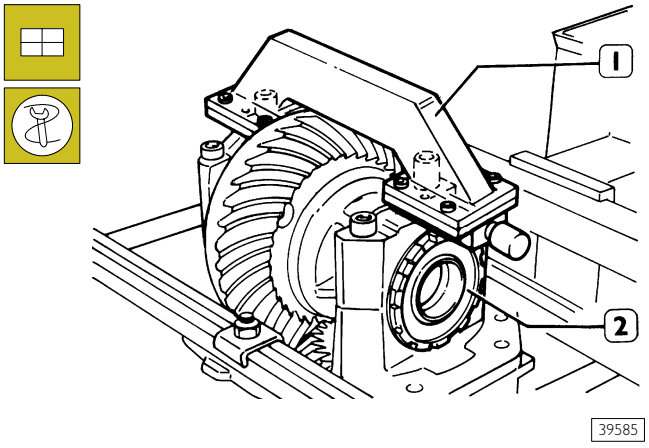
Using the specific hook (1) lift the previously assembled gearcase (2) and set it on the differential housing (3)

Figure 117



Fit in place the bearing outer rings. Fit the caps (2) and tighten, but not completely, the screws (1), Fit in place the adjusting ring nuts checking that they can be screwed easily; with a dynamometric wrench (3) lock the screws to the prescribed torque.

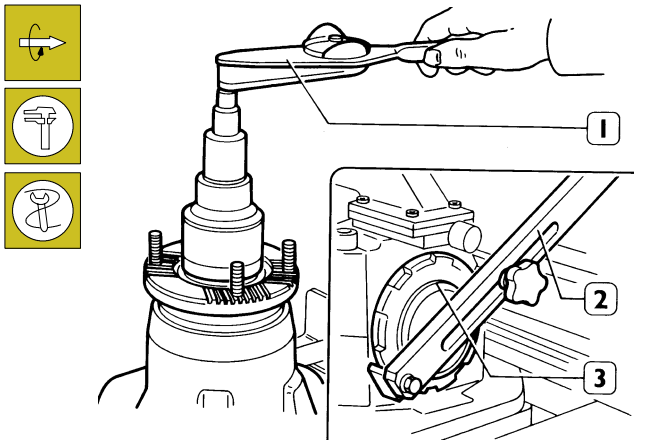
Figure 118



Set tool 99370133 (1) as shown in the figure to prevent excessive angle variation of the caps during adjustment.

Adjusting the gear housing bearings rolling torque

Figure 119



The rolling torque adjustment for the gear housing bearings is obtained measuring the total rolling torque.
Using torque wrench 99389819 (1) and appropriate socket wrench, find the prescribed rolling torque, operating on the bearing adjustmentring nuts with wrench 99355025 (2)

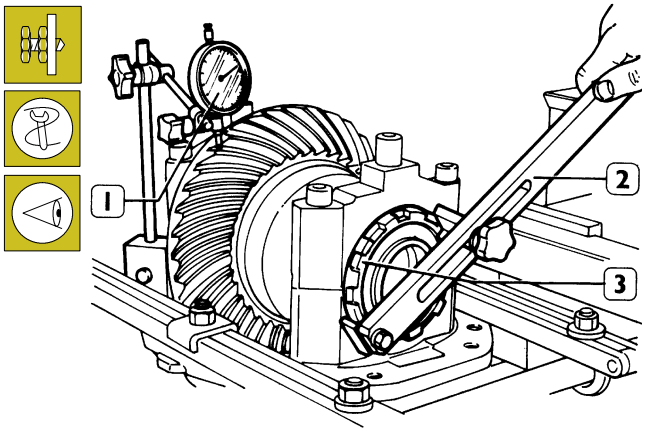
Find from the table below the rolling torque value (this value varies according to the bevel gear pair ratio) and perform adjustment.

No. teeth	Ratio	Total rolling torque Nm
27/32	1,185	a+(2,5÷4,2)
28/37	1,321	a+(2,3÷3,8)
21/40	1,905	a+(1,6-2,1)
19/33	1,737	a+(1,7-2,3)
23/36	1,565	a+(1,9-2,6)

a = 3 ÷ 4 Nm

Adjusting the end play between pinion and bevel gear pair

Figure 120

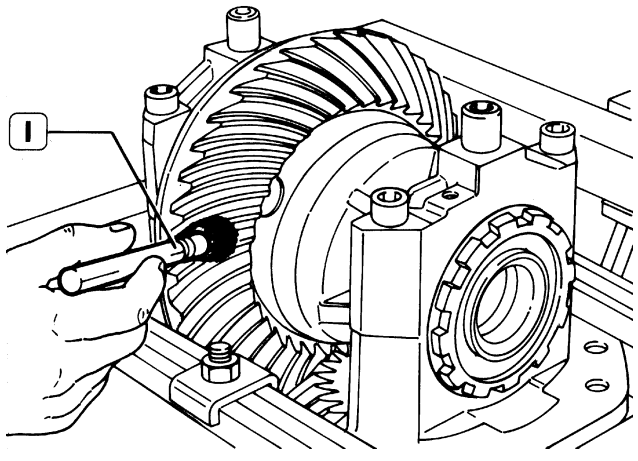


39586

Adjust the end play between the pinion-crown wheel teeth, to obtain 0.18 ÷ 0.23 mm. The procedure is as follows:

- ❑ Set the dial gauge (1) with magnetic base as shown in the figure;
- ❑ using wrench 99355205 (2) tighten the bearing adjustment ring nuts (3) and loosen by the same amount the ring nut on the opposite side. Taking this precaution the rolling torque that has been previously adjusted is maintained.

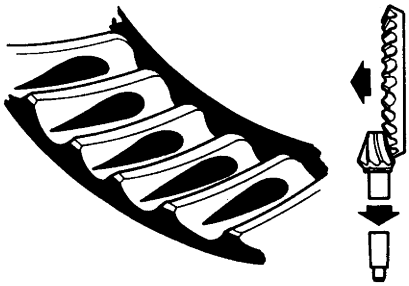
Figure 121



39588

Using a brush (1) apply a thin coating of lead oxide on the crown wheel teeth.
Turn the pinion and find the contact mark between the pinion teeth and the crown wheel teeth.
The figures that follow show the possible contact points and how to correct any errors.

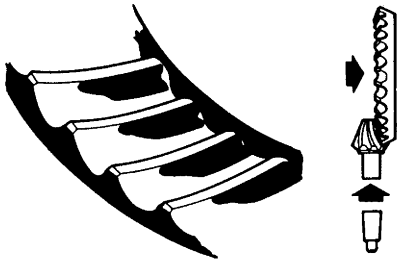
Figure 122



19452

The pinion is too deeply set, therefore it requires further adjustment.
To adjust the exact pinion position, shims must be added under the pinion support to obtain an exact contact.
A slight internal crown wheel movement may be necessary to maintain the exact nominal value.

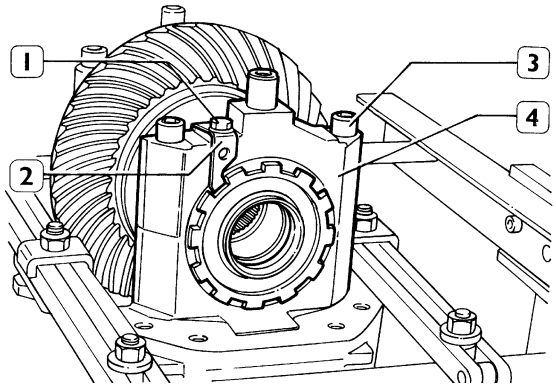
Figure 123



19453

The pinion is too far out, therefore it requires further adjustment.
To adjust the exact pinion position, shims must be removed from under the pinion support to obtain an exact contact.
A slight external crown wheel movement may be necessary to maintain the exact nominal value.

Figure 124



39552

Fit the plate (2) and tighten the fastening screws to the prescribed torque.
If the plate (2) does not fit into the ring nut groove (3) slightly rotate the ring nut until the two parts match. Carry out the same procedure on the other side.

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SINGLE REAR AXLE

SECTION 12.3

SECTION 12.3

Single rear axle

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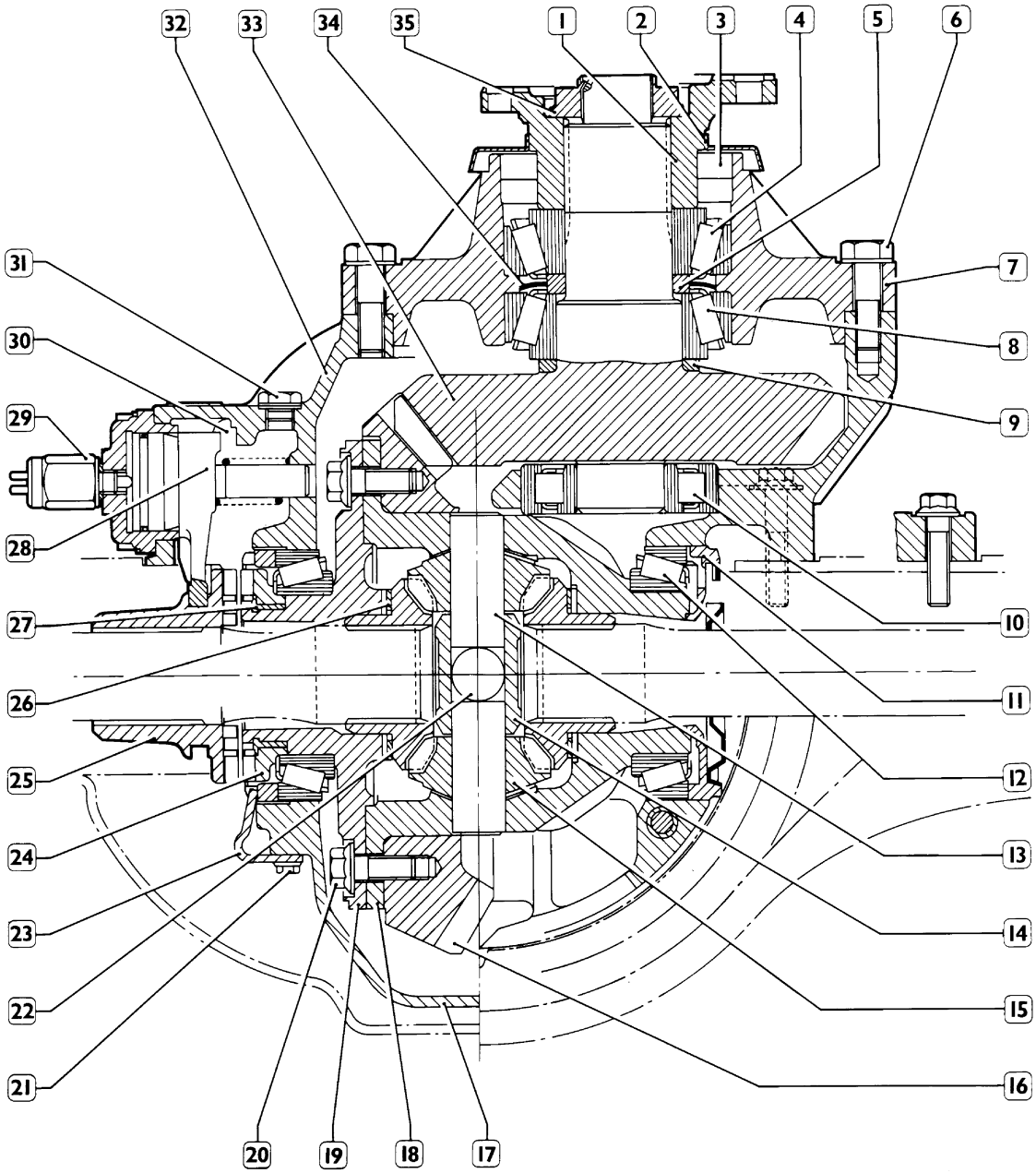
DESCRIPTION

The rear axle is a double reduction type: the first reduction is by means of the pinion - ring bevel gear unit and the second is obtained through an epicyclic unit in the wheel hubs.
The differential housing, with the ring bevel gear , is supported by two taper roller bearings that can be adjusted through two threaded ring nuts.
The pinion is supported by two taper roller bearings and a third straight roller bearing.
The bevel pinion unit is adjusted through adjusting rings that are fitted between the the two taper roller bearings.
The axle is equipped with a pneumatically controlled device to lock the differential.
The half shafts coming from the differential transmit the motion to the epicyclic gears.

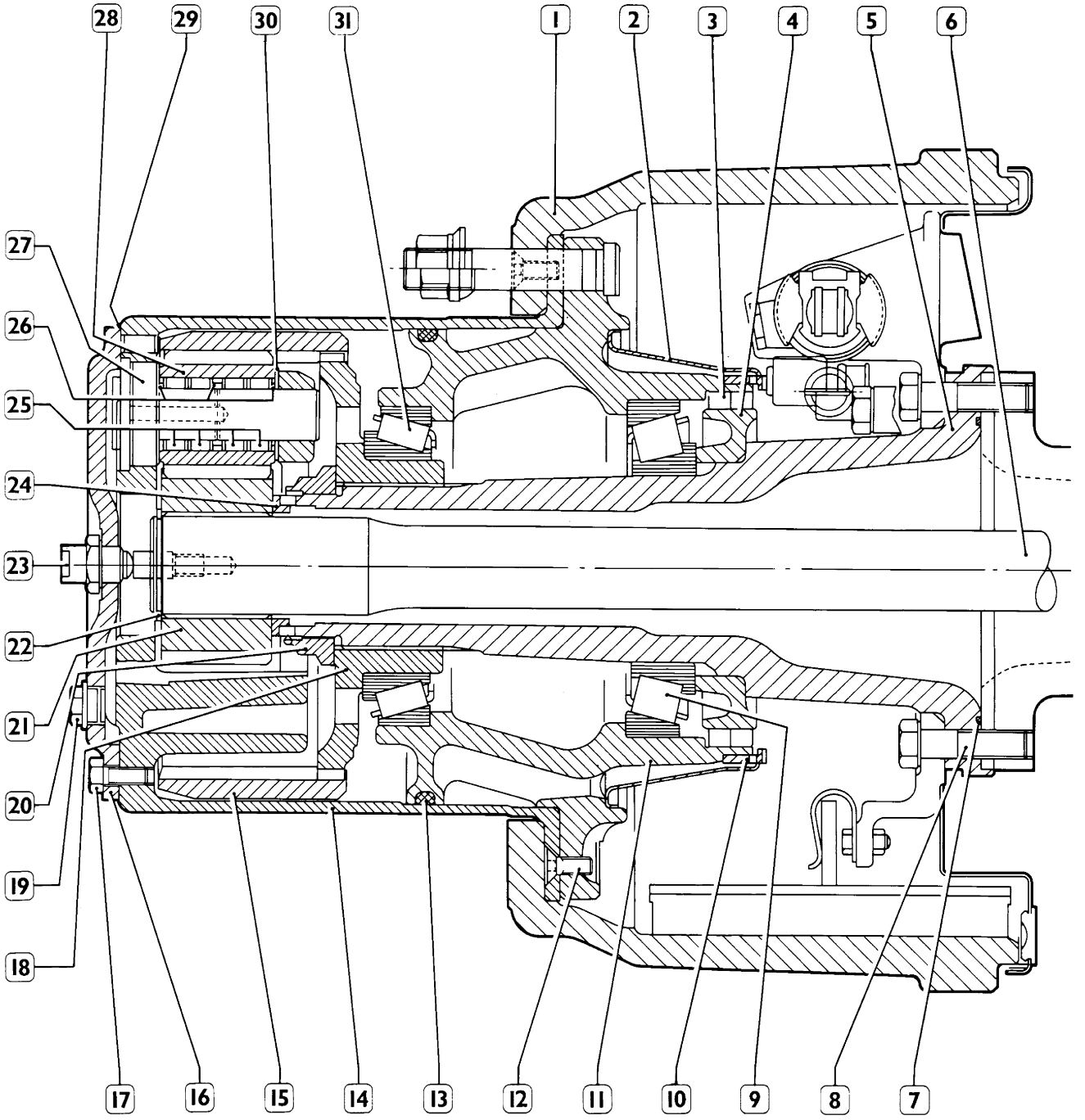
Figure 1



PICTORIAL CROSS SECTION OF THE DIFFERENTIAL

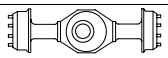
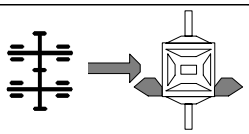
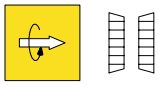
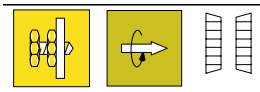
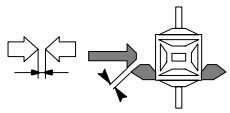
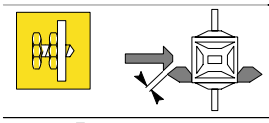
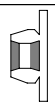
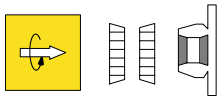
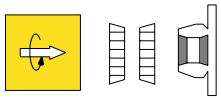
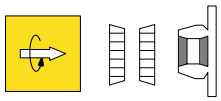
1. Coupling flange - 2.Oil seal - 3. Outer seal ring - 4. Front bearing - 5. Adjusting ring - 6. Screw - 7. Bevel pinion support - 8. Intermediate bearing - 9. Adjusting ring - 10. Rear bearing - 11. Adjusting ring nut - 12. Differential housing bearing - 13. Short pin - 14. Spider - 15. Planetary gear - 16. Crown wheel - 17. Cover - 18. Gear housing - 19. Cover - 20. Screw - 21. Screw - 22. Long pin - 23. Safety plate - 24. Engaging sleeve - 25. Sliding sleeve - 26. Shoulder washer - 27. Split ring - 28. Engaging fork - 29. Transmitter - 30. Spring - 31. Plug - 32. Differential housing - 33. Taper pinion - 34. Oil baffle - 35. Lock nut

Figure 2



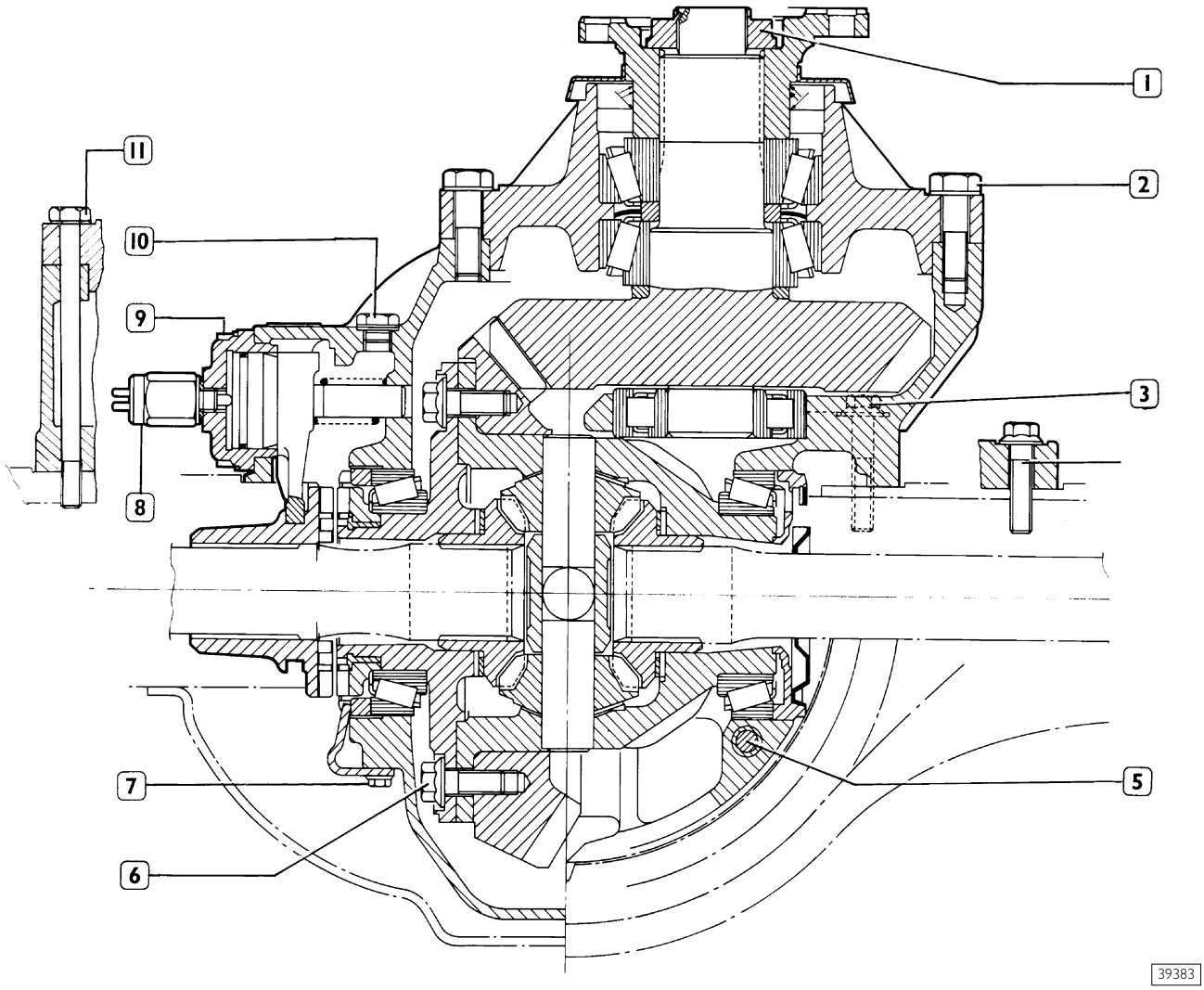
PICTORIAL CROSS SECTION OF EPICYCLIC REDUCTION GEAR AND WHEEL HUB (45139)
1. - Brake drum - 2. Oil manifold - 3. Seal ring - 4. Intermediate ring for sealing rings - 5. Bearing shaft - 6. Half shaft - 7. Seal ring - 8. Screw - 9. Bearing - 10. Phonic wheel - 11. Wheel hub - 12. Screw - 13. Seal ring - 14. Planetary gear support - 15. Crown wheel - 16. Cover - 17. Screw - 18. Crown wheel carrier - 19. Plug - 20. Collar nut - 21. Planetary gear - 22. Circlip - 23. Spacer screw - 24. Spacer ring - 25. Planetary gear needles - 26. Spacer rings - 27. Pin - 28. Planetary gear - 29. Gasket - 30. Spacer washer - 31. Bearing

SPECIFICATIONS AND DATA

 Type of axle: Bearing with double reduction, differential is locked through pneumatic control and reduction gear unit	**ASTRA 451391/2D (IVECO R 8284 D005)**
 Bearings for bevel pinion	2, with taper rollers and 1 with straight rollers
 Reduction bevel gear pair ratio	21/40 (1,905) 19/33 (1,737) 23/36 (1,565) 28/37 (1,321) 27/32 (1,185)
 Epicyclic reduction gear ratio on the wheels	3,2
 Bevel pinion bearings rolling torque without gasket Nm	1,5 ÷ 3,5
 Bevel pinion bearings rolling torque adjustment	through adjustment rings
 Thickness of adjustment rings for bevel pinion bearings rolling torque mm	10 – 10,02 – 10,04 – 10,06 – 10,08 – 10,10 – 10,12 – 10,14 – 10,16 – 10,18 – 10,20 – 10,22 – 10,24 – 10,26 – 10,28 – 10,30 – 10,32 – 10,34 – 10,36 – 10,38 – 10,40 – 10,42 – 10,44 – 10,46 – 10,48 – 10,50
 Thickness of adjustment rings for bevel pinion fitting with reference to the crown wheel mm	3,6 – 3,7 – 3,8 – 3,9 – 4,0 – 4,1 – 4,2 – 4,3 – 4,4 – 4,5 – 4,6
 Backlash between pinion and crown wheel mm	21/40 0,20–0,28 19/33 0,25–0,33 23/36 0,20–0,29 28/37 0,20–0,28 27/32 0,20–0,30
 Bevel pinion to crown wheel backlash adjustment	Through ring nuts
 **WHEEL HUBS**	2, taper roller
 Wheel hub bearings	Two with taper rollers
 Rolling torque of wheel hub bearings: new bearings with surface protection Nm	3 Nm + (12 ÷ 16 Nm)
 Rolling torque of wheel hub bearings: Run-in bearings and new lubricated seal rings Nm	3 Nm + (5 ÷ 7 Nm)
 Rolling torque of wheel hub bearings: Run-in bearings and seal rings Nm	3 Nm + (2,5 ÷ 4,5Nm)
 Half-shaft end play mm	0,5 ÷ 1

TIGHTENING TORQUES

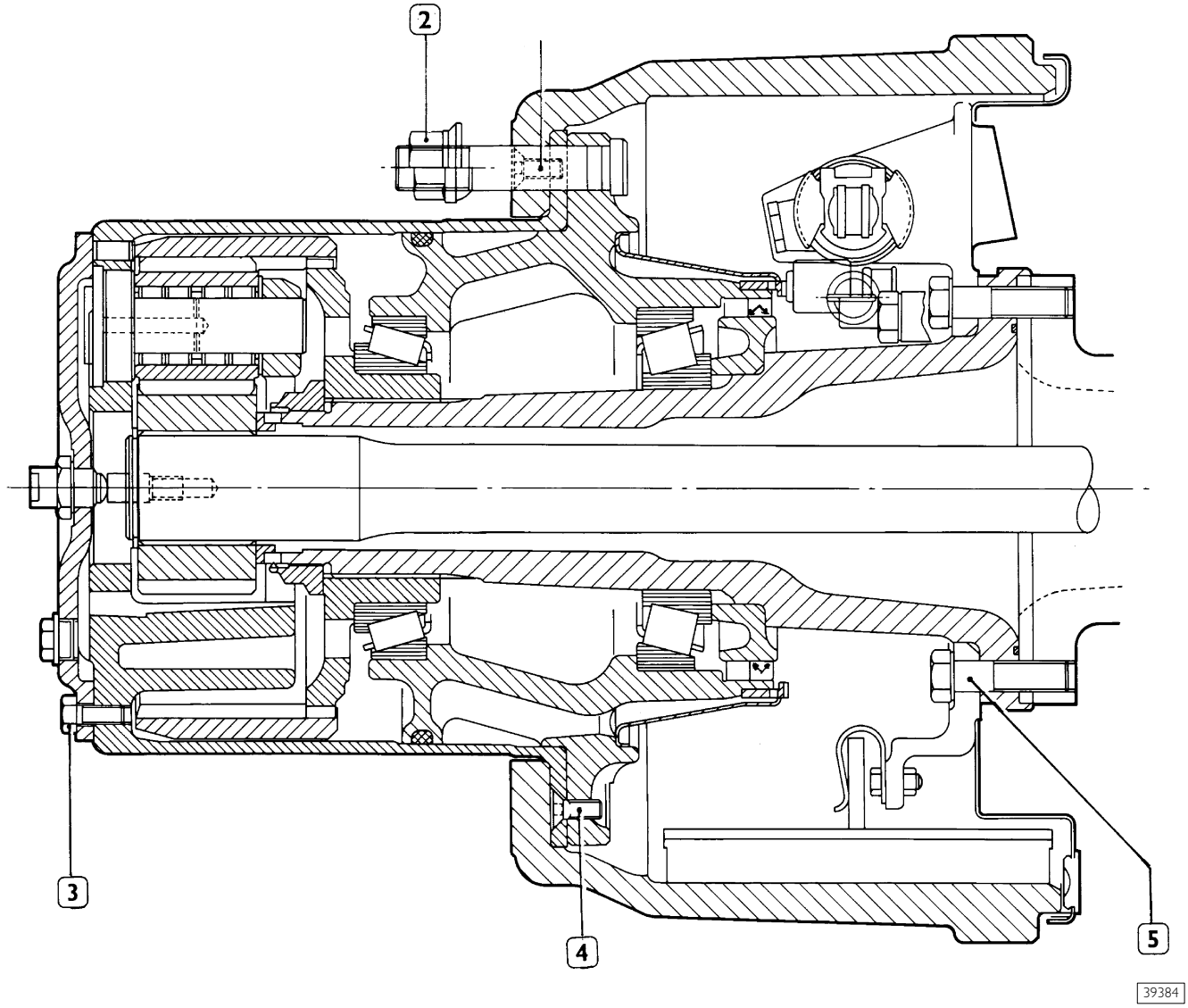
Figure 3



	COMPONENT	TORQUE	
		Nm	Kgm
1	Bevel pinion locking nut	700 ± 50	70 ± 5
2	Bevel pinion support to differential housing fastening screw	165 ± 15	16,5 ± 1,5
3	Differential housing to axle casing fastening screw	160 ± 10	16 ± 1
4	Differential housing to axle casing fastening screw ●	160 ± 10	16 ± 1
5	Bevel pinion support to differential housing fastening screw ♦	280 ± 15	28 ± 1,5
6	Ring bevel gear to gear housing fastening screw	300 ± 10	30 ± 1
7	Safety plate to gear housing cover fastening screw	60 ± 6	6 ± 0,6
8	Pressure switch	61 ± 6	6,1 ± 0,6
9	Hexagonal socket head screw for control cylinder	25 ± 2	2,5 ± 0,2
10	Oil intake plug	40 ± 4	4 ± 0,5
11	Self locking screw	120 ± 10	12 ± 1
	● Apply LOCTITE AVX ♦ Spread LOCTITE 573 sealant		

TIGHTENING TORQUES

Figure 4



	COMPONENT	TORQUE	
		Nm	Kgm
1	Drum flathead screw	25 ± 3	2,5 ± 0,3
2	Wheel nut	565 ÷ 690	56,5 ÷ 69
3	Cover to crown wheel support fastening screw ●	50 ± 5	5 ± 0,5
4	Flathead screw	25 ± 3	2,5 ± 0,3
5	Bearing sleeve screw ♦	280 ± 15	28 ± 1,5
	● Apply LOCTITE AVX ♦ Spread Hylomar SQ 32IM sealant		

TOOLS

TOOL NO.	DESCRIPTION
99305121	Hot air operated equipment
99322205	Rotary stand for unit overhaul
99322215	Stand to overhaul axles
99322225	Unit support (to use on stand 99322205)
99341003	Puller
99341015	Clamp
99341023	Grips
99345055	Counter block for pullers
99354001	Wrench for differential gearcase bearing adjustment ring nut
99354207	Wrench (94.5 mm) for wheel hubs bearing adjustment nut
99355081	Wrench (60 mm) for differental bevel pinion nut (to be used with 99370317)
99356001	Wrench for wheel brake shoes adjustment
99357111	Pliers for brake shoes return spring
99370005	Handle for interchangeable beaters
99370006	Handle for interchangeable beaters
99370007	Handle for interchangeable beaters
99370317	Lever and relevant extension bar to retain flange
99370509	Hook to remove differential gearcase half box
99370616	Support to hold differential gear during removal/re-fitting in place
99370617	Universal support to hold axles during removal/re-fitting in place
99371022	Pair of brackets to hold differential during overhaul (to be used with 99322205 and 99322225)
99372213	Tool for brake drum turning (to be used with 9930100)
99374013	Element to fit in place the differential bevel pinion gasket (to be used with 99370006)
99374025	Element to fit in place the wheel hub internal gasket (to be used with 99370005)
99374093	Beater to fit in place bearings outer tracks (91 -134) (to be used with 99370007)
99374094	Beater to fit in place bearings outer tracks (134-215) (to be used with 99370007)
99374451	Equipment for half shafts removal/re-fitting in place
99389819	Dynamometric wrench 0 to 10 kgm connection 1/4"
99389821	Dynamometric wrench 0 to 70 kgm connection 3/8"
99395026	Tool to check hubs rolling torque (to be used with dynamometric wrench)
99395027	Tool to find proper differential bevel pinion adjustment shims (to be used with 99395603)
99395603	Dial gauge (0-5 mm)

DIAGNOSTICS

Main axle faults:
1 - Wheel hubs noisy
2 - Noise
3 - Noise at release
4 - Noise during acceleration
5 - Cornering noise

1 WHEEL HUBS NOISY

Insufficient lubrication	– YES →	Check there are no leaks from gaskets or the axle casing and top up oil to correct level.
NO ↓		
Wheel hub bearings inefficient	– YES →	Remove the hub and replace inefficient parts.
NO ↓		
Bad adjustment of wheel hub bearings	– YES →	Adjust bearings
NO ↓		
Half-shaft splines to fit planetary gears of epicyclic gears are worn	– YES →	Overhaul and replace worn or damaged parts

2 NOISE

Lubricating oil level low	– YES →	Check there are no leaks from gaskets or axle casing and top up to correct level
NO ↓		
Half shaft splines to fit the differential crown wheels damaged	– YES →	Overhaul the axle and replace worn or damaged parts.

Bad adjustment of hub bearings	– YES →	Adjust the bearings backlash.
NO ↓		
Bad adjustment or wear on differential gears or bearings	– YES →	Locate the trouble and overhaul the unit.

3 NOISE AT RELEASE

Improper fitting backlash between pinion and ring bevel gear	– YES →	Remove the gear housing inspection cover and adjust backlash between pinion and ring bevel gear.

4 NOISE DURING ACCELERATION

Insufficient lubrication	– YES →	Check that there are no leaks from the gaskets or the casing and top up to the correct level.
NO ↓		
Gear housing bearings badly set or deteriorated	– YES →	Overhaul the unit.
NO ↓		
Bad tooth contact between pinion and ring bevel gear	– YES →	Adjust the contact.

5 CORNERING NOISE

Improper backlash between planetary gears and crown wheels.	– YES →	Overhaul or replace the unit.

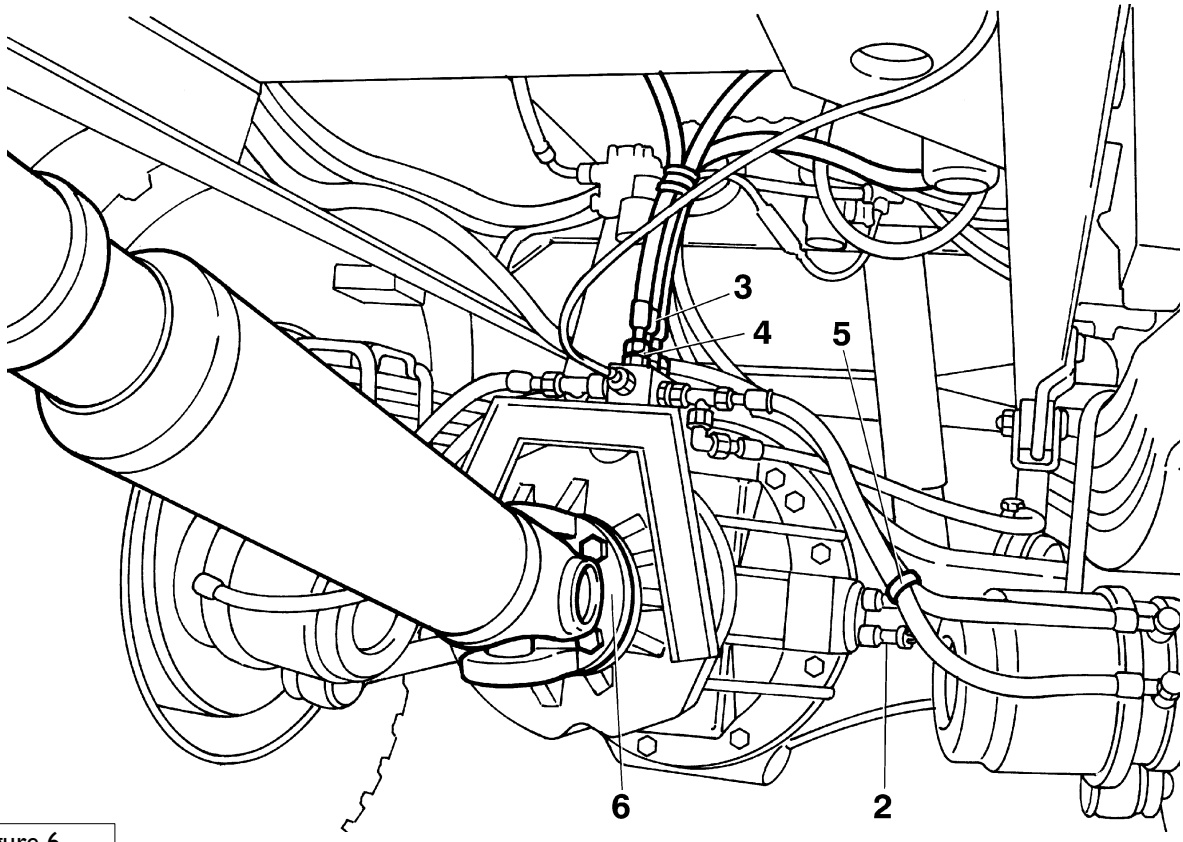
REMOVING - REFITTING THE REAR AXLE

Removal

To remove the rear axle proceed as follows:

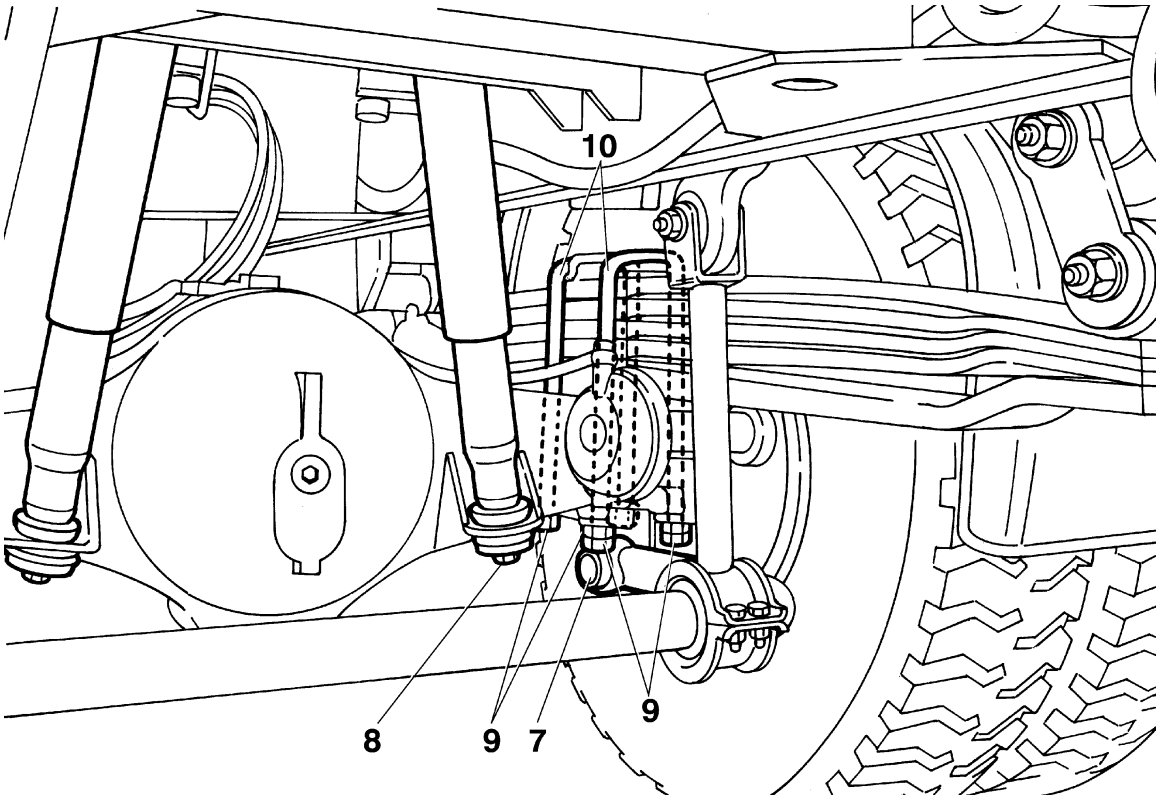
- ❑ place the vehicle on a flat ground and suitably lock the front wheels;
- ❑ loosen both rear wheel fastening nuts;
- ❑ using a hydraulic jack lift the rear part of the vehicle and rest it on two stands;

Figure 5



17812301

Figure 6



17812302

- ❑ remove both rear wheels;
- ❑ disconnect ABS transmitter electrical cables from both sides (only vehicles provided with ABS);
- ❑ disconnect the electrical cable (2) for the differential led;
- ❑ disconnect the pneumatic connections for parking brake (3), brake air delivery (4) and differential locking (5);
- ❑ remove braking control rod (11);
- ❑ undo the screws fixing the propeller shaft flange (6), and secure temporarily the shaft to the chassis to avoid interference during next operations;
- ❑ remove the bolts (7) fixing the stabilizer bar to the rear axle and rotate it downwards;
- ❑ unscrew the nuts (8) fixing the shock absorbers to the rear axle;
- ❑ set a hydraulic jack fitted with tool 99370617 under the rear axle;
- ❑ unscrew the nuts (9) from both sides and lift the leaf spring fixing brackets (10) then, lower the axle and take away the leaf spring.

Refitting

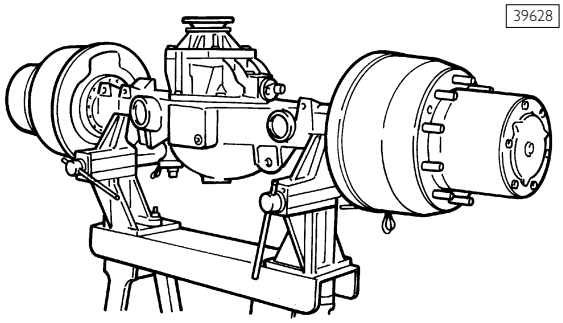
To refit, follow the removal operations in reverse order.

REAR AXLE ASSEMBLY OVERHAUL OPERATIONS

The removal and re-fitting into place operations for the half-shafts, drums and brake shoes, air bleeder, wheel hubs differential and epicyclic gears can all be carried out with the units fitted on the vehicle.

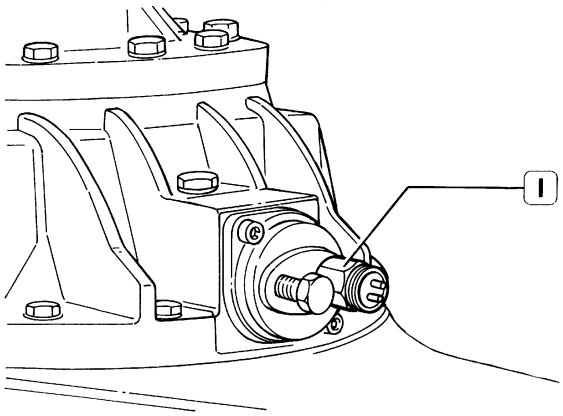
Before setting the axle assembly on the stand to overhaul, unscrew the axle casing lower plug todrain the oil.

Figure 7



Set the whole axle assembly on stand 99322215.

Figure 9

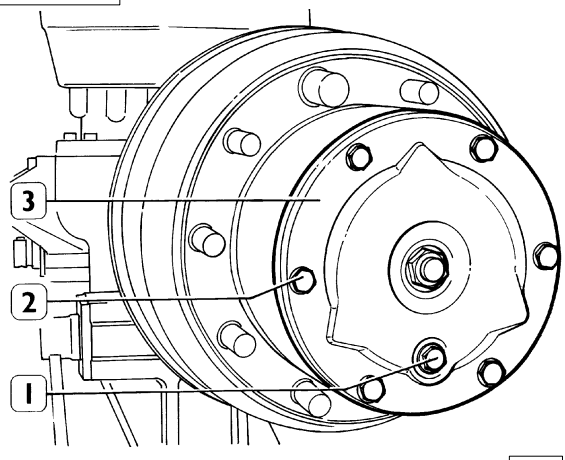


Lock the sliding sleeve of the differential locking device with a screw.
To do this, remove the threaded coupling from the control cylinder and in its place (1) fit a screw (M14 x 1.5).
At the same time, turn the axle mechanism so that the sliding sleeve and enagagement sleeve are engaged. This will prevent accidental movement of the sleeve while removing the half-shaft.

Place a vessel under the wheel hub to collect the oil.

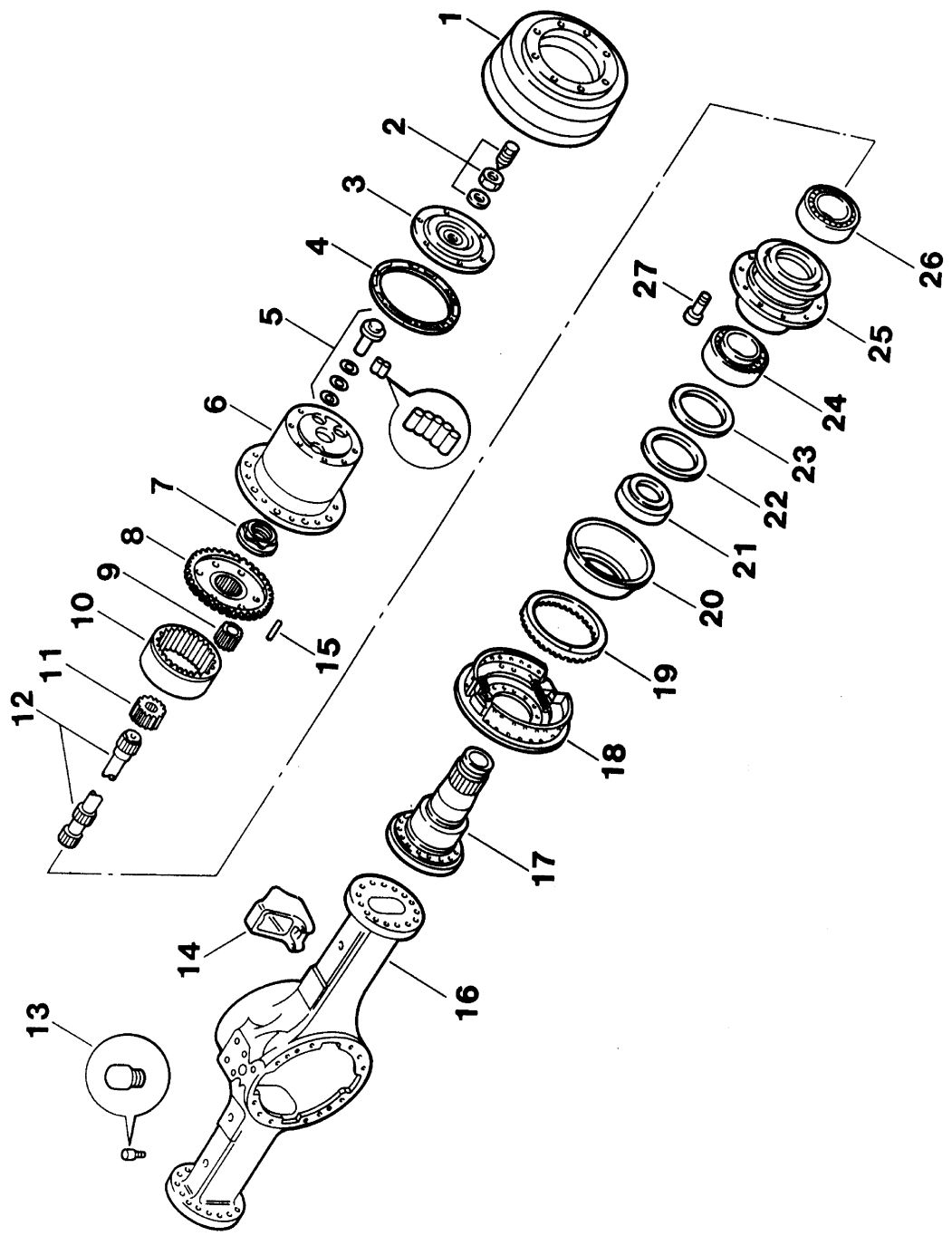
REMOVING THE EPICYCLIC REDUCTION GEAR

Figure 8



Remove the screws (2); remove the cover (3) and collect the oil.

Figure 10

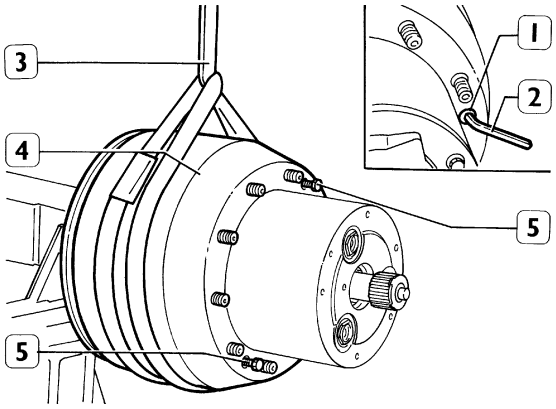


40430

WHEEL HUB COMPONENTS

1. Brake drum - 2. Adjusting screw and nut - 3. Cover - 4. Gasket - 5. Planetary gear pin and rollers - 6. Planetary gear carrier - 7. Adjusting nut - 8. Crown wheel carrier - 9. Planetary wheel- 10. Crown wheel - 11. Crown wheel gear - 12. Half-shaft - 13. Bleeder - 14. Bracket - 15. Shoulder pin - 16. Axle casing - 17. Bearing shaft - 18. Braking unit - 19. Phonic wheel - 20. Oil cup - 21. Supporting ring - 22. Seal ring - 23. Seal ring - 24. Bearing - 25. Wheel hub - 26. Bearing - 27. Bolt

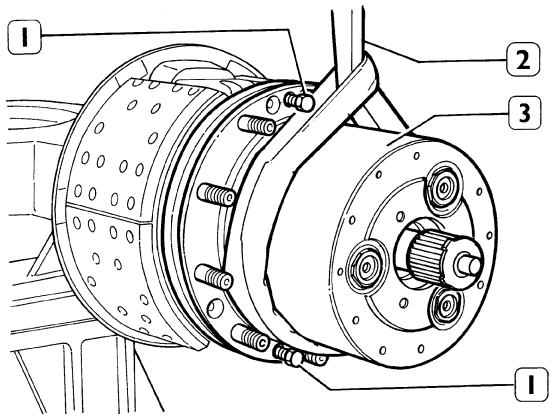
Figure 11



40338

Using a socket wrench (2) unscrew the two drum retaining screws (1); replace them with counteracting screws (5), tighten to remove the drum (4) from the hub, then take it away with a rope (3) and lifting equipment.

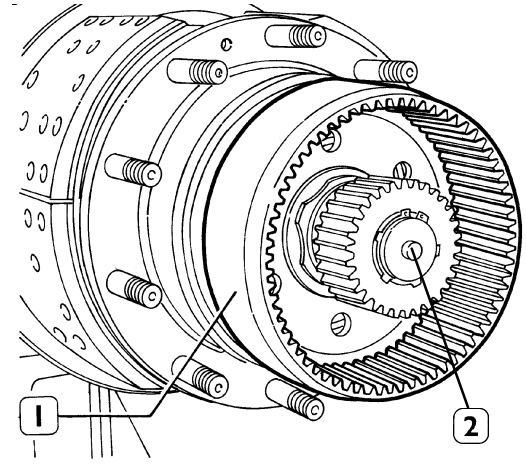
Figure 12



40054

Remove the 3 retaining screws from the planetary gear support (3); insert the counteracting screws (1) and using a rope (2) remove the support (3)

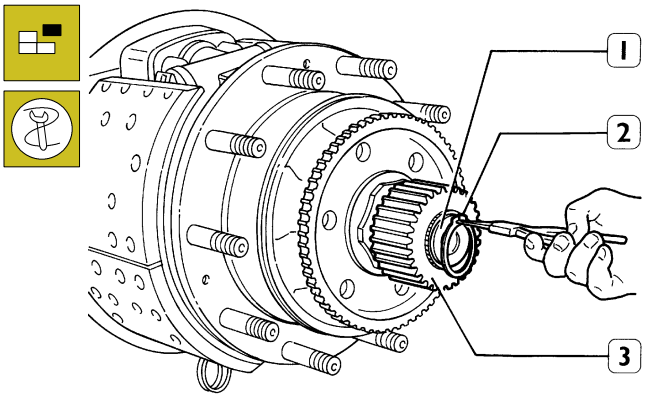
Figure 13



40055

Withdraw the crown wheel (1) from the crown wheel carrier. Take out the shoulder pin (2)

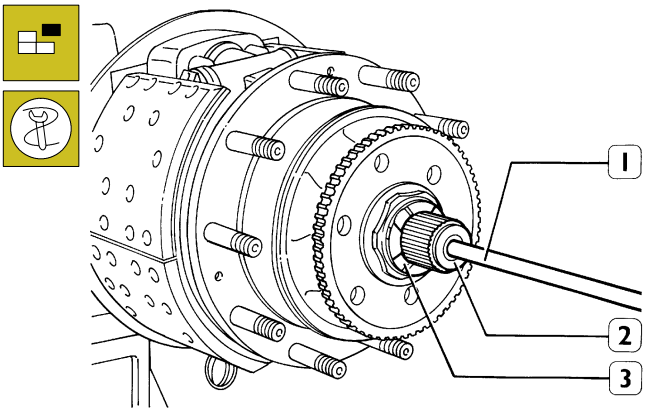
Figure 14



39635

Use appropriate pliers to remove the circlip (2) withdraw the planetary gear (3) from the half-shaft (1).

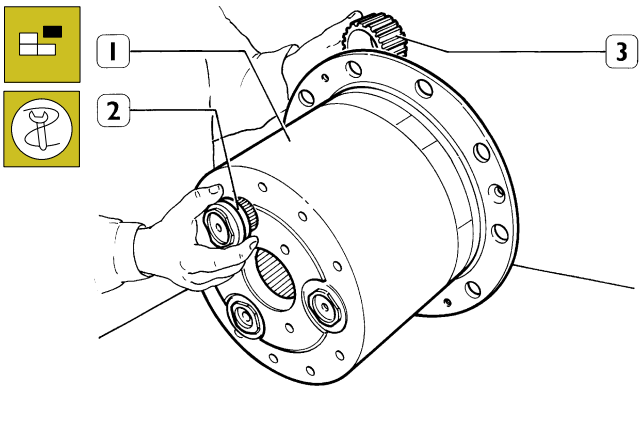
Figure 15



39636

Screw tool 9937445 (1) into the shoulder pin seat and remove the half shaft (2) from the bearing shaft.
Remove the spacer ring (3)

Figure 16

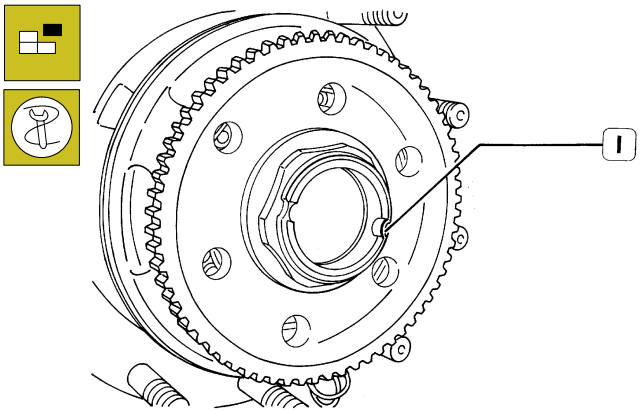


40056

Remove the pins (2) from the planetary gear support (1). Remove the planetary gears (3) from the support (1) and set aside the needles and spacer rings.

Removing the wheel hubs

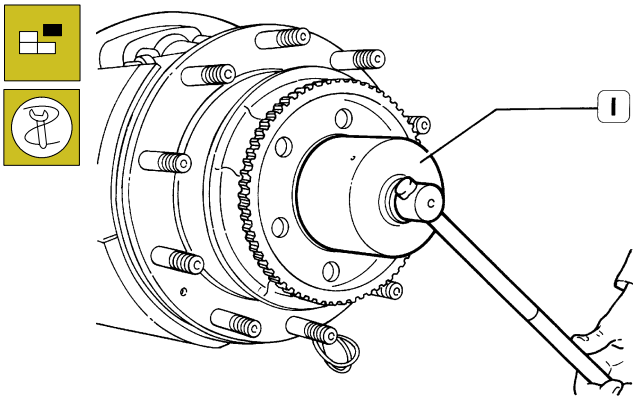
Figure 17



39637

Using a suitable punch straighten the dents (1) on the adjusting nut.

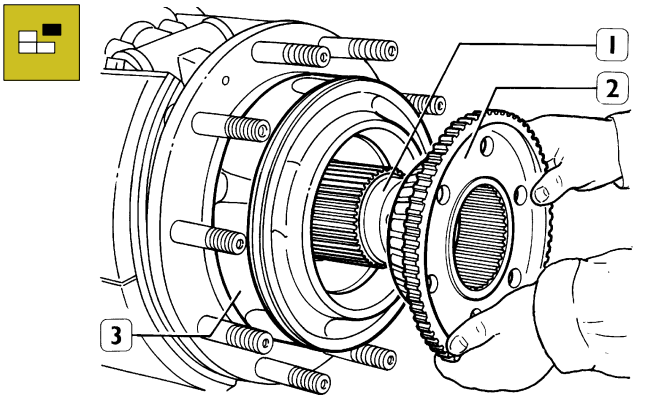
Figure 18



39638

Using socket wrench 99354207 (1) unscrew the adjusting nut.

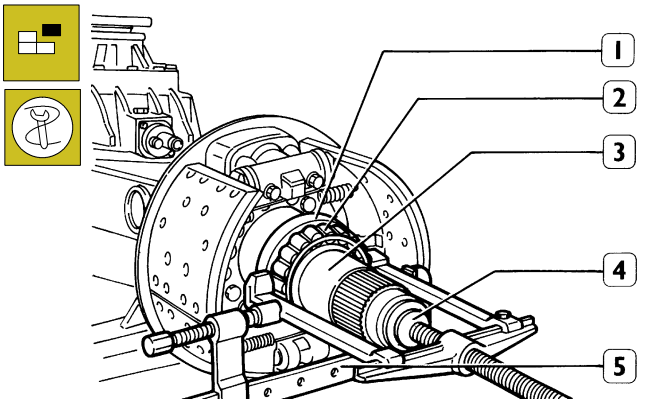
Figure 19



39639

Withdraw the bearing shaft (1), the crown wheel carrier (2) with the relevant bearing and complete wheel hub (3)

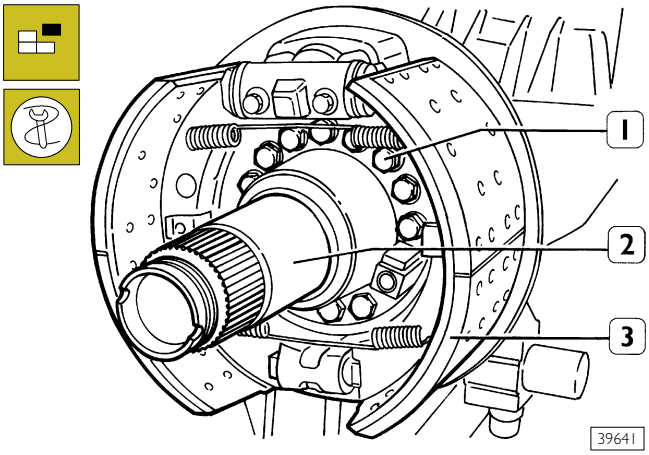
Figure 20



39640

Using a puller, clamp (5) and counter block 99345055 (4), remove the gasket ring (1) and taper roller bearing (2) from the bearing shaft (3).

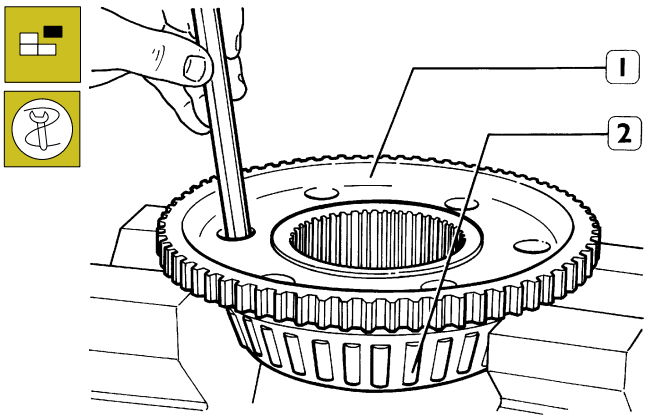
Figure 21



39641

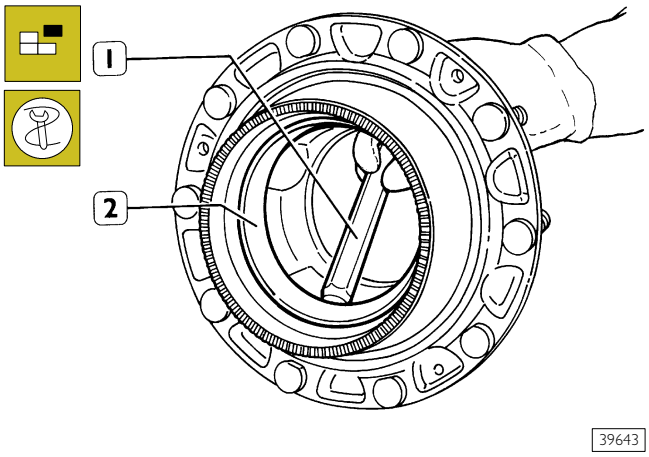
Check the bearing shaft (2) and if it is damaged, replace it. Using tool 99372217, release the brake shoes (3) and after unscrewing the hexagonal screws (1) locked with LOCTITE, remove the brake carrier plate with the bearing shaft.

Figure 22



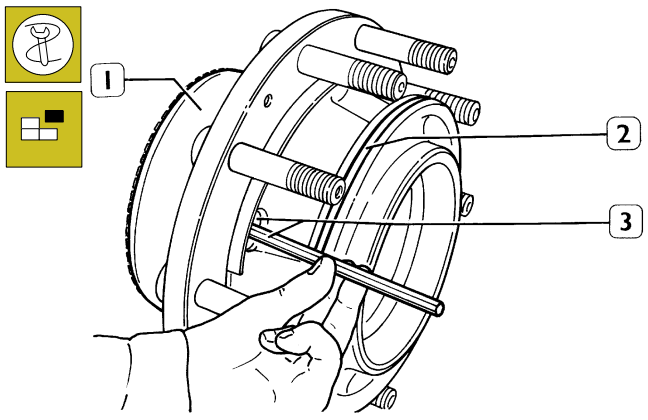
With a suitable beater fitted in the holes on the crown wheel carrier, remove the outer taper roller bearing (2) from the crown wheel carrier (1).

Figure 23



Use a bronze beater (1) to drive out the inner bearing outer ring (2).
The seal ring will come away with it.
In the same way extract the outer bearing outer ring. If necessary remove the phonic wheel.

Figure 24



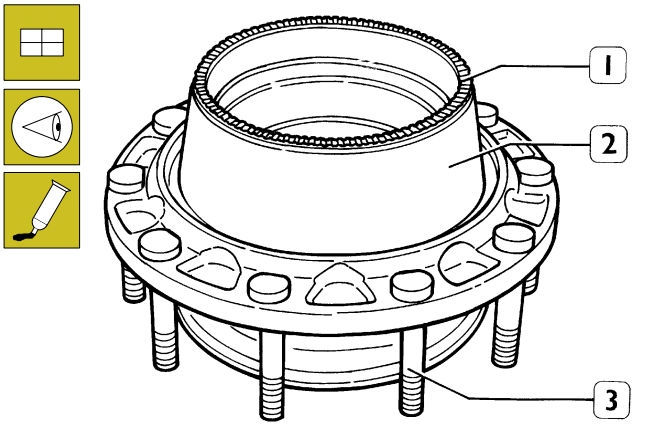
Check the oil manifold (1) and if it is damaged, replace it. To do this, extract it with a suitable beater inserted through the hub slots (3). Remove the shaped seal ring (2).

WHEEL HUBS AND EPICYCLIC REDUCTION GEAR COMPONENTS CHECK

Carefully clean the wheel hub components. Check the half shafts to ensure they are not strained. If necessary straighten the half shafts under a hydraulic press. If the results obtained are not satisfactory, replace the half-shafts. Check the wheel bolts, if the threads are strained or damaged, replace them under the press. After fitting in place check that the orthogonality error does not exceed 0.3 mm.
Lubricate the bearings and turn the roller cage freely; the rotation must be even with no signs of stiffness.
Check the threads on the bearing adjustment nut and the bearing shafts; if necessary replace the nuts.
Check the oil manifold, if it is damaged replace it.
All seal elements must be replaced with new ones.
Carefully clean all the epicyclic gear components.
Visually check the teeth of the crown wheel carrier, the crown wheel, the planetary wheels and planetary gear.
Check the spacer rings, bearing needles and support pins.
Replace any worn or damaged parts.

FITTING IN PLACE THE WHEEL HUBS

Figure 25



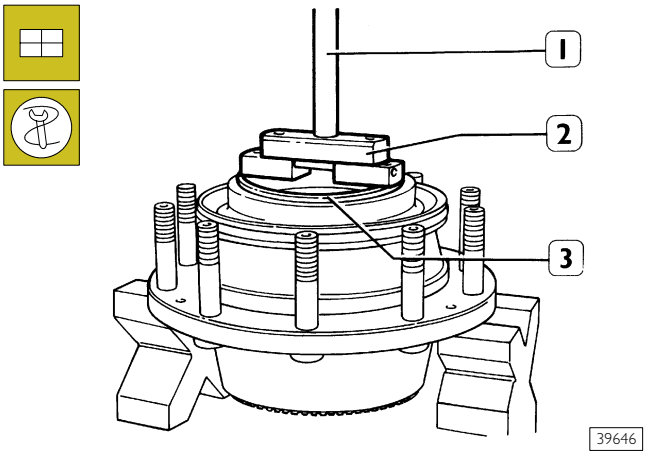
If the bolts (3) require replacement, before fitting in place the new bolts make sure that the contact surface of the bolt head is free of swarf, burrs and dents.

After the bolts have been driven in, check that they are perfectly flush on the hub and that the orthogonality error does not exceed 0.3 mm.

If it is necessary to replace the oil cup (2) before fitting in place the new one, spread LOCTITE 573 sealant on the hub to cup coupling surfaces and on the cup housing on the hub.

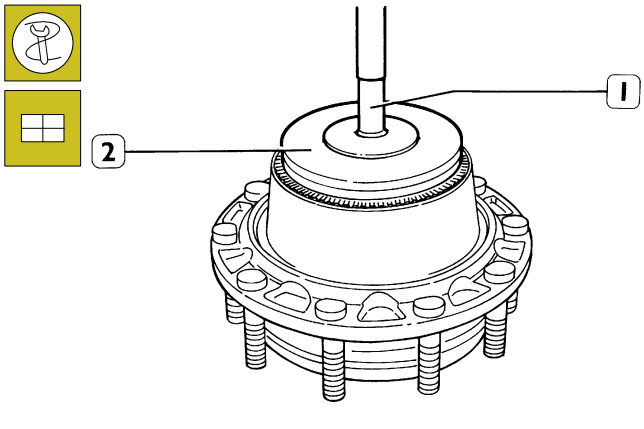
Re-fit in place the phonic wheel (1) making sure, after fitting, that the phonic wheel rests perfectly on the hub seat.
Use a dial gauge to check that the phonic wheel orthogonality error is not over 0.2mm.

Figure 26



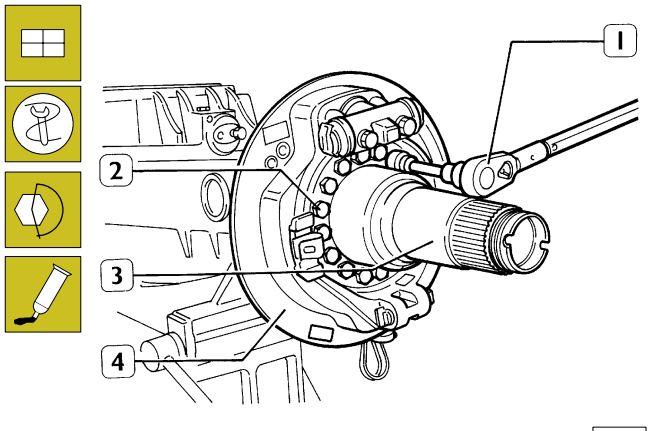
Use beater 99374093 (2) to drive in the outer bearing outer ring (3) (under the press) leaving approx 5 mm of the stroke; finish driving in by hand using handle 99370007 (1).

Figure 27



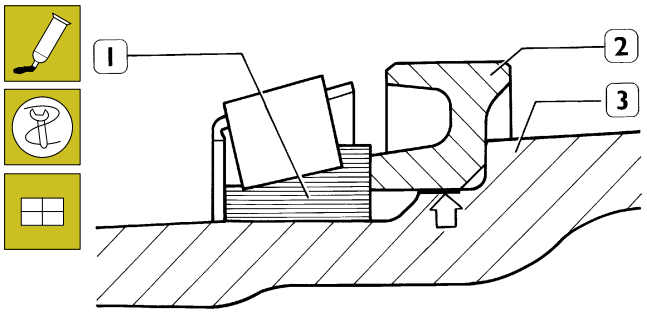
Using tool 99374025 (2) with the relevant intermediate ring and handle 99370005 (1) drive the internal seal ring into its housing. Use the same tool but without the intermediate ring to fit the external seal ring.

Figure 28



Place the seal ring on the bearing shaft, spread LOCTITE AVX on the coupling surfaces between the axle casing and bearing shaft. Fit in place the bearing shaft (3) with the brake carrier plate (4) and dust guard plate. Apply LOCTITE AVX to the screws (2) and with a dynamometric wrench (1) tighten them to a torque of 280 ± 15 Nm.

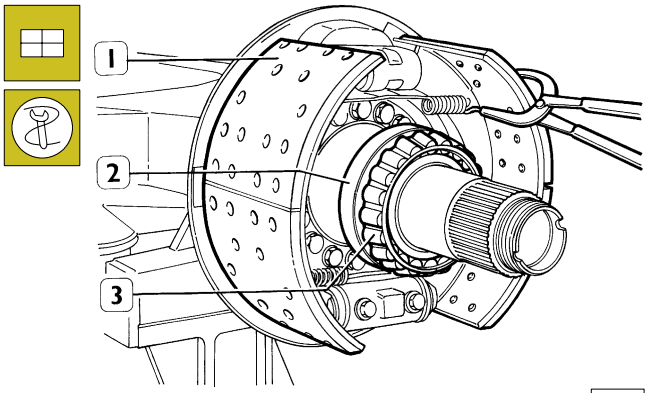
Figure 29



40375

Spread Hylomar SQ32IM sealant on the bearing shaft (3) ring (2) housing (⇒) for the seal rings. Heat the ring (2) and fit it on the bearing shaft (3). Heat the taper roller bearing inner ring (1) to approx 100°C and fit it on the bearing shaft.

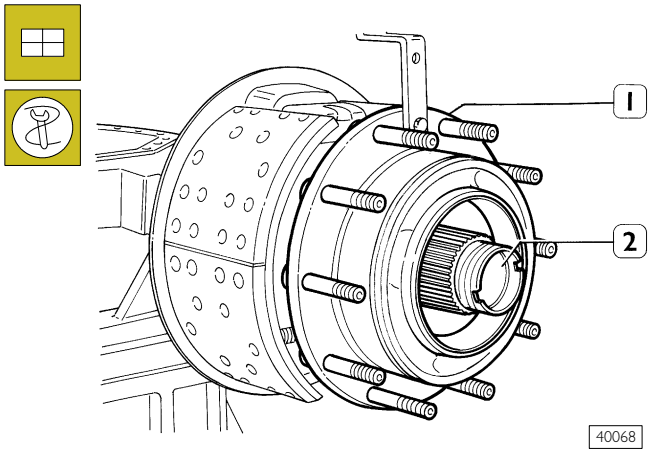
Figure 30



40067

Re-fit in place the brake shoe (1) using tool 99372217.

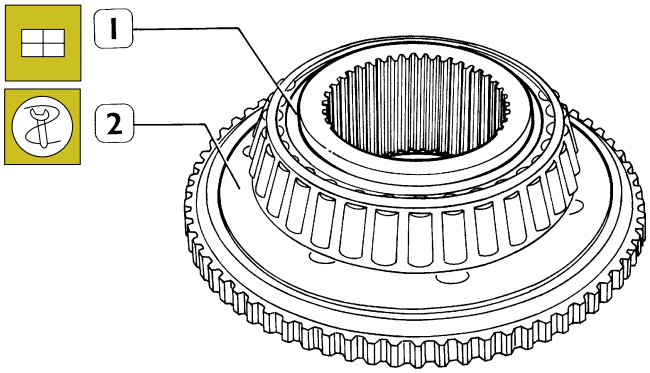
Figure 31



40068

Using the suitable tool set the complete hub (1) on the bearing shaft (2)

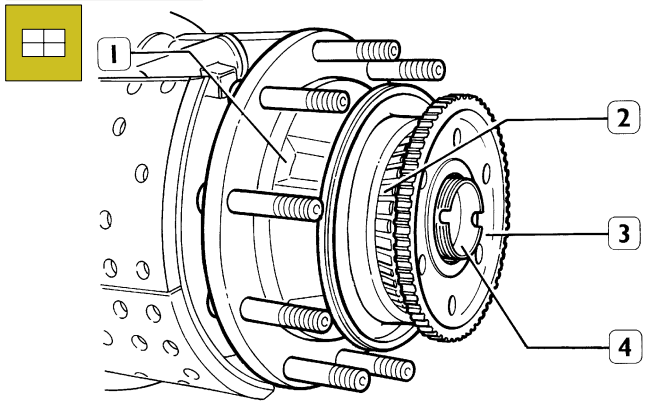
Figure 32



40377

Heat the taper roller bearing (1) to approx 100°C and with a suitable beater drive it into its seat on the crown wheel carrier (2).

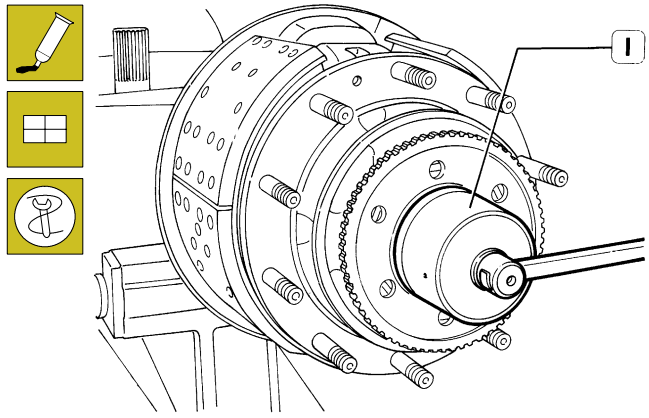
Figure 33



39650

Connect the crown wheel carrier (3) with its relevant taper roller bearing (2) onto the bearing shaft (4).

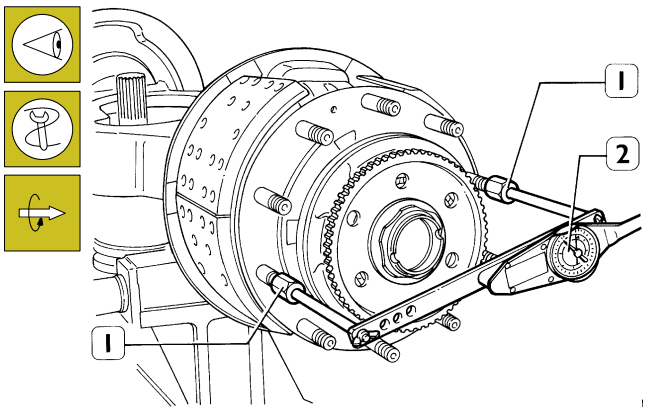
Figure 34



40070

Apply a thin coating of Molycote on the adjusting nut contact surface, screw, then tighten with wrench 99354207 (1) until it becomes difficult to turn the hub. Release the hub by axially hammering it in both directions.

Figure 35



40071

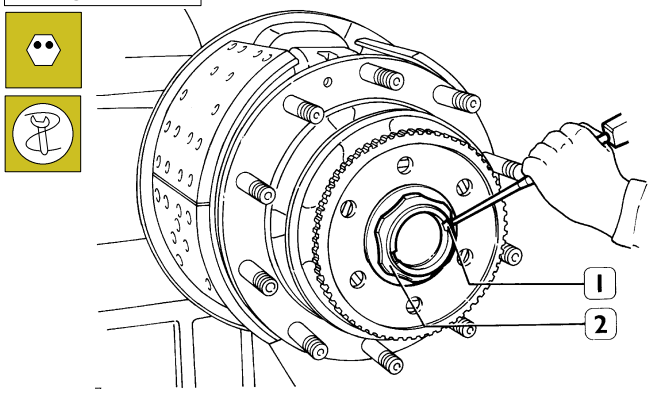
Set up tool (1) 99395026 and with a torque wrench (2) find the wheel hub rolling torque.

When finding the hub rolling torque the hub rotation must not exceed 40 r.p.m.

The hub rolling torque values vary according to the following conditions:

- ❑ new bearings with surface protection 3 + (12 ÷ 16) Nm
- ❑ run-in bearings and new lubricated seal rings 3 + (5 ÷ 7) Nm
- ❑ run-in bearings and seal rings 3 + (2.5 ÷ 4.5) Nm

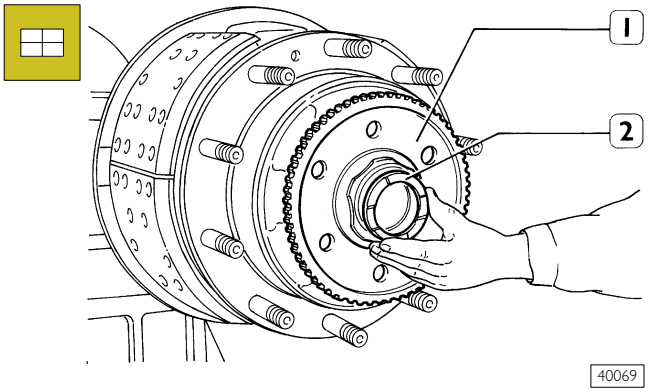
Figure 36



40072

Having obtained the prescribed rolling torque, use a suitable punch to dent the adjusting nut (2) in the two specific grooves on the bearing shaft (1).

Figure 37

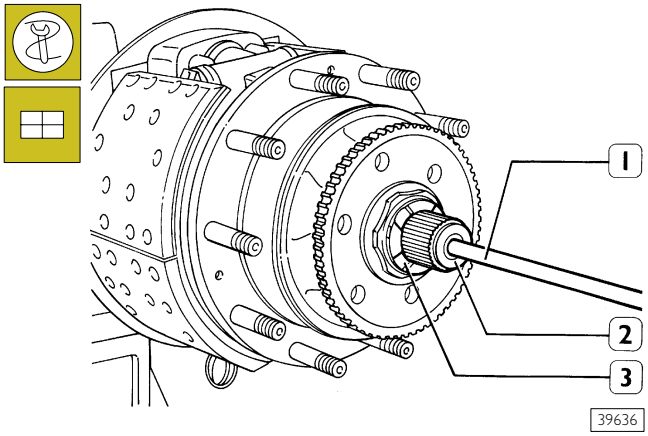


40069

Fit the spacer ring (2) in the bearing shaft.

Fitting in place the epicyclic reduction gear

Figure 38

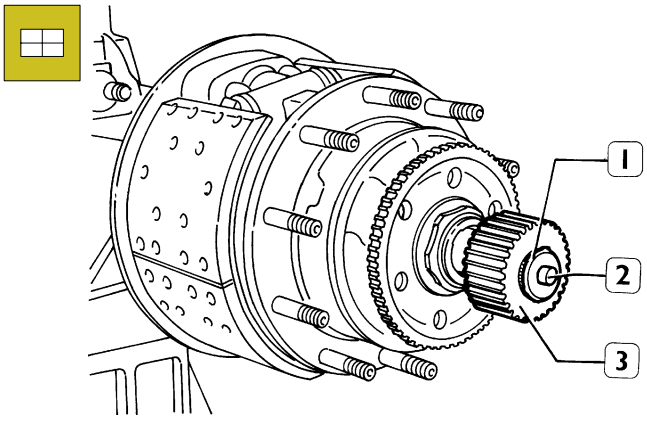


39636

Use tool 9937445 (1) to insert the half shaft (2) into the bearing shaft (3)

The double toothed short half shaft is to be fitted in the bearing shaft on the differential locking side.

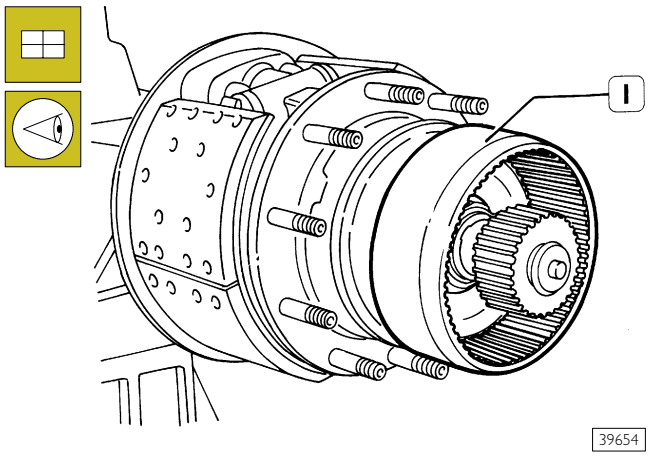
Figure 39



39653

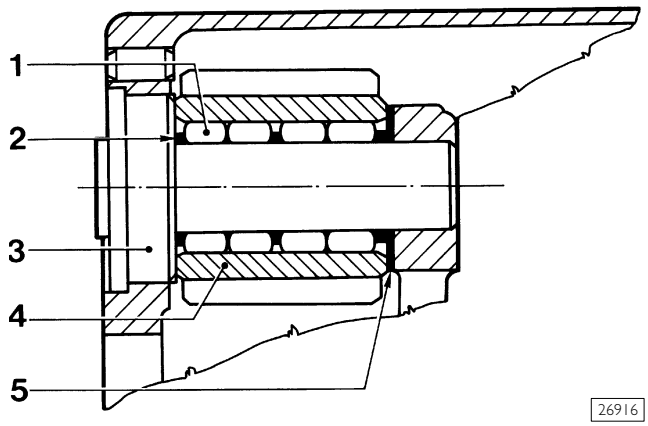
Place the planetary gear (3) on the splined section of the half shaft and the circlip (1) in its seat. Force the shoulder pin (1) into its seat in the half shaft.

Figure 40



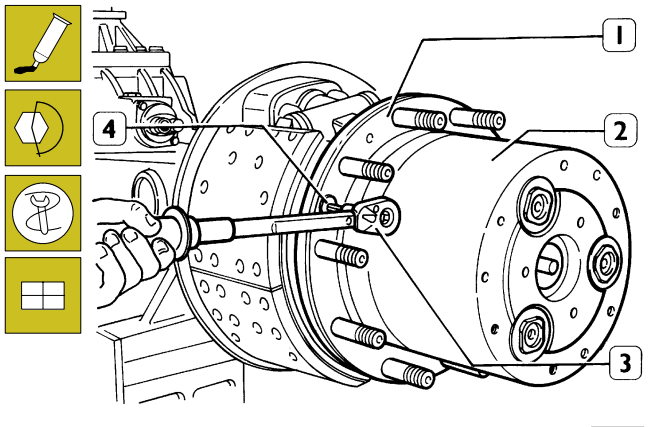
Position the crown wheel (1) with the chamfer directed outwards, then place it on the crown wheel carrier.

Figure 41



Grease the needles (1) arrange them with three spacer rings (2) in the planetary gear (4) as shown in the figure.
Insert the planetary gear (4) and spacer washer (5) in the planetary gear carrier support.
Insert the pin (3) from the cover side pushing it down to the bottom of its seat.
Repeat the same operation for the other two planetary gears.

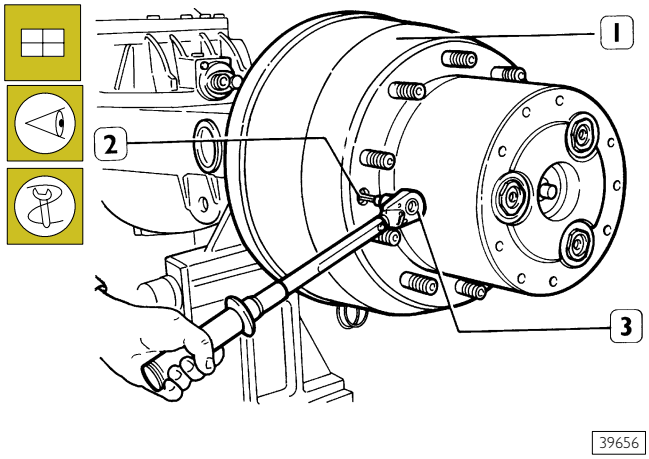
Figure 42



Spread a thin coating of Hylomar SQ 321 M or Reinzoplast sealant on the contact surfaces of the planetary gear support (2) and the wheel hub (1)

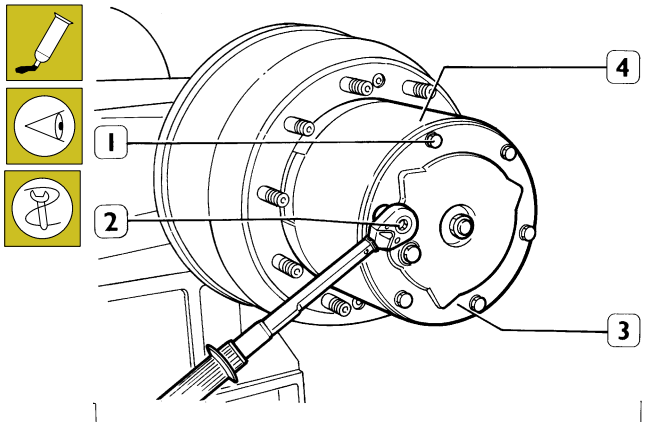
Push the planetary gear support (2) onto the hub, for easier tooth meshing, move the coupling flange alternately in the two directions. Take care that the holes to fasten the planetary gear support to the hub coincide.
Insert the three flathead screws(4) and tighten them with a dynamometric wrench (3) to the torque of 25 ± 3 Nm.

Figure 43



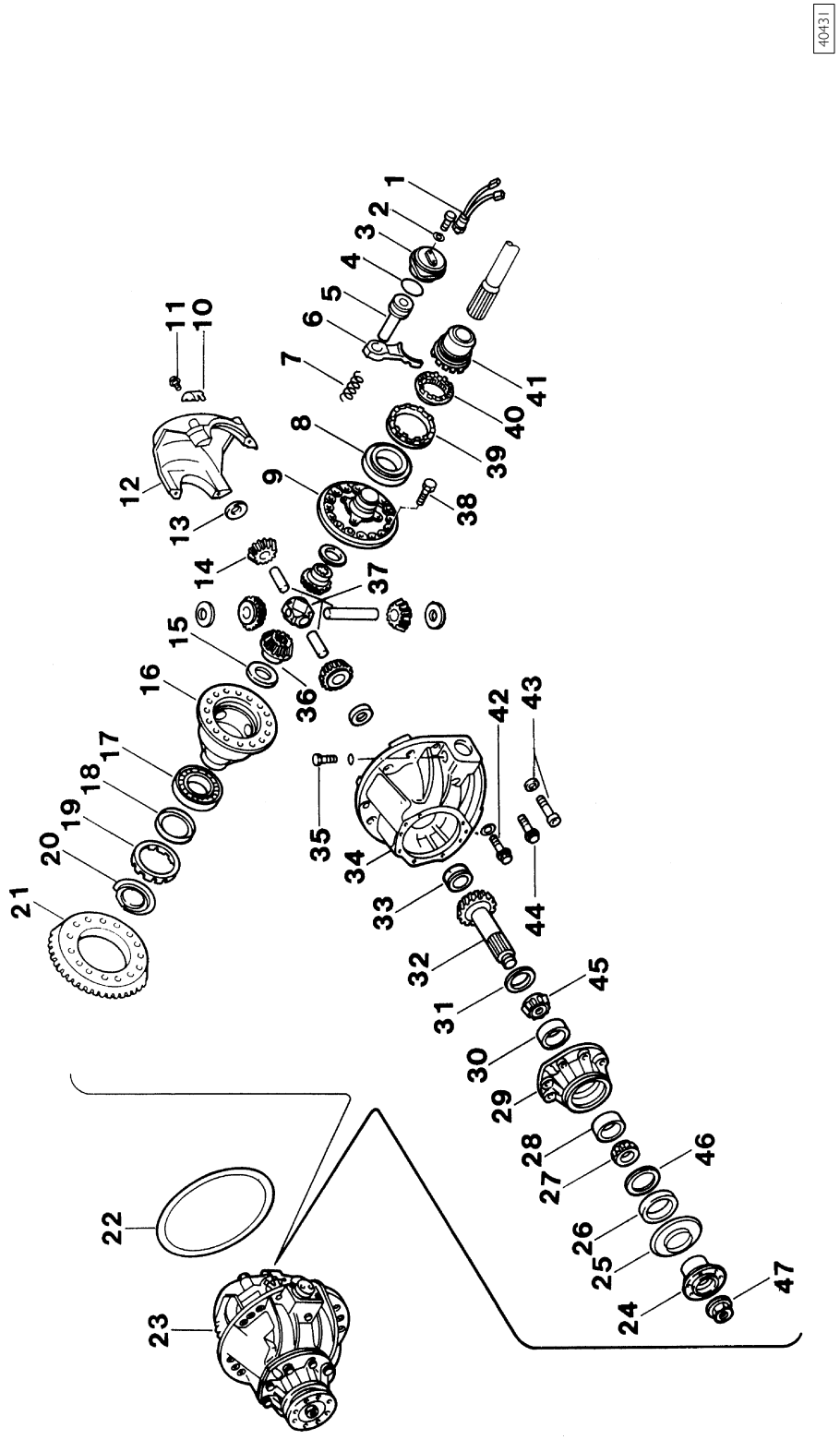
Fit the brake drum (1) onto the planetary gear support. Fasten the brake drum with the two flathead screws (2) tightening them with dynamometric wrench (3) to the torque of 25 ± 3 Nm.

Figure 44



Spread a thin coating of Hylomar SQ 321 M sealant on the contact surfaces of the cover (3) and the planetary gear support (4).
Position the cover so that the pin chamfers coincide with the notches in the cover.
Spread sealant paste on the threads of the screws (1) and with dynamometric wrench (2) tighten to a torque of 50 ± 5 Nm.

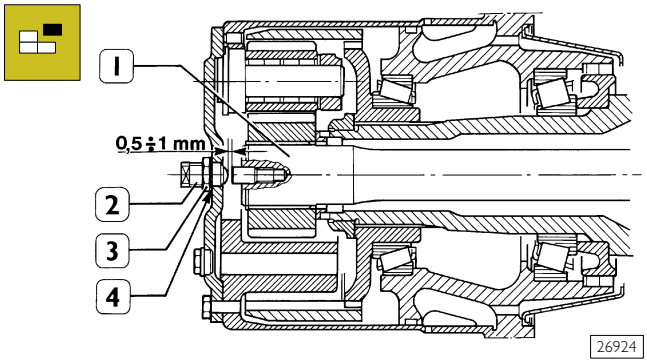
Figure 45



DIFFERENTIAL UNIT COMPONENTS

1. Electric transmitter - 2. Seal and union ring - 3. Cover - 4. Seal ring - 5. Piston - 6. Fork - 7. Spring - 8. Bearing - 9. Cover - 10. Plate - 11. Screw - 12. Cover - 13. Washer - 15. Shoulder washer - 16. Half-box - 17. Bearing - 18. Ring - 19. Ring nut - 20. Oil baffle - 21. Crown wheel - 22. Seal ring - 23. Differential unit - 24. Flange - 25. Dust guard - 26. Seal ring - 27. 28. Bearing - 29. Pinion support - 30. 45. Bearing - 31. Adjusting ring - 32. Pinion - 33. Bearing - 34. Box - 35. Screw - 36. Crown Wheel - 37. Pins and spider - 38. Screw - 39. Ring nut - 40. Sleeve - 41. Sliding sleeve - 42. Screw - 43. Screw - 44. Screw - 46. Rin - 47. Nut

Figure 51



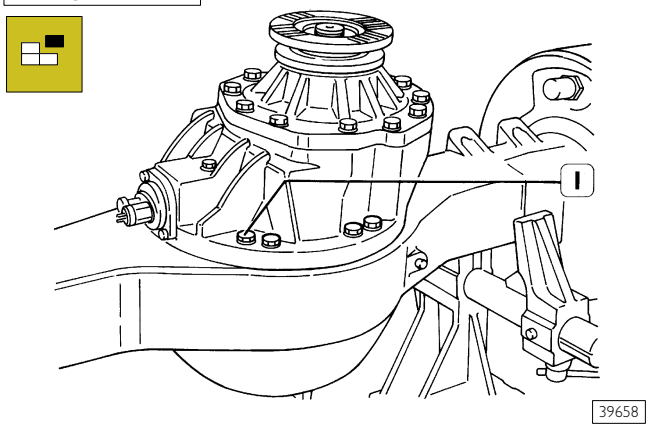
The half shaft (1) end play is to be between 0.5 and 1 mm. To obtain this, tighten the adjusting screw (2) to its stop, then come back by half a turn and lock it with the hexagonal nut (3).

The flat surface of the hexagonal nut should be directed towards the seal ring (4).

REMOVAL AND RE-FITTING IN PLACE THE DIFFERENTIAL

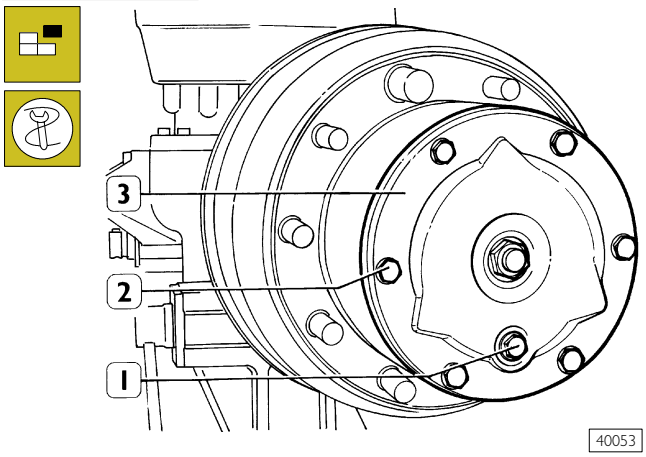
Removal

Figure 46



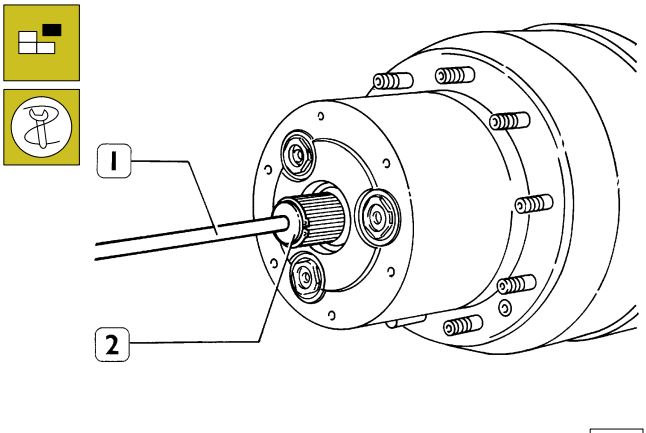
Remove the screws (1) fastening the differential housing to the axle casing. Remove the cap screws and hexagonal socket screws.

Figure 47



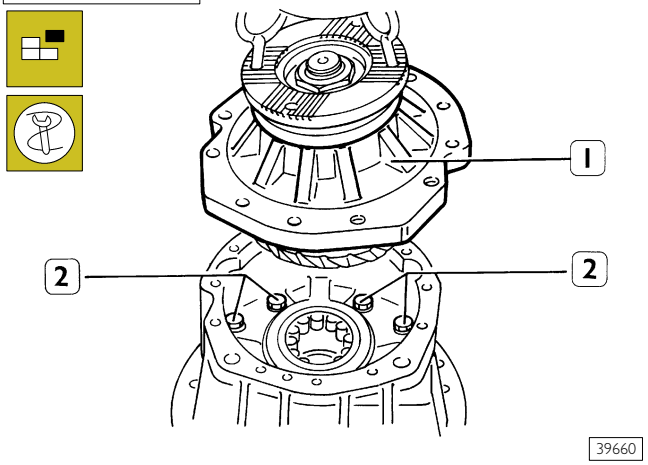
Screw on the oil intake cap (1). Move one of the cover (3) hex screws (2) to a low position and unscrew it. Drain the oil from the epicyclic gears on the wheels.

Figure 48



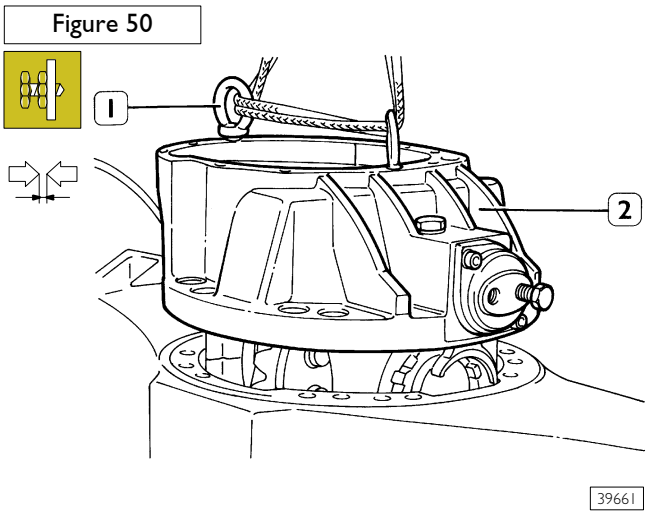
Fit tool 9937445 (1) into the shoulder pin seat threads and withdraw the half-shaft (2) from the bearing shaft

Figure 49



Using the specific eye hooks and a rope, lift the pinion support (1) and remove the four differential housing screws (2).

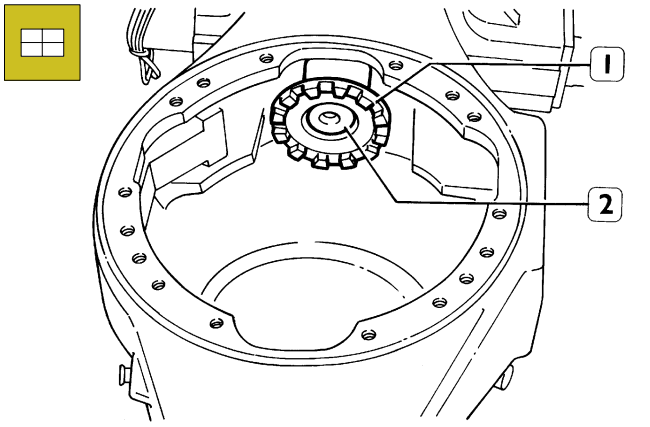
Figure 50



Using the specific eye hooks (1) and a rope, lift the differential housing (2).

Re-fitting in place

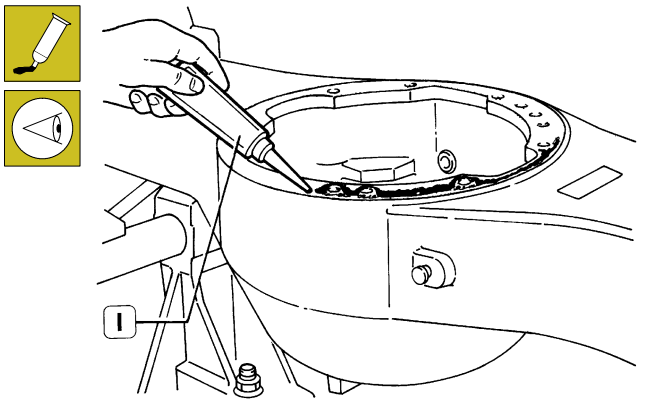
Figure 52



39662

Fit in place the sliding sleeve (1) on the double-tooth half-shaft (2)

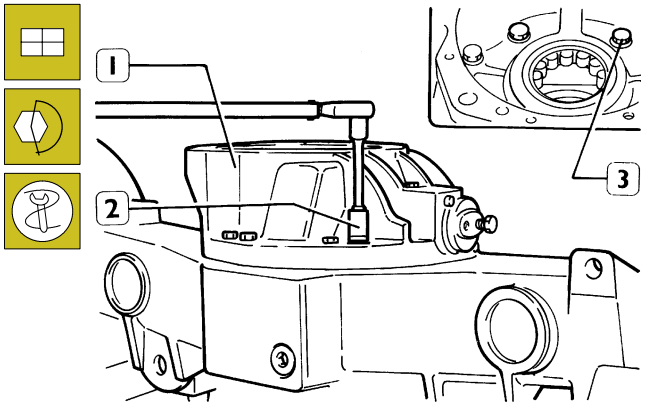
Figure 53



39663

Spread LOCTITE AVX on the contact surface (1). When fitting in place the differential housing it is important to make sure that the differential locking engagement fork is correctly positioned in the sliding sleeve seat.

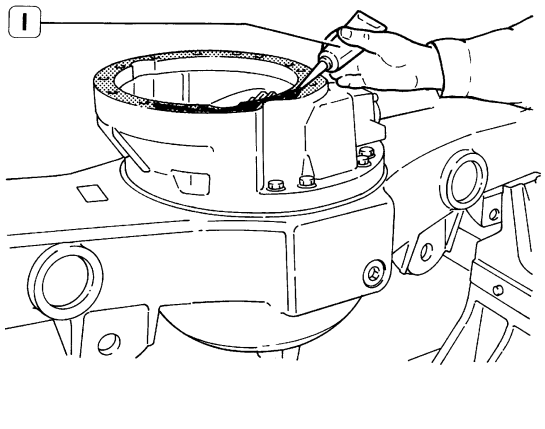
Figure 54



39664

Set the seal ring and fit in place the differential housing (1). Using a dynamometric wrench tighten the external (2) and internal (3) screws to the prescribed torque.

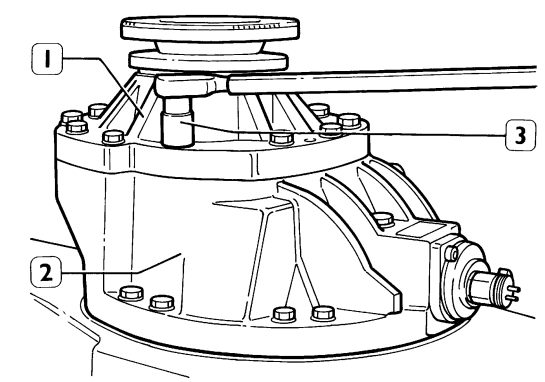
Figure 55



39665

Spread LOCTITE 573 on the contact surface (1)

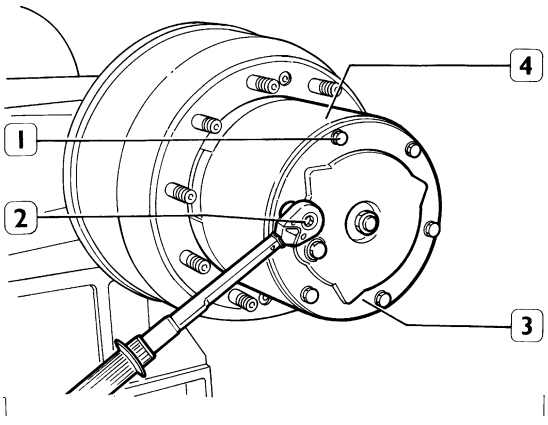
Figure 56



39666

Set the bevel pinion support (1) on the differential housing (2). Use dynamometric wrench (3) to tighten the screws to the prescribed torque.

Figure 57

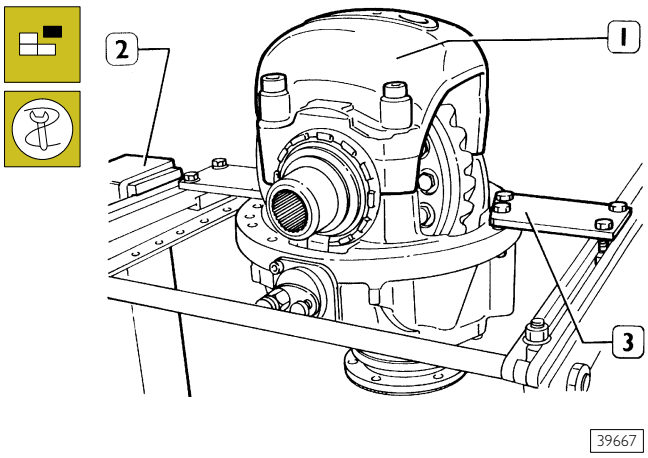


40073

Spread a thin coating of Hylomar SQ 321 M sealant paste on the contact surfaces of the cover (3) and the crown wheel support (4). Position the cover so that the pin chamfers coincide with the notches in the cover.
Spread sealant paste on the screw (1) threads and with a dynamometric wrench (2) tighten to the prescribed torque.

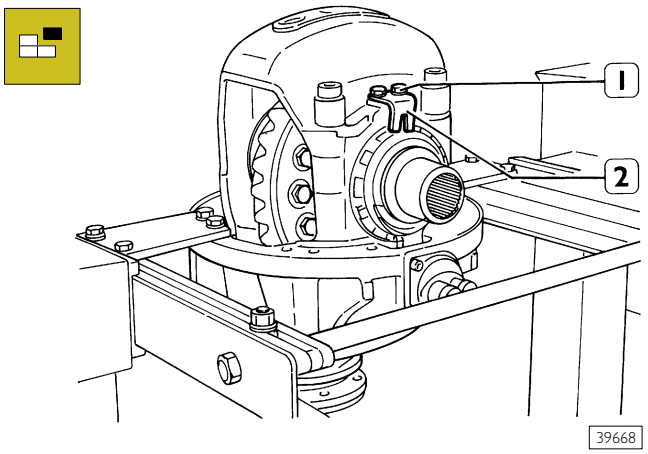
REMOVING THE DIFFERENTIAL HOUSING

Figure 58



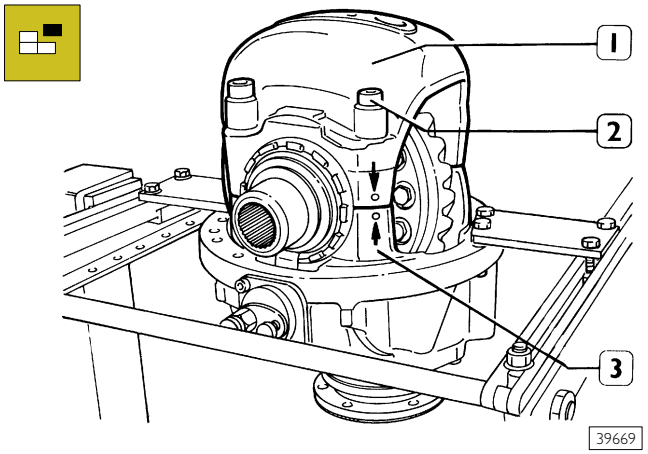
Set the complete differential housing, with the gear housing cover (1) upwards, on rotary stand 99322205 (2) fitted with support 99322228 and pair of brackets 99371022 (3).

Figure 59



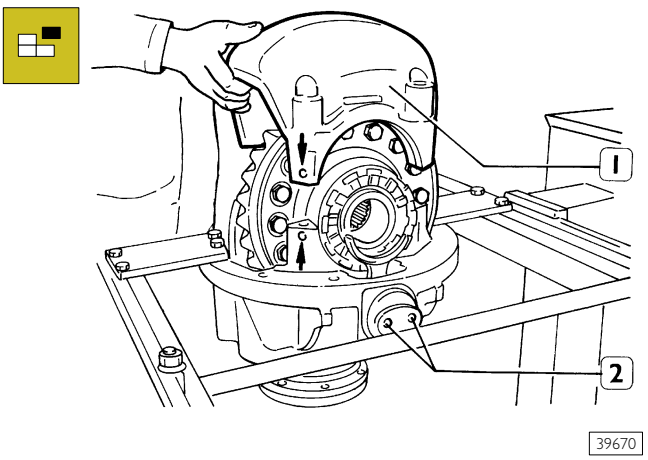
Remove the screws (1) then the safety plate (2). Carry out the same operation on the other side.

Figure 60



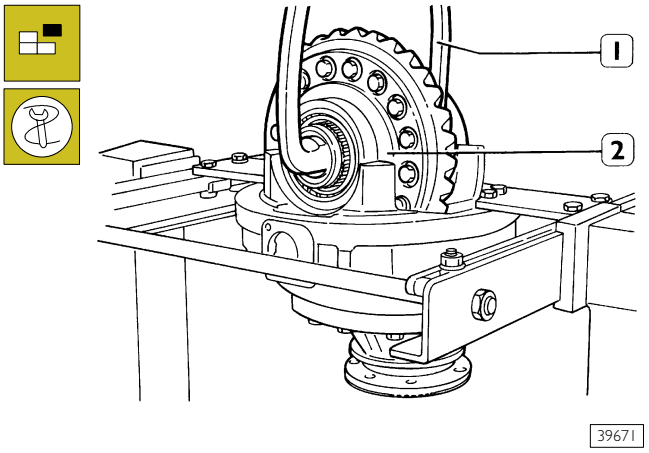
Mark the cover (1) position with reference to the differential housing (3) ⇒ ⇐.
Remove the cover fastening screws (2) (locked with LOCTITE).

Figure 61



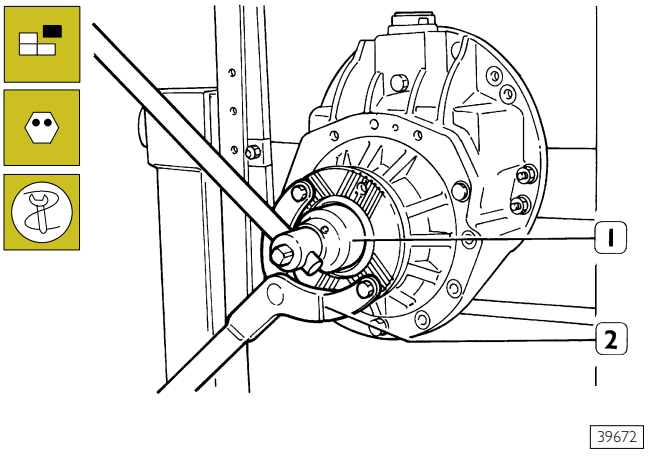
Lift the gear housing cover (1).

Figure 62



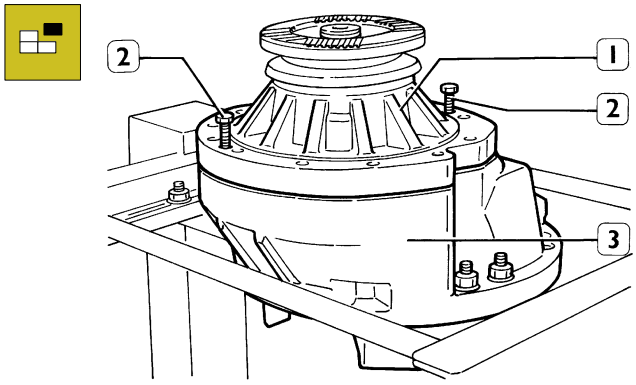
Use hook 99370509 (1) to lift the gear housing (2) with the relevant taper roller bearings and bearing outer rings.

Figure 63



Rotate the differential housing by 90°.
Remove the adjusting nut dent.
Apply the counter lever 993701317 (2) to the coupling flange, with socket wrench 9935508 (1) loosen the lock nut.

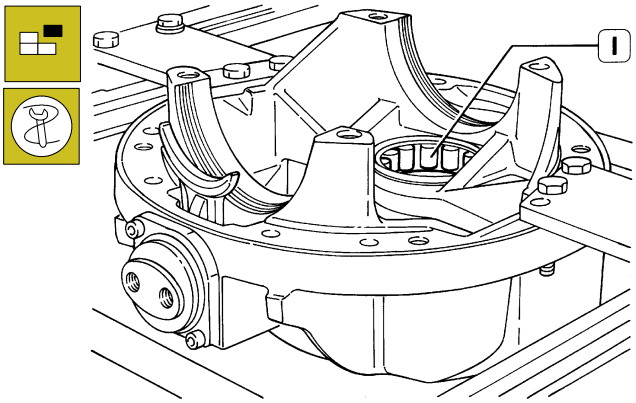
Figure 64



39673

Remove the screws and washers fastening the bevel pinion support (1) to the differential housing (3). Insert the counteracting screws (2) and take out the complete differential housing support.

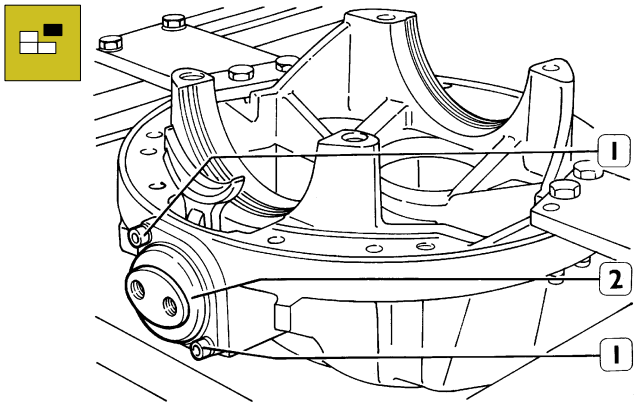
Figure 65



39674

Use a beater to expel the bevel pinion straight roller bearing (1) from its seat in the differential housing.

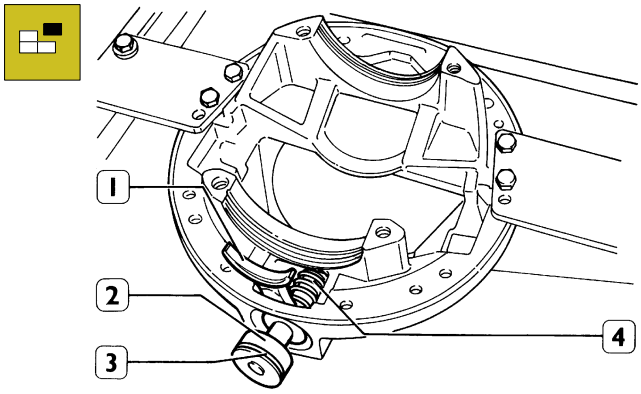
Figure 66



39675

Remove the two hexagonal socket head screws (1) and remove the differential locking device control cylinder (2).

Figure 67

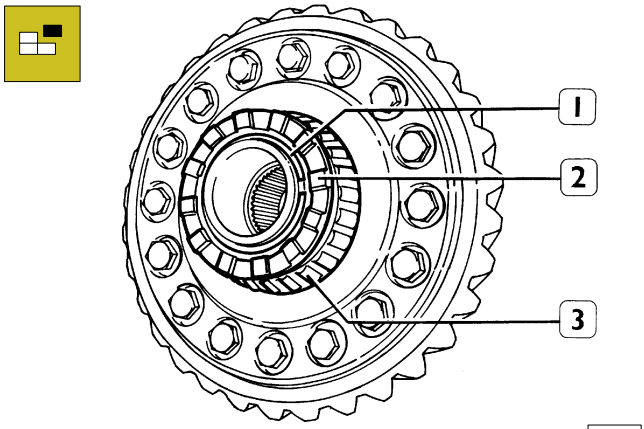


39676

Withdraw the control piston (2) with the seal ring (3), engagement fork (1) and compression spring (4).

REMOVING THE GEAR HOUSING

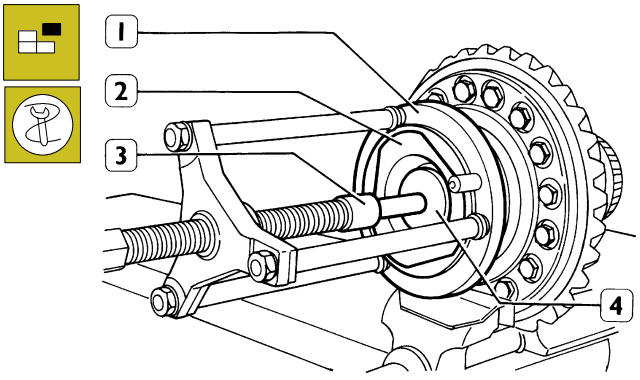
Figure 68



39677

Remove the split ring (1) and take away the differential locking device engagement sleeve (3) from the gear housing cover (2).

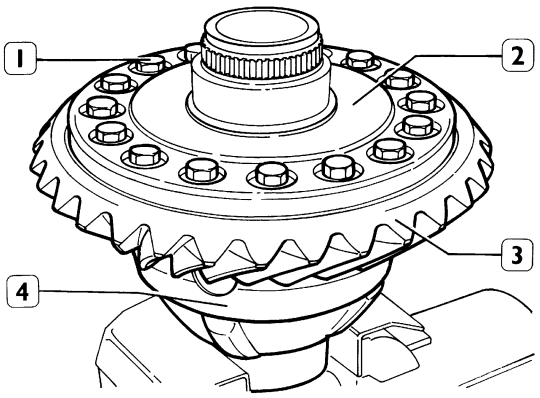
Figure 69



39678

Using puller 99347101 (1) equipped with a pair of gripping rings 99347182 (2), extension bar 99347361 (3) and counter block 99345055 (4), take out the taper roller bearing from the gear housing.
Repeat the same operation on the other side.

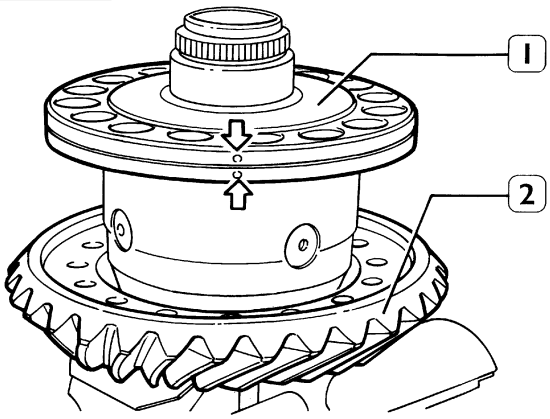
Figure 70



39679

Unscrew and remove the screws (1) that fasten the ring bevel gear (3) and cover (2) to the half-box (4).

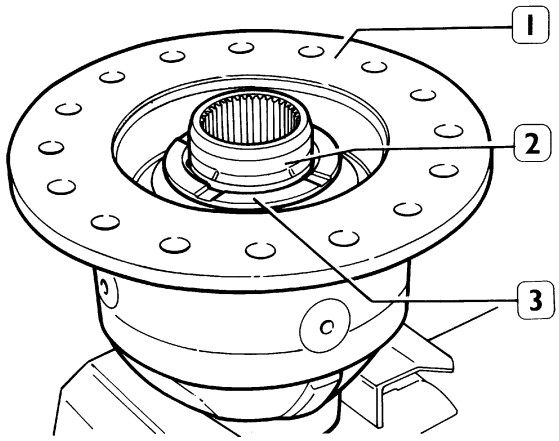
Figure 71



39680

Mark the cover and gear housing (⇒ ⇐).
Remove the gear housing cover (1) and release the ring bevel gear (2)

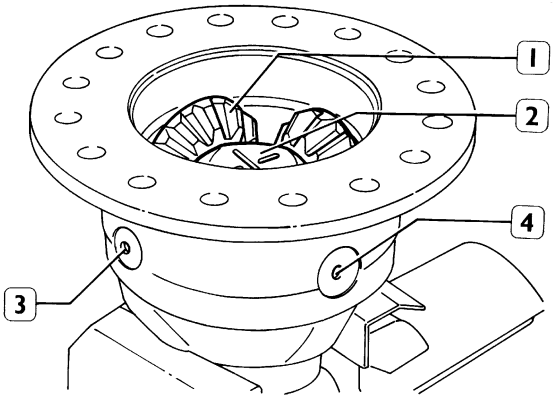
Figure 72



39681

Remove the crown wheel (2) with the relevant shoulder washer (3) from the gear housing (1).

Figure 73



39682

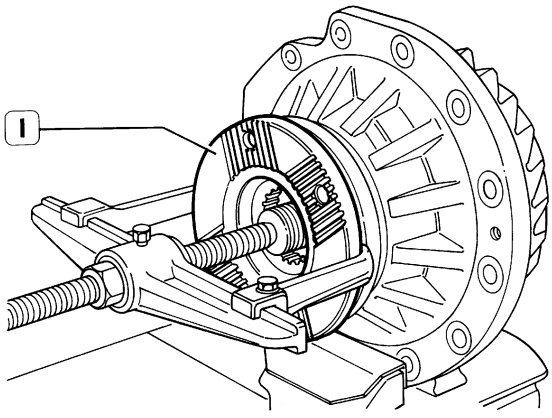
Use a beater to remove the long pin (4) then the two short pins (3).

The exact position of the pins is marked on the spider (2) by a long stripe for the long pin and two short stripes for the short pins.

Remove the spider (2) and 4 planetary gears (1) with the shoulder washers.
Remove the crown wheel and shoulder washer.

REMOVING THE BEVEL PINION SUPPORT

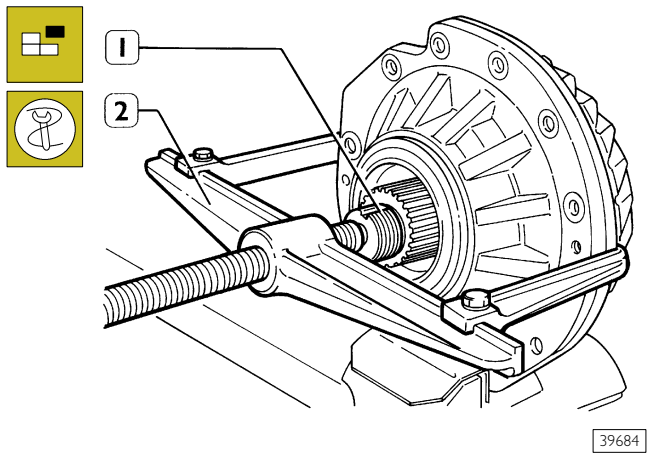
Figure 74



39683

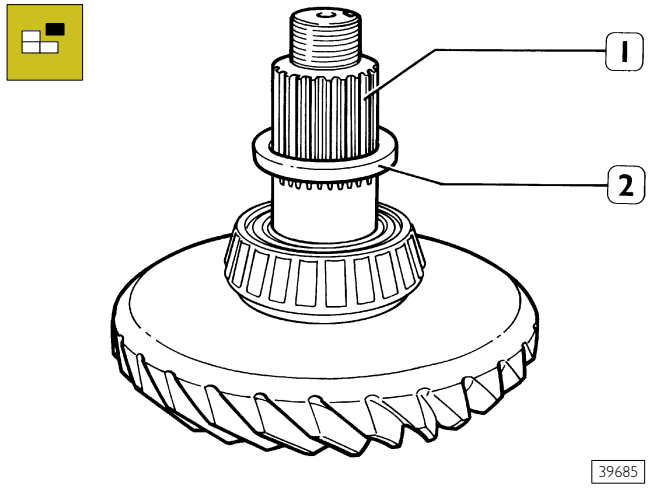
Remove the previously loosened lock nut and the coupling flange (1).
If the flange removal is difficult, use a universal puller.

Figure 75



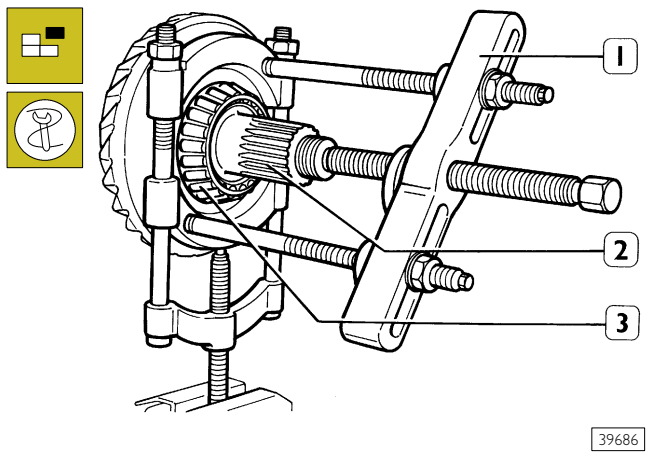
Take out the bevel pinion (1) with intermediate bearing and adjusting ring from the support. It is suggested to use a press for this operation, but if this is not possible, use a puller (2)

Figure 76



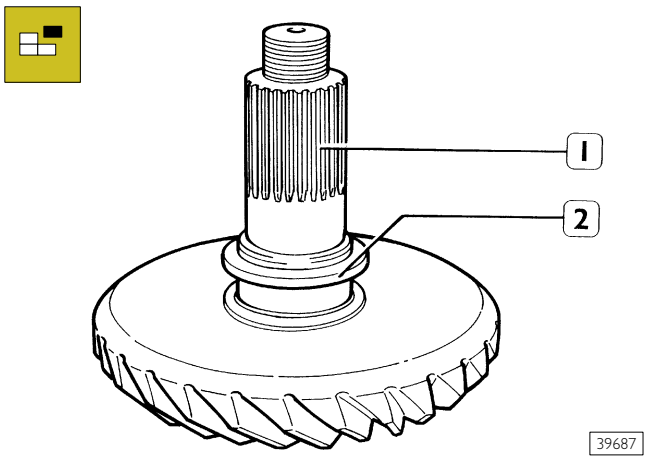
Remove the bearing adjusting nut (2) from the bevel pinion (1).

Figure 77



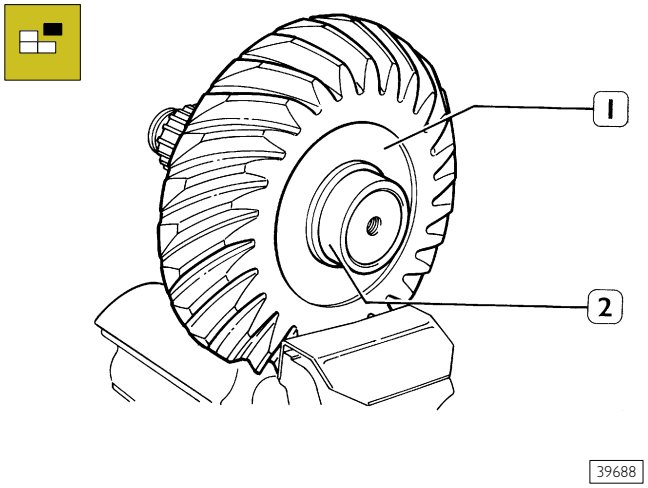
With a universal puller 99348001 (1) remove the intermediate taper roller bearing (3) from the bevel pinion (2).

Figure 78



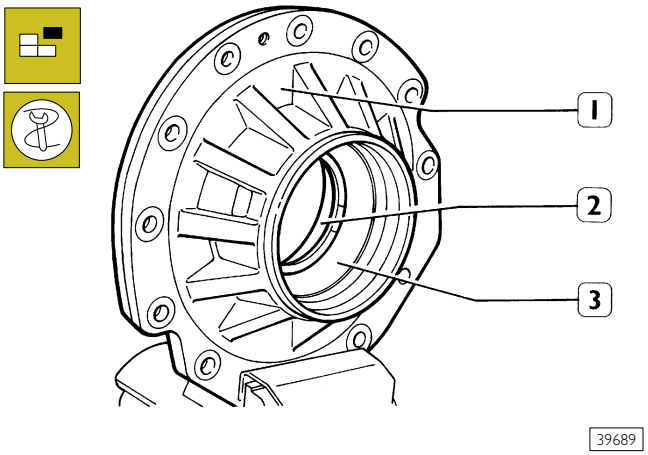
Withdraw the pinion location adjusting ring (2) from the bevel pinion (1)

Figure 79



Remove the rear straight roller bearing inner ring (2) from the bevel pinion (1). This is a destructive operation.

Figure 80



Use a beater to take out the front and intermediate bearings outer rings (3 and 2) from the support (1).

DIFFERENTIAL COMPONENTS CHECK

Carefully clean all the differential components.
Lubricate the bearings and rotate the roller cage freely. The rotation must be even and without signs of stiffness.

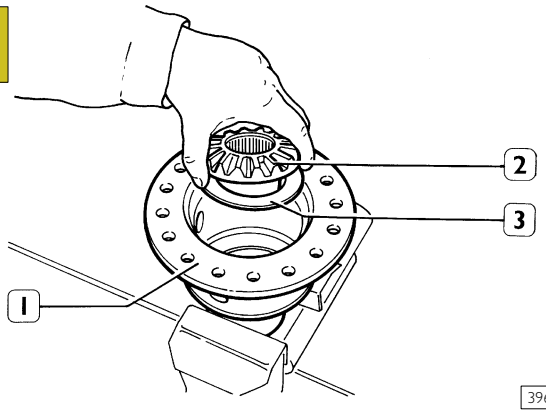
Carefully clean all the threads in order to obtain exact adjustments and accurate driving torques.

Check that the splined section for flange-pinion connection is not badly worn, if it is, replace the pinion.

When replacing the crown wheel or pinion it is necessary to replace both parts since they are supplied in pairs.

FITTING IN PLACE THE GEAR HOUSING

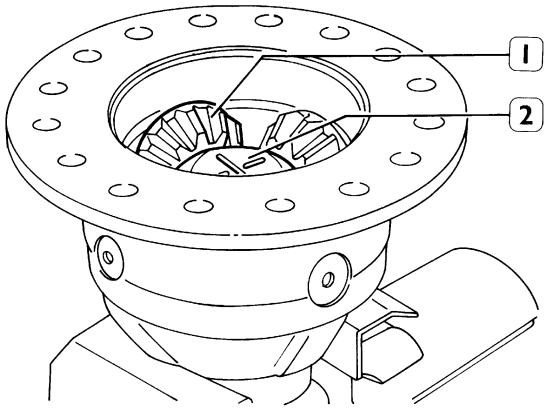
Figure 81



39690

Lock the gear housing (1) in a vice and set the crown wheel (2) with shoulder ring (3) in its housing.

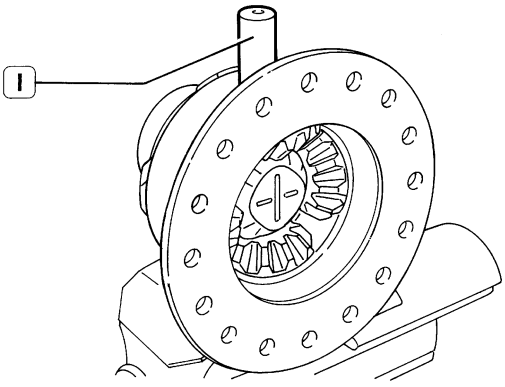
Figure 82



39691

Set the 4 planetary gears (1) with the shoulder washers and fit in the spider (2).

Figure 83

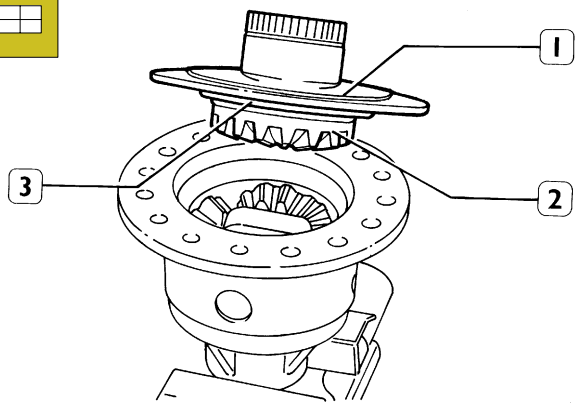


39692

Insert the long pin (1) and two short pins.

The long (through) pin is inserted first.
The exact position of the pins is marked on the spider (2) by a long stripe for the long pin and two short stripes for the short pins.

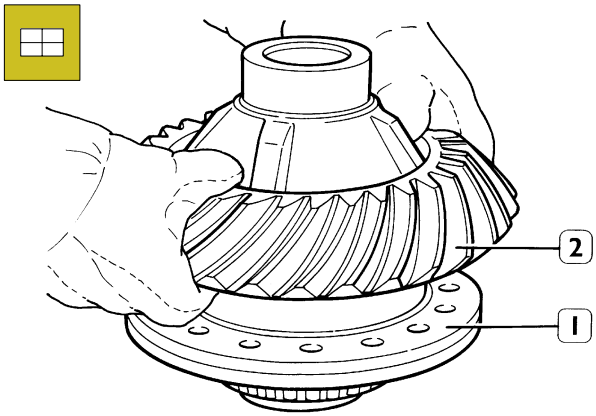
Figure 84



39693

Set the crown wheel (2) with its shoulder washer (3) on the planetary gears.
Fit in place the cover (1) on the housing matching the marking made before removal.

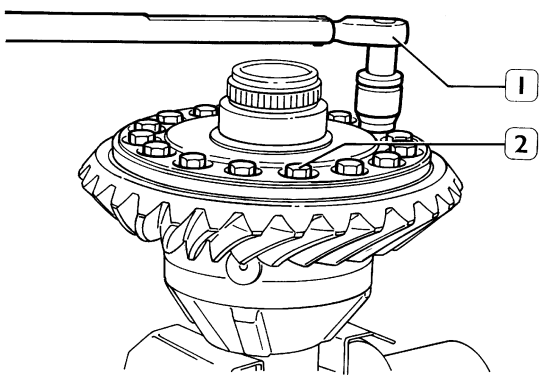
Figure 85



39694

Heat the bevel ring gear (2) to approx. 80°C, fit it in its housing on the gear housing (1) and lock it immediately with two fastening screws.

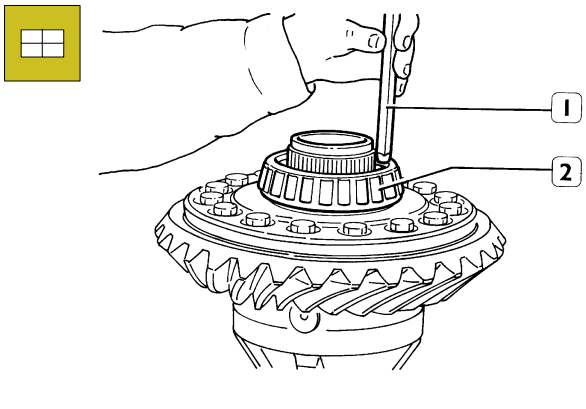
Figure 86



39695

Insert the rest of the fastening screws (2) and with a dynamometric wrench (1) tighten them to a torque of 300 ± 10 Nm (30 ± 1 kgm).

Figure 87

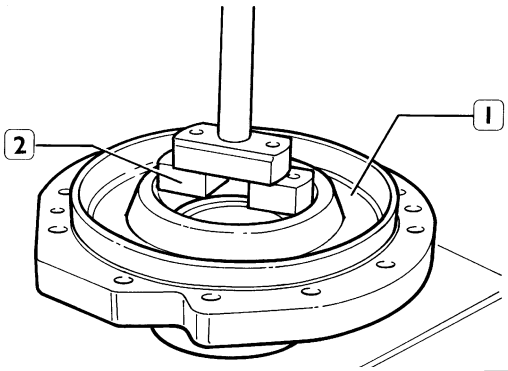


39696

Heat the bearing (2) to a temperature of 100°C for approx. 15 minutes then drive it in the gear housing cover using a suitable beater (1). Repeat this operation on the other side.

FITTING IN PLACE THE BEVEL PINION SUPPORT

Figure 88

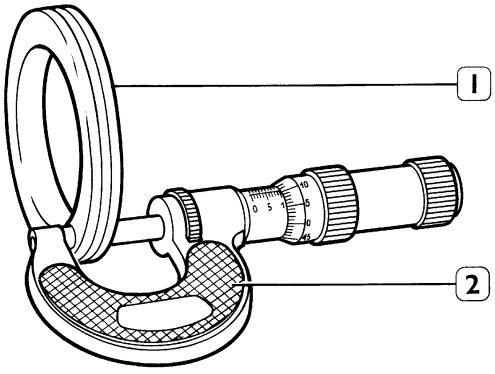


39697

Connect a new oil baffle to the pinion support (1).
Use beater 99374093 (2) to drive the intermediate bearing outer ring and the front bearing outer ring right down into their seats.

Procedure to determine the thickness of the bevel pinion rolling torque adjusting ring

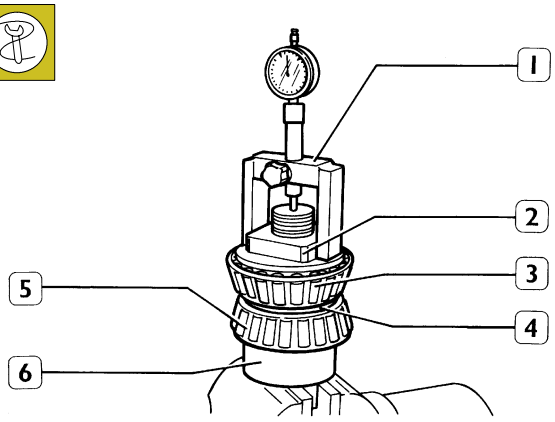
Figure 89



39572

Measure the thickness of the removed adjusting ring (1) and make a note of the value (value A).

Figure 90



39698

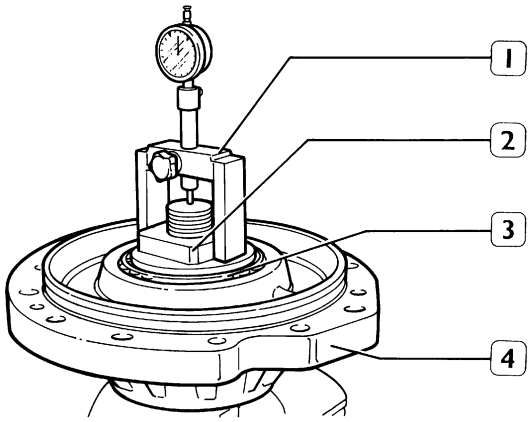
Fit tool 99395027 (6) in a vice and place on it:

- ❑ the pinion side bearing (5)
- ❑ adjusting ring (4), already measured, and bearing (3)

Screw the ring nut (2) and lock it tightly.
Position the dial gauge fitted to element (1) of tool 99395027 (6) on the bearing (3) and set the gauge to zero on the end of the tool (6).
Remove from the tool (6):

- ❑ element (1)
- ❑ ring nut (2)
- ❑ bearing (3)
- ❑ adjusting ring (4)

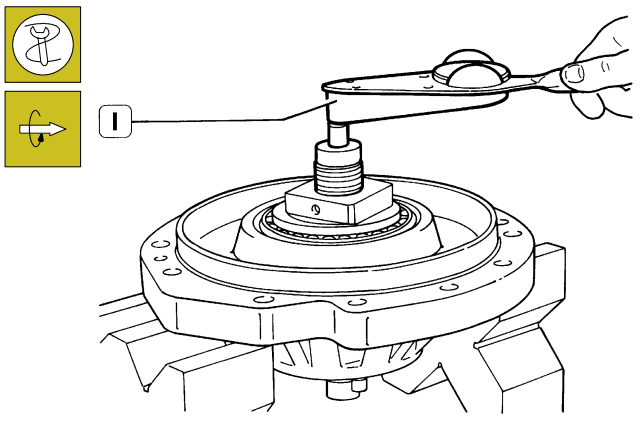
Figure 91



39699

Set the support (4, figure 91) on the bearing (5, figure 90); set bearing (3) on the support.
Manually tighten the ring nut (2) and check the rolling torque as indicated in figure 92.

Figure 92



39700

Set the complete support on 2 parallel bars and with a dynamometric wrench (1) applied on tool 99395027 find the rolling torque which should be 1.5 to 3.5 Nm. If this is not so operate on the ring nut (2, figure 91). Place element (1, figure 91) with the dial gauage set to zero, on the bearing (3) and find the deviation, if any (value B)

Adjusting ring thickness "**S**" is obtained through the following formula:

S = A - (B) + C

where:

A = Thickness of adjusting ring fitted to set the dial gauage to zero;

B = Deviation value found;

C = 0.05 mm coefficient that takes into account the bearings dilation cause by assembling interference on the bevel pinion;

First example

A = 13.12 mm
B = + 0.13 mm
C = 0.05 mm

S = 13.12 - (+ 0.13) + 0.05 =
S = 13.12 - 0.13 + 0.05 = 13.04 mm.

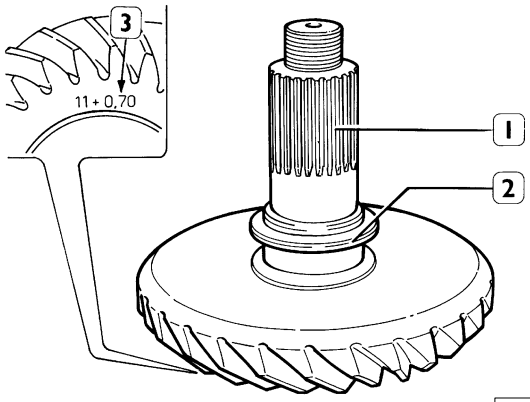
Second example

A = 13.12 mm
B = - 0.13 mm
C = 0.05 mm

S = 13.12 - (- 0.13) + 0.05 =
S = 13.12 + 0.13 + 0.05 = 13.35 mm.

Remove the elements from tool 9939507.

Figure 93



39701

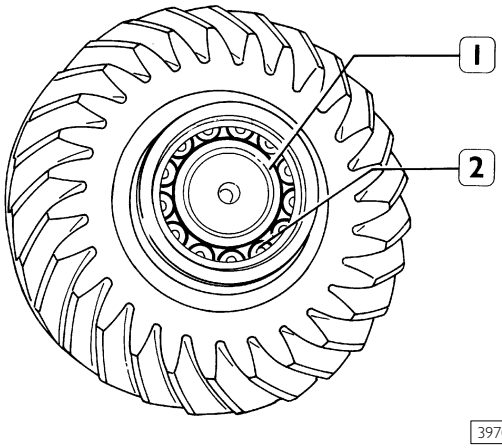
On the bevel pinion (1) fit in place the adjusting ring (2) to set the pinion with reference to the crown wheel and the chamfer directed downwards. The thickness of the adjusting ring depends on the reference value (3) engraved on the bevel pinion.

Figure 94

Value engraved on pinion	Adjusting ring thickness
0	4,6
0,1	4,5
0,2	4,4
0,3	4,3
0,4	4,2
0,5	4,1
0,6	4,0
0,7	3,9
0,8	3,8
0,9	3,7
1,0	3,6

Table to determine the thickness of adjusting rings, bevel pinion position with reference to the crown wheel.

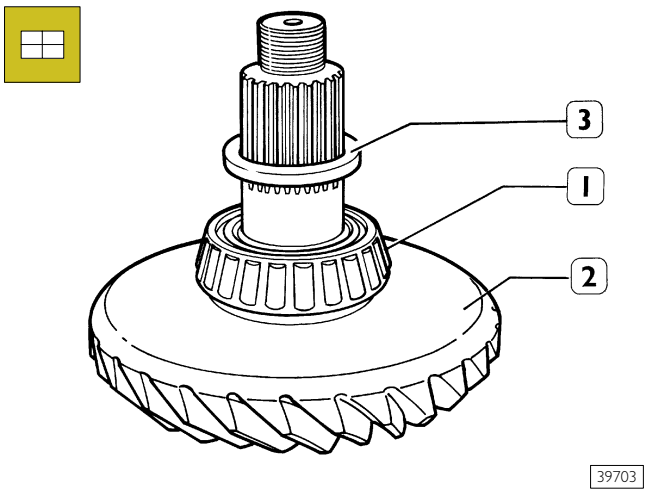
Figure 95



39702

Heat the rear straight roller bearing (2) inner ring (1) to a temperature of 100°C and fit in place on the bevel pinion.

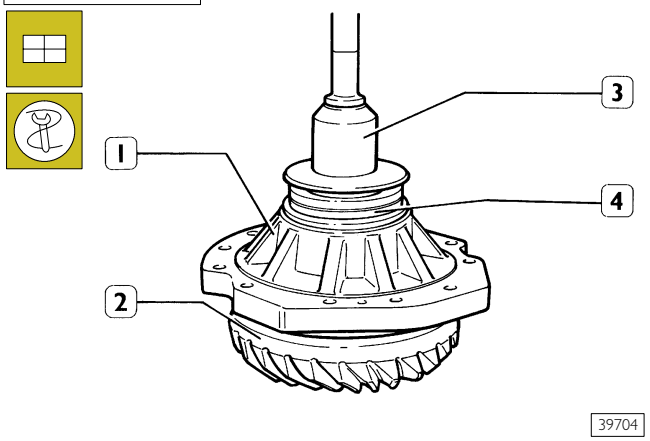
Figure 96



39703

Heat the intermediate bearing (1) to approx. 100°C and fit in place on the bevel pinion (2).
Fit in place the adjusting ring (3) with the proper thickness.

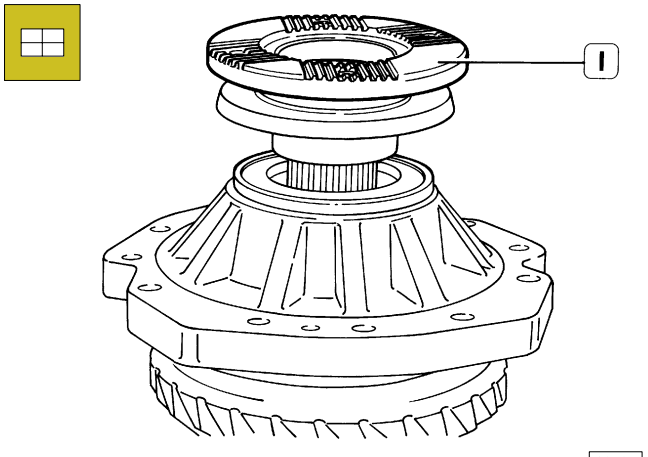
Figure 97



39704

Fit in place the support (1), already assembled, on the bevel pinion (2). Fit in place the front bearing. With a connection device (3) fit in place the oil seal ring (4)

Figure 98

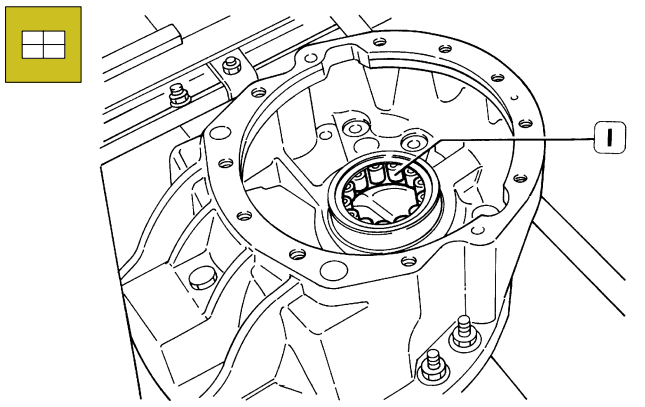


39705

Fit in place the coupling flange (1) using a suitable beater, then manually tighten the lock nut.

FITTING IN PLACE THE DIFFERENTIAL HOUSING

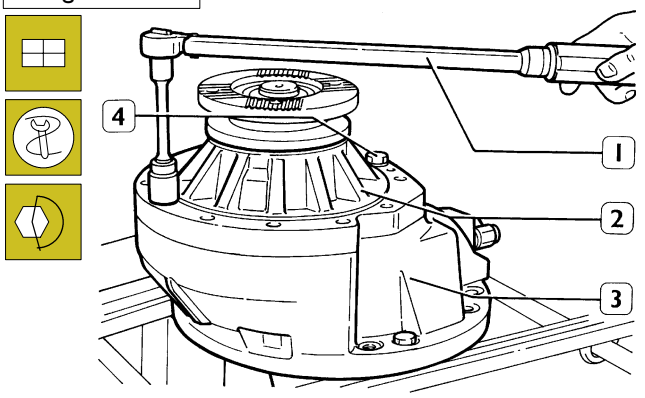
Figure 99



39706

Use a beater to drive the rear straight roller bearing (1) into its seat in the differential housing.

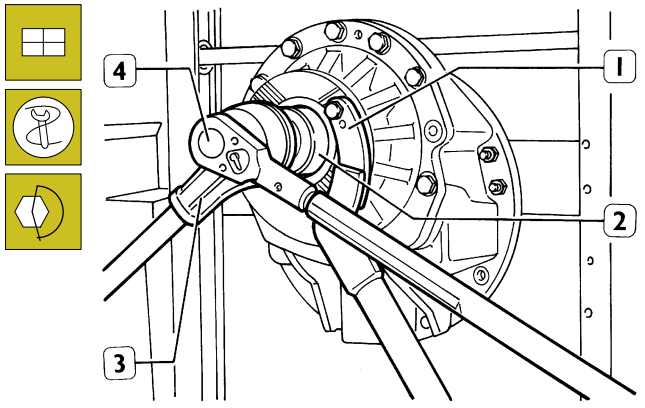
Figure 100



39707

Fit in place on the differential housing (3) the already assembled bevel pinion support (2), insert 2 screws (4) with spring washers in diametrically opposite positions. With a dynamometric wrench (1) tighten them to a torque of 160 ± 10 Nm (16 ± 1 kgm).

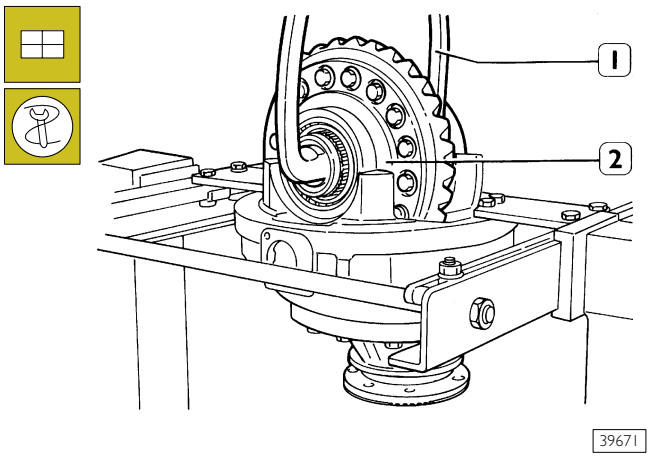
Figure 101



39708

Lock the coupling flange rotation with counter lever 99370317 (1) and using socket wrench 9935508l, multiplier (3) and dynamometric wrench (4) tighten the lock nut to a torque of 700 ± 50 Nm (70 ±5 kgm).

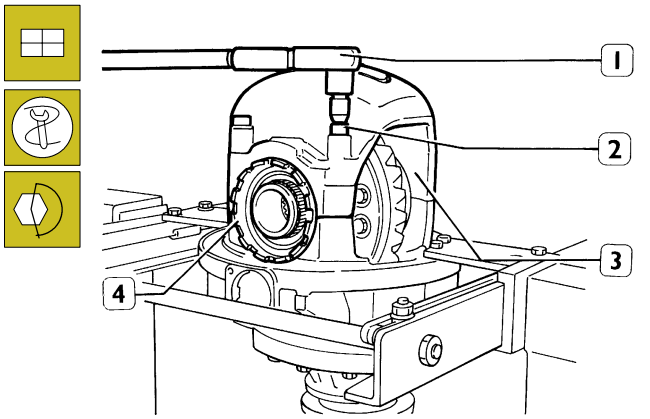
Figure 102



39671

With hook (1) 99370509 set the gear housing (2) with the rlevant roller bearings on the differential housing.

Figure 103



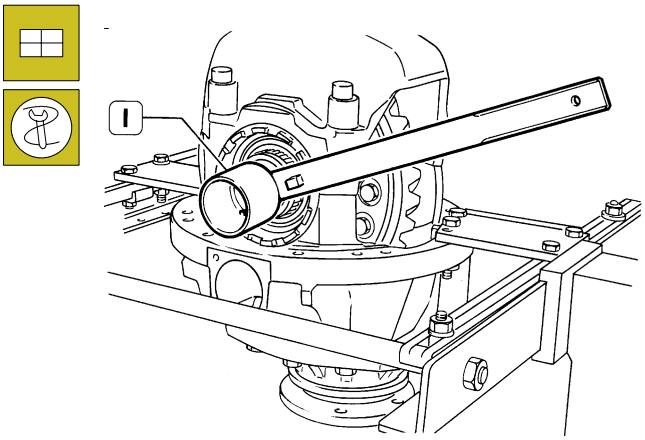
39709

Fit in place the cover (3) matching the marks made when removing, slightly lock the screws (2) and check that the adjusting ring nuts (4) can be screwed without difficulty.
Remove the screws (2), spread LOCTITE AVX on the threads and with a dynametric wrench (1) tighten them to a torque of 280 ± 15 Nm.

Adjusting the rolling torque of the gear housing bearings

The rolling torque adjustment of gear housing bearings is obtained by measuring the total rolling torque.
Find in the table in figure 103 the total rolling torque value (this value varies according to the bevel pair ratio).

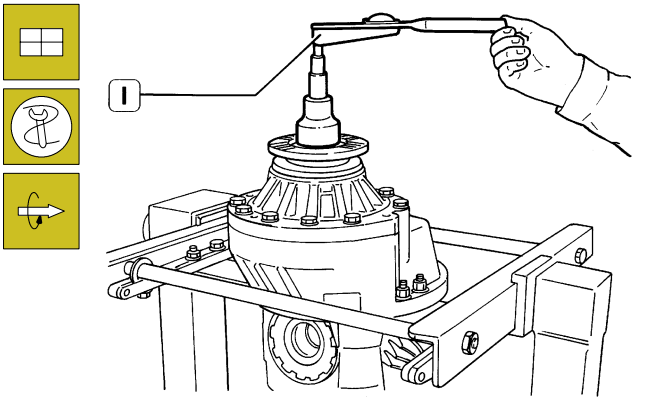
Figure 104



39712

Using torque wrench 99389819 (1) and appropriate socket wrench find the prescribed rolling torque, operating on the bearing adjustment ring nuts (figure 104), through wrench 99354001 (1).

Figure 105



39711

Find from the table below the rolling torque value (this value varies according to the bevel gear pair ratio) and perform adjustment.

Teeth No.	Ratio	Total rolling torque Nm
27/32	1,185	a+(2,5÷4,2)
28/37	1,321	a+(2,3÷3,8)
21/40	1,905	a+(1,6–2,1)
19/33	1,737	a+(1,7–2,3)
23/36	1,565	a+(1,9–2,6)

a = 3÷4 Nm

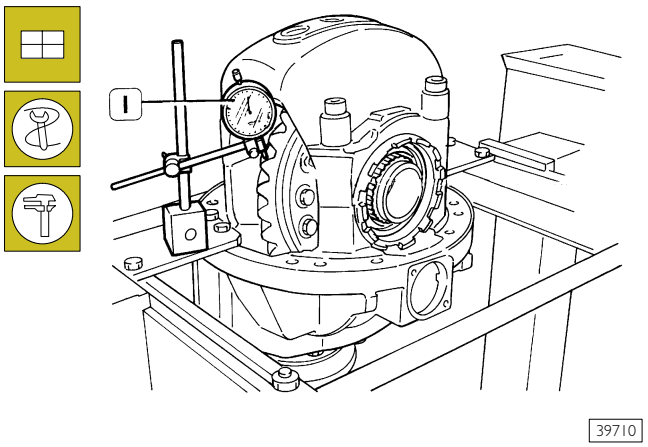
Total rolling torque Nm

Adjust the backlash between the teeth of the bevel pair operating as follows:

- ❑ Find the clearance value between the teeth; this varies according to the bevel pair ratio;

No. Teeth	Ratio	Clearance between teeth
21/40	1,905	0,20 ÷ 0,28
19/33	1,737	0,25 ÷ 0,33
23/36	1,565	0,20 ÷ 0,29
28/37	1,321	0,20 ÷ 0,28
27/32	1,185	0,20 ÷ 0,30

Figure 106

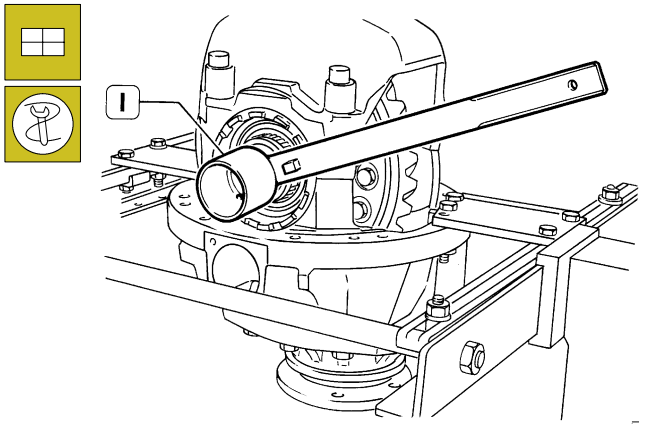


39710

- ❑ Set the dial gauge (1) with magnetic base as shown in the figure
- ❑ Lock the bevel pinion rotation through counter lever 99370317; reverse the crown wheel rotation and with the dial gauge find the backlash between the teeth of the two gears.

If it is not satisfactory, operate on the adjusting ring nuts using wrench 99354001 (1, figure 107)

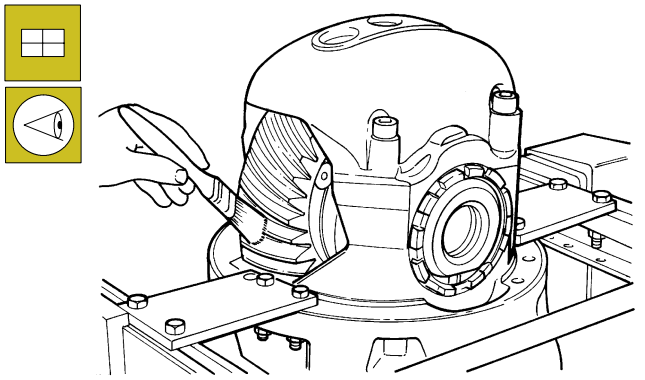
Figure 107



39711

To avoid altering the previously obtained rolling torque when adjusting the backlash between the teeth of the pinion and crown wheel, the adjusting ring nut can be tightened using wrench 99354001 (1) by the same amount as the ring nut on the other side has been loosened.
After the adjustment has been completed, check that the two ring nuts permit the mounting of the safety plates.

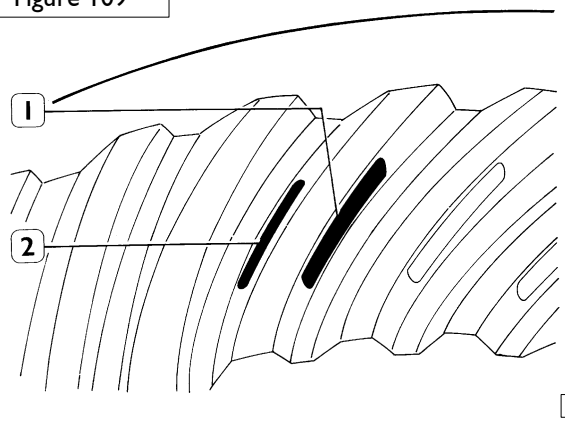
Figure 108



39704

Using a brush apply a thin coating of lead oxide to the crown wheel teeth.
Rotate the pinion and find the pinion teeth contact marks on the crown wheel teeth.
The figures that follow indicate possible contact points and how to correct any errors.

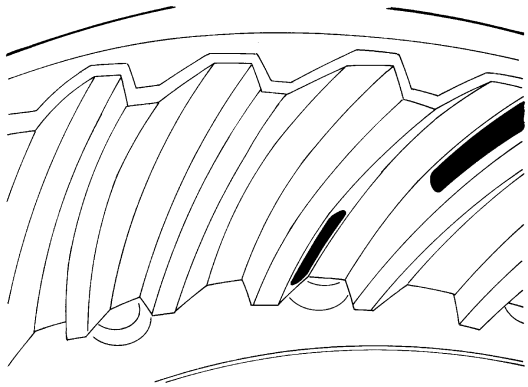
Figure 109



40160

The lead oxide should mark both the drawn surface (1) and the thrusting surface (2) approximately along the centreline of the tooth width. Without load, both meshing areas that contact are slightly displaced with reference to the crown wheel outer diameter.

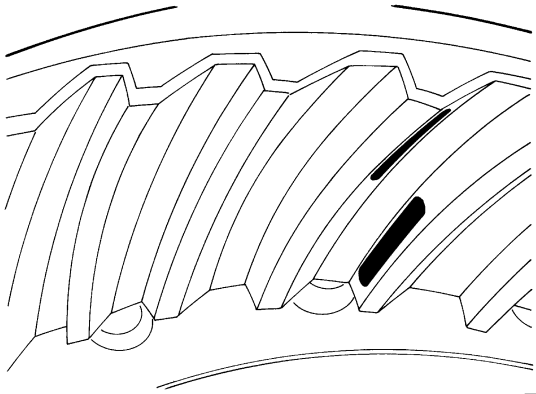
Figure 110



40161A

If the mark on the drawn surface (toward the outer diameter) and on the thrusting surface (toward the inner diameter) is displaced, this means that the pinion is too near the crown wheel.
- Cure: Increase the shim of the adjusting ring between the intermediate bearing and the bevel pinion

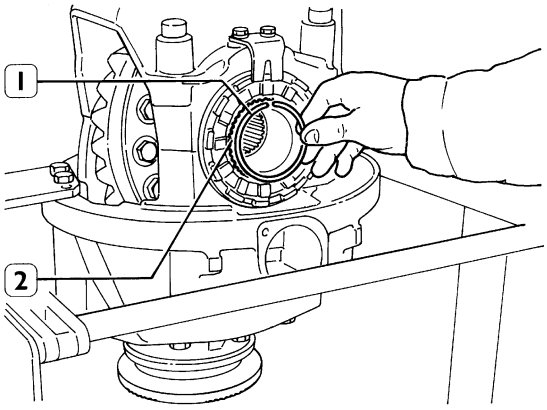
Figure 111



40161B

If the mark on the drawn surface is displaced towards the inner diameter and the mark on the thrusting surface is displaced towards the crown outer diameter, this means that the pinion is too far from the crown wheel axis.
Cure - reduce the shim of the adjusting ring between the intermediate bearing and the bevel pinion.

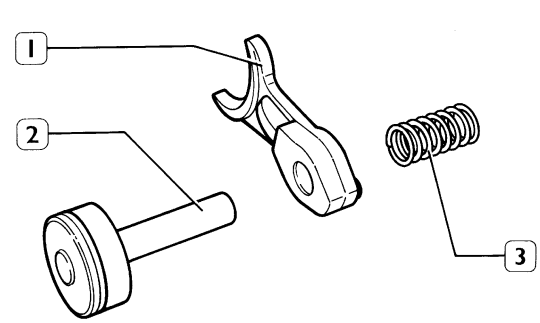
Figure 112



39713

Fit in place the engaging sleeve (1) on the gear housing teeth and using a screwdriver fit the split ring (2) into its groove.

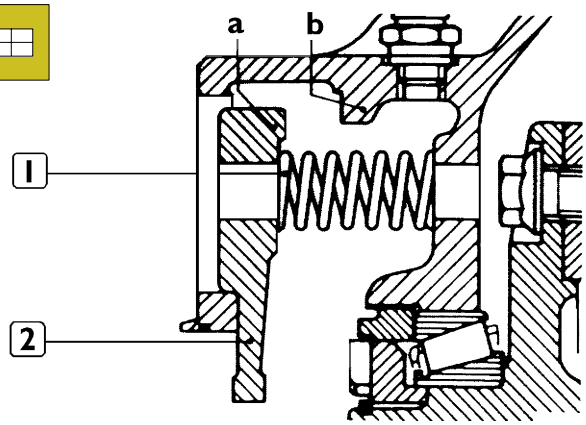
Figure 113



39714

Fit in place the differential locking device assembly composed of the control cylinder, piston (2), enagaging fork (1) and compression spring (3).

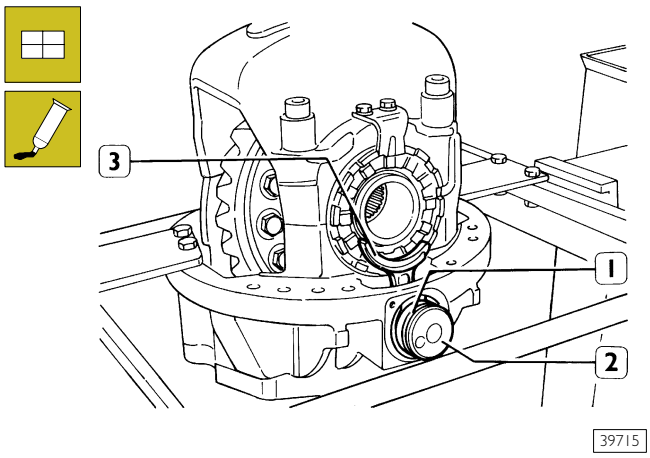
Figure 114



26609

Insert the compression spring (1) in the differential housing. Fit in place the engaging fork (2) so that the stop at the end of stroke (a) corresponds to the end of stroke (b) on the differential housing.

Figure 115



Fit in place a new seal ring (1) on the control piston (2) and grease it.
Insert the control piston (2) into the enagaging fork (3) in the compression spring, then in the specific hole in the differential housing.
Remove the bevel pinion support again.
Fitting in place the differential in the axle casing
1° Fit in place the sliding sleeve on the half-shaft
2° Fit in place the gear housing taking care that the control fork fits into the sliding sleeve spline
3° Tighten the screw and at the same time push the half shaft so that the sliding sleeve fits into the enagaging sleeve on the differential
4° Apply LOCTITE 573 to the thread and under the screw heads then tighten with a dynamometric wrench to the prescribed torque
5° Spread LOCTITE 573 on the contact surface, re-fit into place the pinion support and tighten the screws to the prescribed torque.

INTERMEDIATE AXLE IN TANDEM

SECTION 12.4

SECTION 12.4

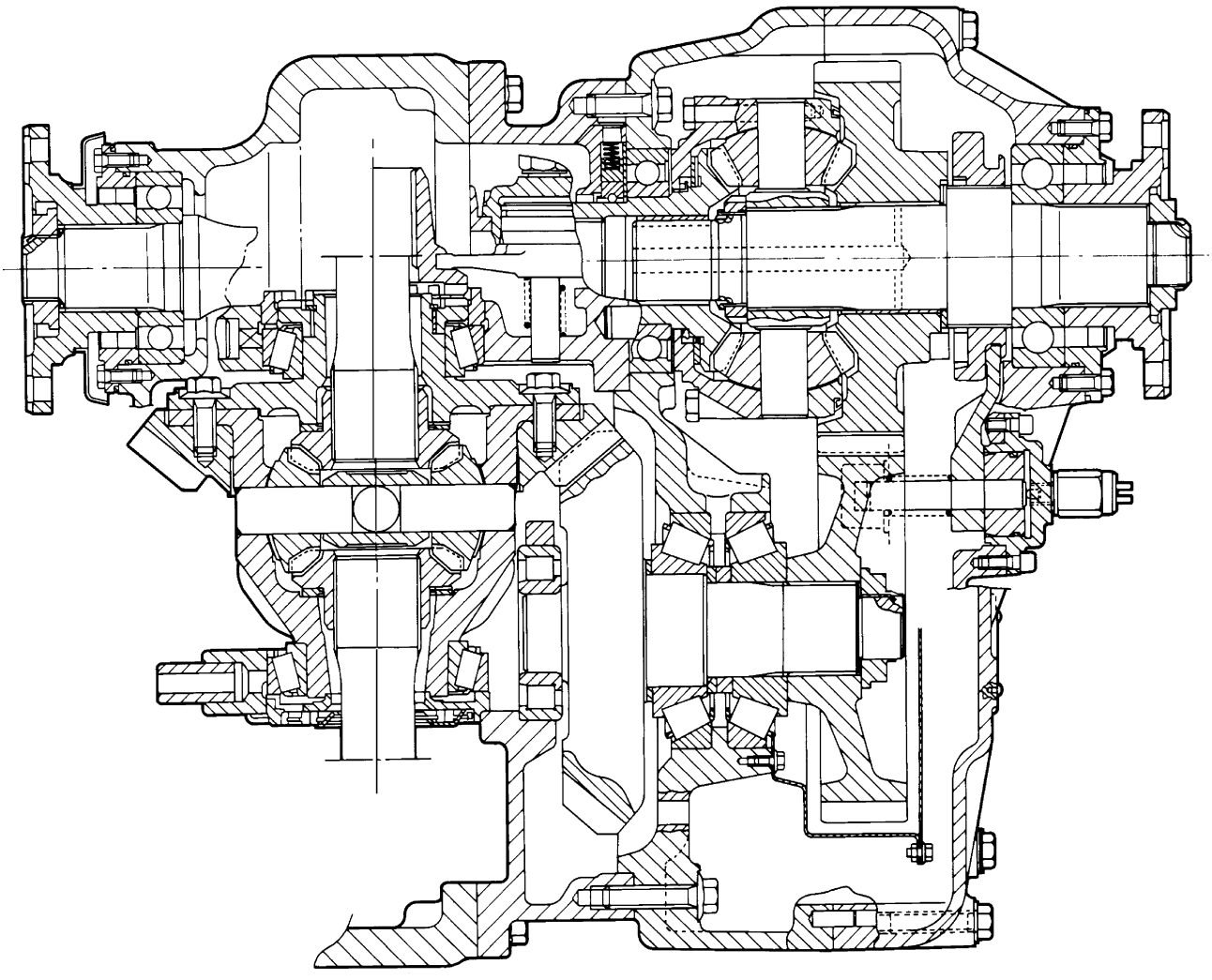
Intermediate axle in tandem

DESCRIPTION

The intermediate axle is a double reduction type. The first reduction is obtained through the pinion -ring bevel gear, the second through an epicyclic unit in the wheel hubs.

A reduction gear unit on the intermediate axle transmits the driving torque between the two axles.
The axle has a pneumatic device to lock the differential and another to lock the reduction gear unit.

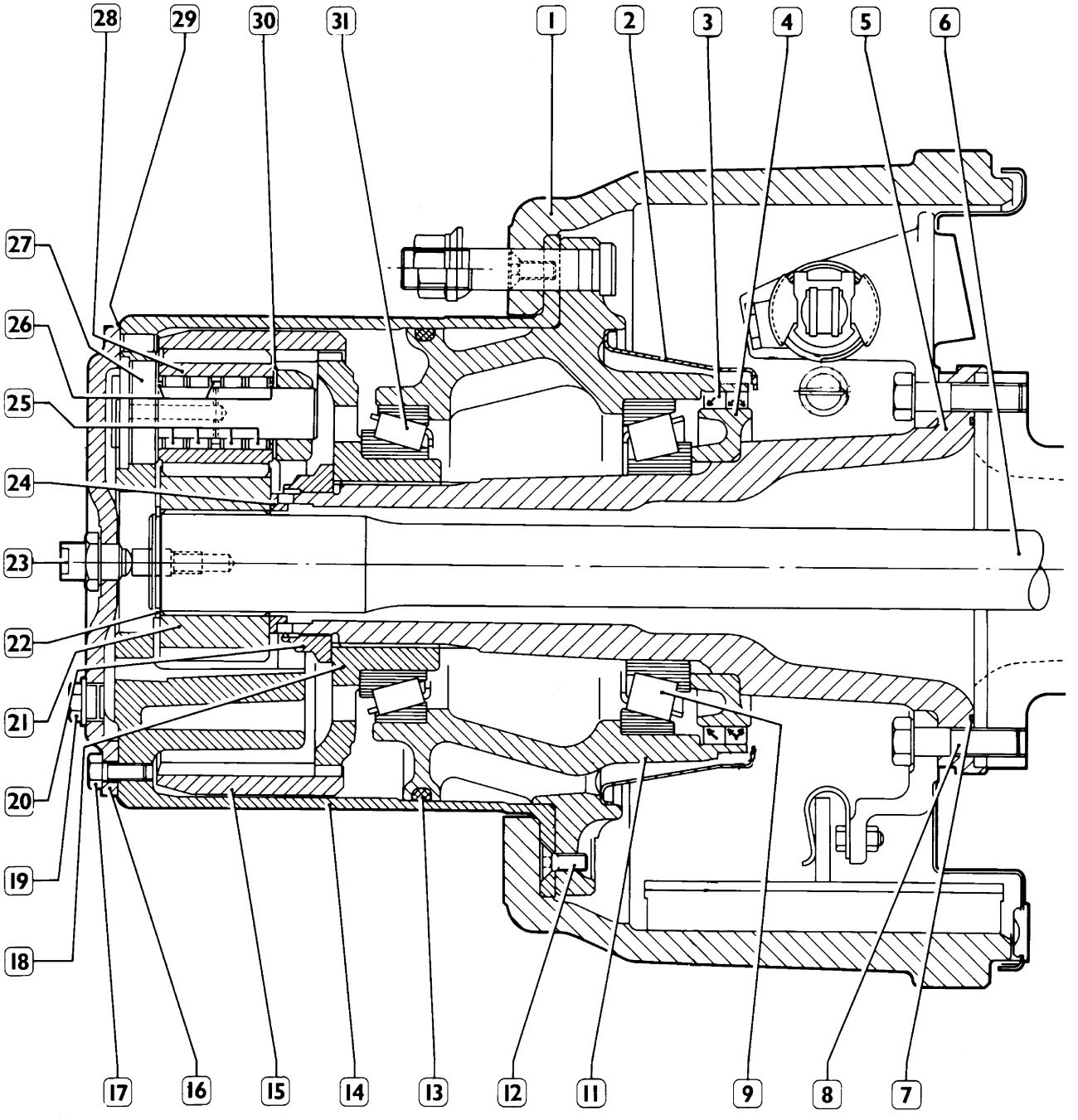
Figure 1



39385A

LONGITUDINAL PICTORIAL SECTION OF DIFFERENTIAL REDUCTION GEAR UNIT

Figure 2



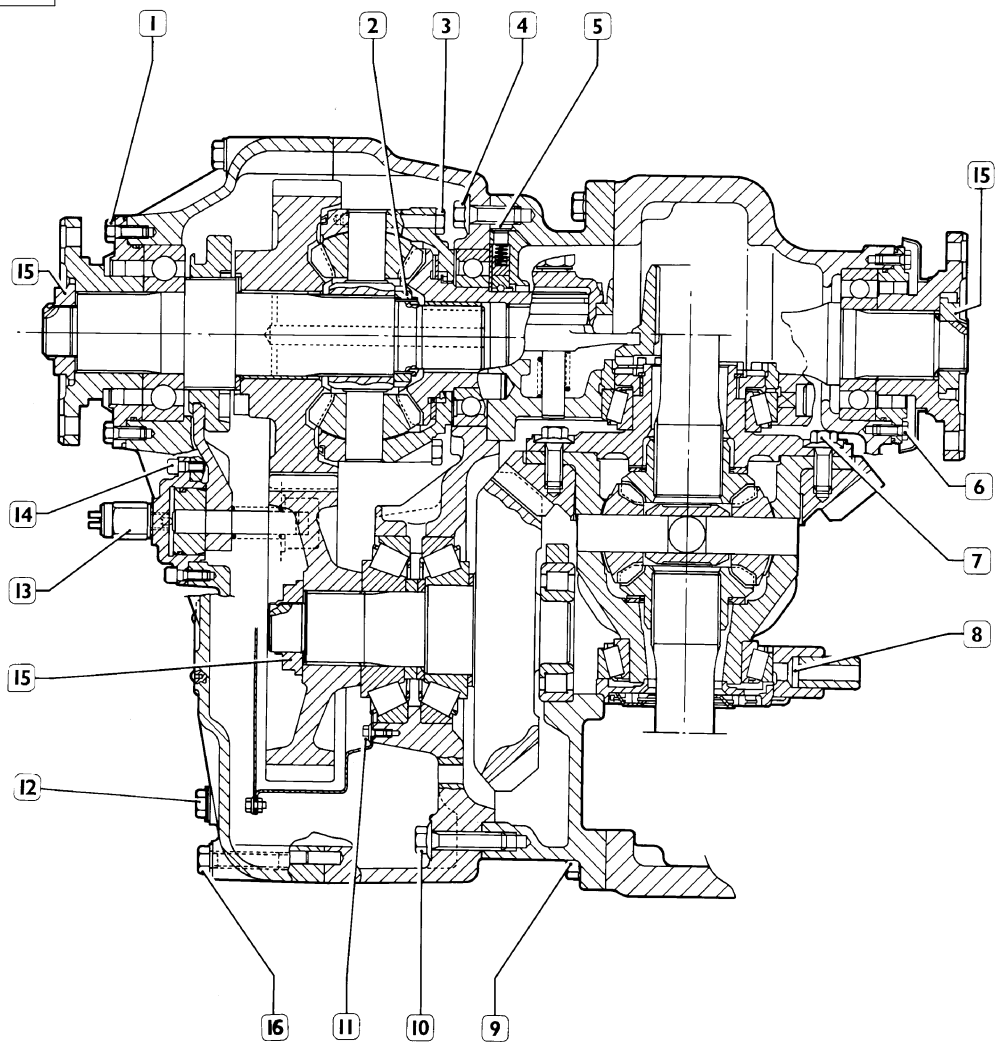
CROSS SECTION OF EPICYCLIC REDUCTION GEAR AND WHEEL HUB (45139)

1. Brake drum - 2. Oil manifold - 3. Seal rings - 4. Intermediate ring for sealing gasket - 5. Bearing shaft - 6. Half-shaft - 7. Seal ring - 8. Screw - 9. Bearing - 11. Wheel hub - 12. Screw - 13. Seal ring - 14. Planetary gear carrier - 15. Crown wheel - 16. Cover - 17. Screw - 18. Crown wheel carrier - 19. Plug - 20. Collar nut - 21. Planetary gear - 22. Circlip - 23. Spacer screw - 24. Spacer ring - 25. Needles for planetary gear - 26. Spacer rings - 27. Support pin - 28. Planetary gear - 29. Gasket - 30. Spacer - 31. Bearing

SPECIFICATIONS AND DATA

Type of axle: Bearing with single reduction, differential is locked through pneumatic control and reduction gear unit	**ASTRA 453291/2D (IVECO R 9189 D'001)**
Bearings for bevel pinion	2, with taper rollers and 1 with straight rollers
Reduction bevel gear pair ratio	23/36 (1,565) - 19/33 (1,737) - 21/40 (1,905)
Epicyclic reduction gear ratio on the wheels	3,2
Bevel pinion bearings rolling torque Nm	1,5 ÷ 3,5
Bevel pinion bearings rolling torque adjustment	through adjustment rings
Thickness of adjustment rings for bevel pinion bearings rolling torque mm	10-10,02-10,04-10,06-10,08-10,10-10,12-10,14-10,16-10,18-10, 20-10,22-10,24-10,26-10,28-10,30-10,32-10,34-10,36-10,38-10,40-10,42-10,44-10,46-10,48-10,50
Thickness of adjustment rings for bevel pinion fitting with reference to the crown wheel mm	3,6-3,7-3,8-3,9-4,0-4,1-4,2-4,3-4,4-4,5-4,6
Backlash between pinion and crown wheel mm	23/36 (1,565) = 0,20 ÷ 0,29 19/33 (1,737) = 0,25 ÷ 0,33 21/40 (1,905) = 0,20 ÷ 0,28
Adjustment of backlash between pinion and crown wheel	Through ring
WHEEL HUBS	
Wheel hub bearings	Two with taper rollers
Rolling torque of wheel hub bearings: new bearings with surface protection Nm	3 + (12 ÷ 16)
Rolling torque of wheel hub bearings: run-in bearings and new lubricated seal rings Nm	3 + (5 ÷ 7)
Rolling torque of wheel hub bearings: run-in bearings and seal rings Nm	3 + (2,5 ÷ 4,5)
Half-shaft end play mm	0,5 ÷ 1

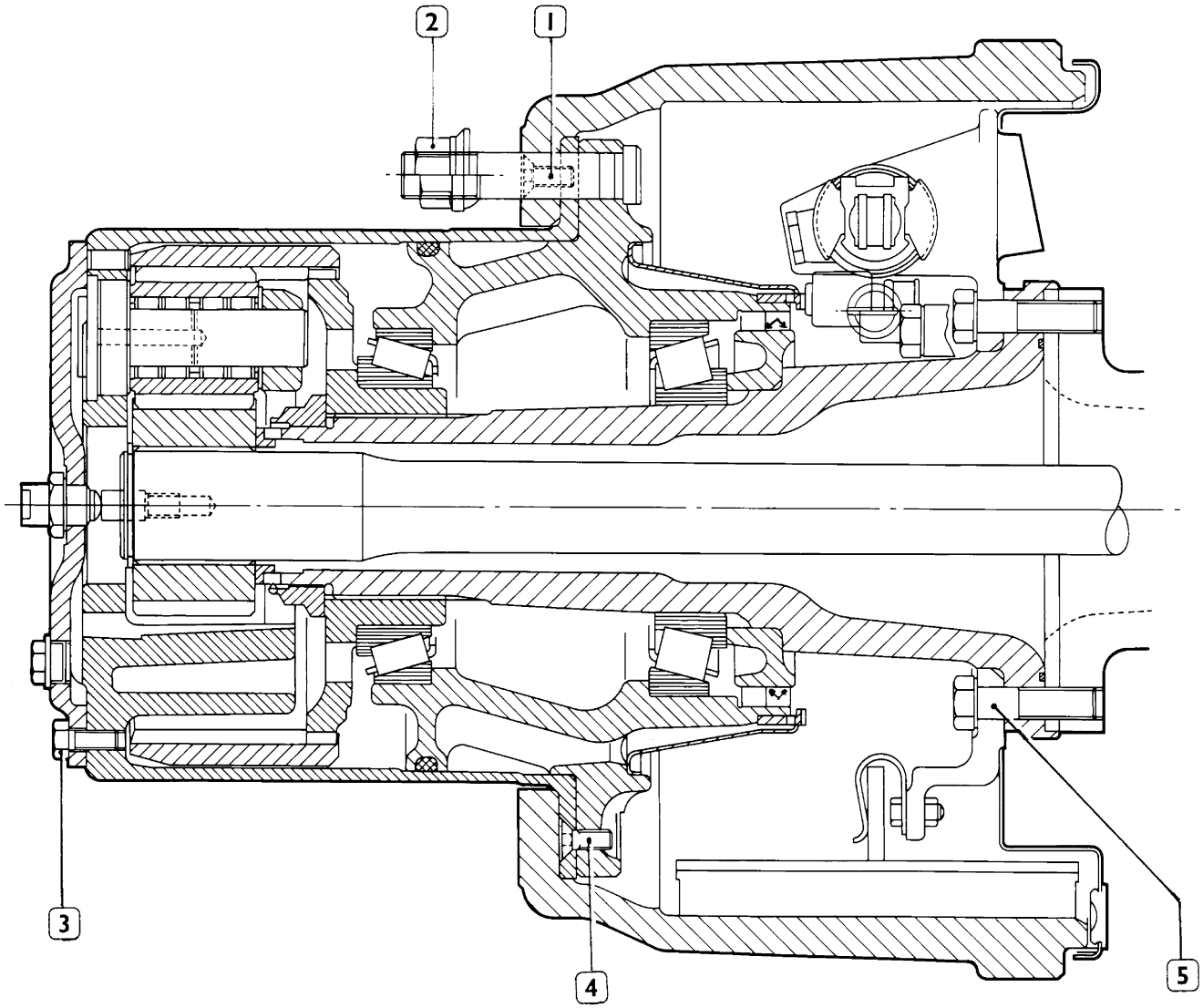
Figure 3



TIGHTENING TORQUES

	COMPONENT	TORQUE	
		Nm	Kgm
1	Hexagonal socket head screw for cover	62 ± 6	6,2 ± 0,6
2	Ring nut	230 ± 20	23 ± 2
3	Hexagonal socket head screw	67 ± 8	6,7 ± ,0,8
4	Self-locking screw	260 ± 25	26 ± 2,5
5	Threaded plug M12x1.5	21 ± 2	2 ± 0,2
6	Hexagonal socket head screw for cover	33 ± 3	3 ± 0,3
7	Self-locking screw	300 ± 10	30 ± 1
8	Self-locking screw to fasten safety plate	51 ± 5	5 ± 0,5
9	Self-locking screw	260 ± 25	26 ± 2,5
10	Self-locking screw	260 ± 25	26 ± 2,5
11	Self-locking screw to fasten oil drain	16 ± 2	1,6 ± 0,2
12	Threaded plug	110 ± 10	11 ± 1
13	Transmitter	66 ± 1	6,6 ± 0,1
14	Cap screw	25 ± 2	2,5 ± 0,2
15	Self-locking nut	700 ± 50	70 ± 5
16	Screw for cover	182,5	18,2
*	Caps to gear housing M16 fastening screw	270 ± 10	27 ± 1

Figure 4



	COMPONENT	TORQUE	
		Nm	Kgm
1	Flathead screw to fasten drum	25 ± 3	2,5 ± 0,3
2	Wheel fastening nut	650	65
3	Planetary gear carrier to cover fastening screw ●	50 ± 5	5 ± ,0,5
4	Flathead screw	25 ± 3	2,5 ± 0,3
5	Supporting sleeve fastening screw ◆	280 ± 15	28 ± 1,5
	● Use LOCTIT AVX to lock ◆ Spread Hylomar SQ 321M sealant		

TOOLS

TOOL NO.	DESCRIPTION
99305121	Hot air operated equipment
99322205	Rotary stand for unit overhaul
99322225	Unit holder (to be mounted on stand 99322205)
99341003	Puller
99341017	Pair of brackets with holes
99345053	Counter block for pullers
99354001	Wrench for differential gearcase bearing adjustment ring nut
99355081	Wrench (60 mm) for differental bevel pinion nut (to be used with 99370317)
99355121	Wrench for reduction gear unit main shaft ring nut
99363310	Tool for spur gear stop on reduction gear bevel pinion Handle for interchangeable beaters
99370005	Handle for interchangeable beaters
99370007	Handle for interchangeable beaters
99370122	Beater to fit in place the crown wheel bushes in the reduction gear main shaft
99370133	Tool to lock differential cap angle
99370217	Lever and relevant extension bar
99370509	Hook to remove differential gearcase half box
99370630	Support to hold reduction gear unit during removal/re-fitting in place
99374013	Element to fit in place the differential bevel pinion gasket (to be used with 99370006)
99374094	Beater to fit in place bearings outer tracks (134-215) (to be used with 99370007)
99374233	Element to fit in place seal ring on reduction gear unit driving shaft
99374235	Element to fit in place front seal ring on reduction gear unit crown wheel main shaft
99374272	Element to fit in place rear seal ring on reduction gear unit crown wheel main shaft (to be used with 99370006)
99389816	Torque multiplier (x4) with square input coupling 3/4" output 1" (max. 2745 Nm)
99389819	Dynamometric wrench 0 to 10 kgm connection 1/4"
9938982l	Dynamometric wrench 0 to 70 kgm connection 3/8"
99395026	Tool to check hubs rolling torque (to be used with dynamometric wrench)
99395027	Tool to find proper differential bevel pinion adjustment shims (to be used with 99395603)
99395603	Dial gauge (0-5 mm)

DIAGNOSTIC

Main axle faults:
1 - Wheel hubs noisy
2 - Noise
3 - Noise at release
4 - Noise during acceleration
5 - Cornering noise

1 WHEEL HUBS NOISY

Insufficient lubrication – YES → Check there are no leaks from gaskets or the axle casing and top up oil to correct level.

NO ↓

Wheel hub bearings inefficient – YES → Remove the hub and replace inefficient parts.

NO ↓

Bad adjustment of wheel hub bearings – YES → Adjust bearings

NO ↓

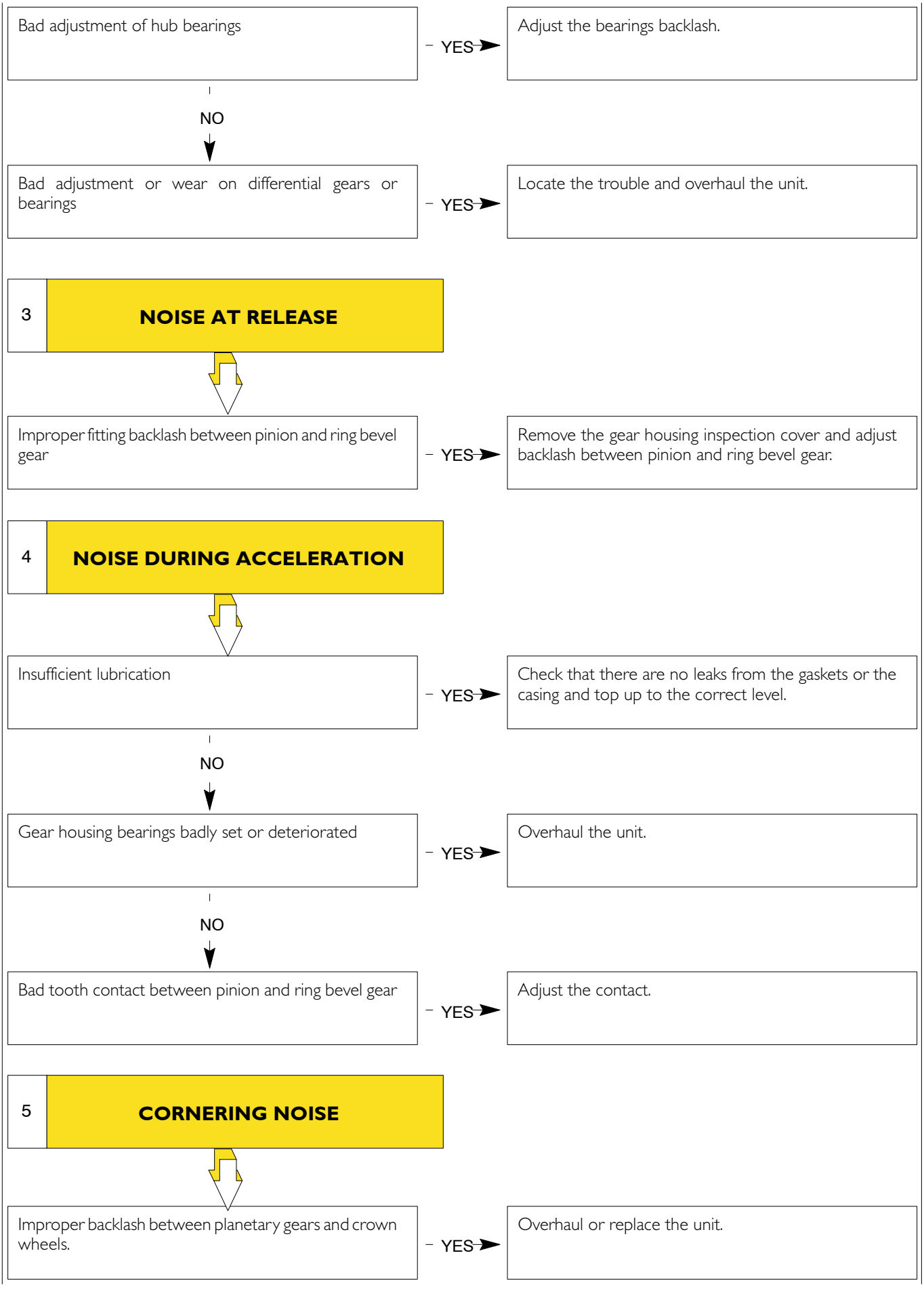
Half-shaft splines to fit planetary gears of epicyclic gears are worn – YES → Overhaul and replace worn or damaged parts

2 NOISE

Lubricating oil level low – YES → Check there are no leaks from gaskets or axle casing and top up to correct level

NO ↓

Half shaft splines to fit the differential crown wheels damaged – YES → Overhaul the axle and replace worn or damaged parts.


Bad adjustment of hub bearings
YES
Adjust the bearings backlash.
NO
Bad adjustment or wear on differential gears or bearings
YES
Locate the trouble and overhaul the unit.
3
NOISE AT RELEASE
Improper fitting backlash between pinion and ring bevel gear
YES
Remove the gear housing inspection cover and adjust backlash between pinion and ring bevel gear.
4
NOISE DURING ACCELERATION
Insufficient lubrication
YES
Check that there are no leaks from the gaskets or the casing and top up to the correct level.
NO
Gear housing bearings badly set or deteriorated
YES
Overhaul the unit.
NO
Bad tooth contact between pinion and ring bevel gear
YES
Adjust the contact.
5
CORNERING NOISE
Improper backlash between planetary gears and crown wheels.
YES
Overhaul or replace the unit.

REMOVING - REFITTING THE INTERMEDIATE AXLE

Removal

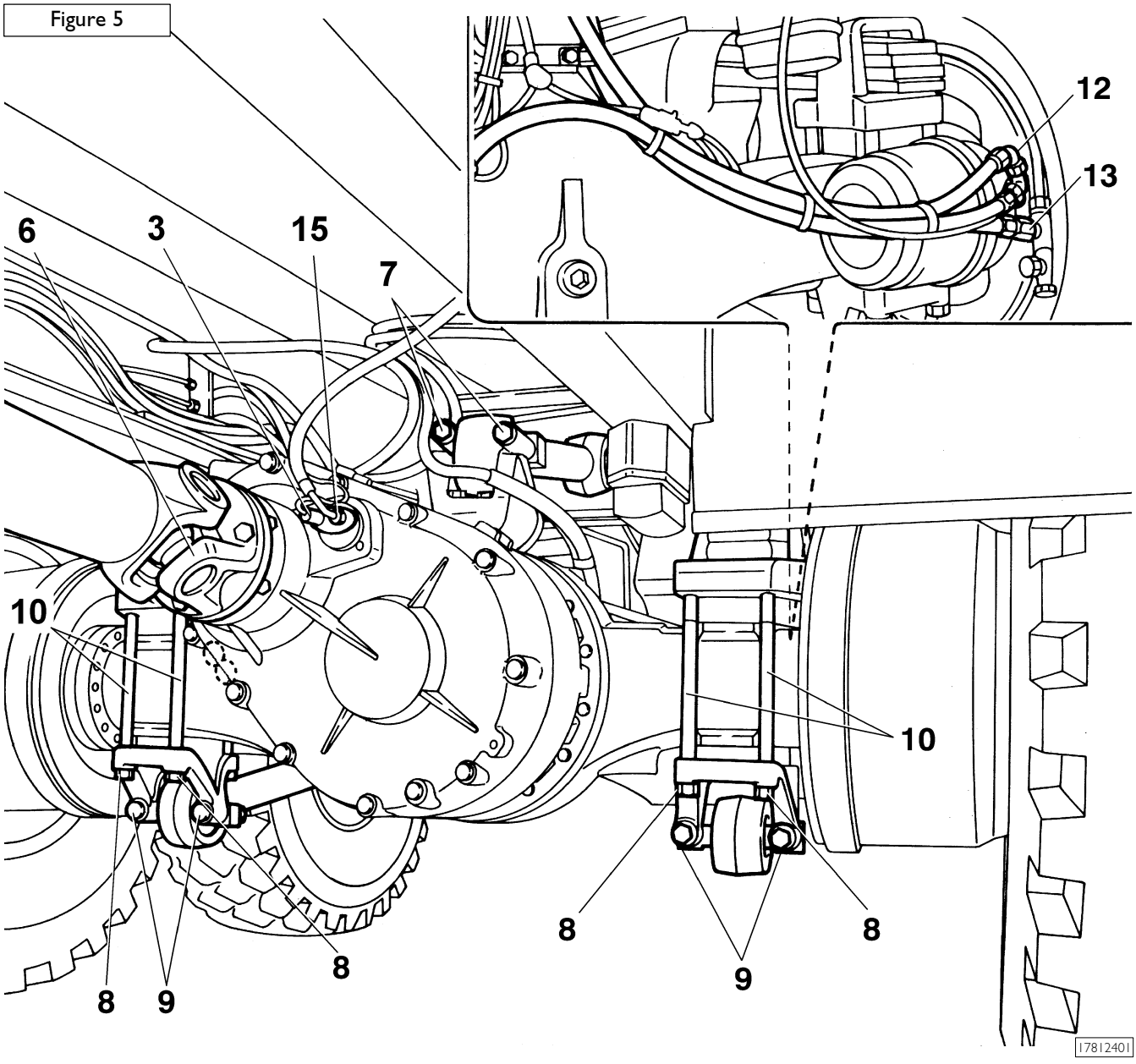
To remove the intermediate axle proceed as follows:

- ❑ place the vehicle on a flat ground and suitably lock the front wheels;
- ❑ loosen both rear wheel fastening nuts;
- ❑ using a hydraulic jack lift the rear part of the vehicle and rest it on two stands;
- ❑ remove both rear wheels;
- ❑ disconnect the electrical cable (2) for the differential led and the electrical cable (3) for the led signalling the differential connection between axles;
- ❑ disconnect the pneumatic connections for parking brake (12), brake air delivery (13), differential locking (14) and differential locking between axles (15);
- ❑ undo the screws fixing the flange to input (6) and output (not shown) propeller shaft and secure temporarily the shafts to the chassis to avoid interference during next operations;
- ❑ remove the bolts (7) fixing the axle securing upper rod;
- ❑ unscrew the bolts (8) fixing the axle securing lower rod from both sides;
- ❑ set a hydraulic jack fitted with tool 99370617 under the axle;
- ❑ unscrew the nuts (9) from both sides and lift the leaf spring fixing brackets (10) then, lower the axle and take away the leaf spring.

Refitting

To refit, follow the removal operations in reverse order.

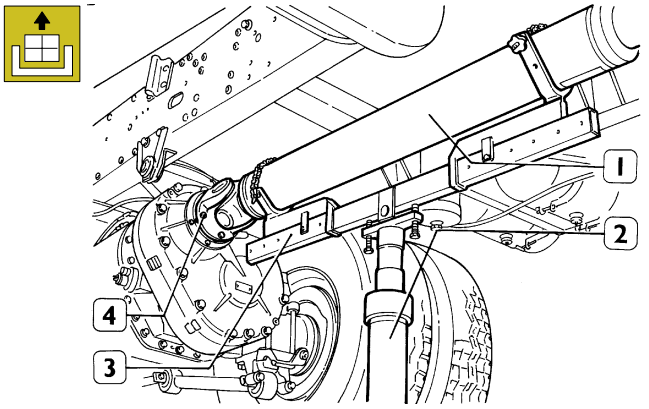
Figure 5



REMOVAL-RE-FITTING IN PLACE THE DIFFERENTIAL-REDUCTION GEAR UNIT (with axle on vehicle)

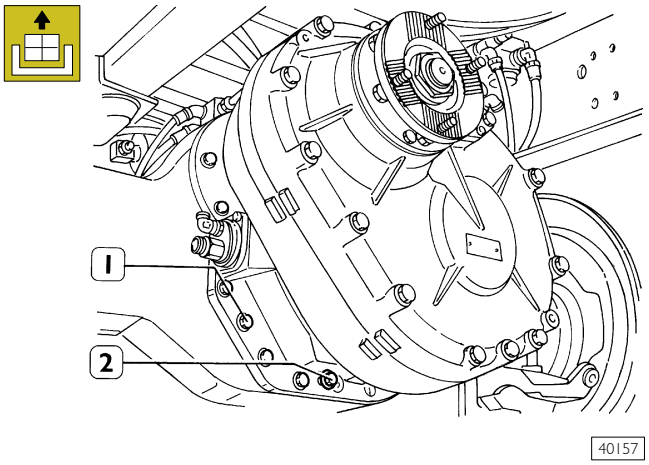
Removal

Figure 6



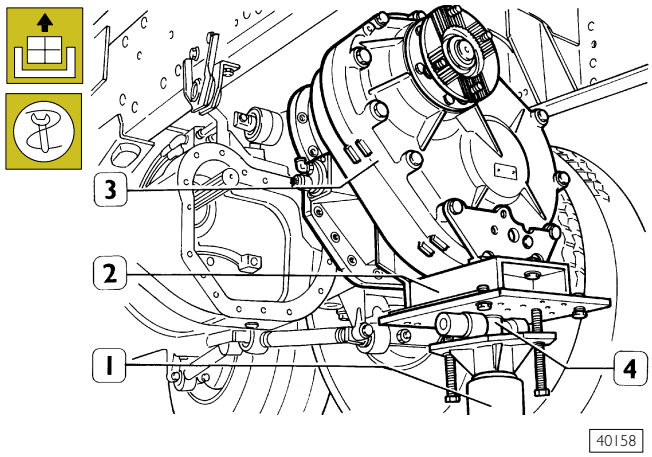
Set a hydraulic jack (2) equipped with support 99370618 (3) under the propeller shaft (1)
Unscrew the flange (4) screws and nuts to release the propeller shaft (1) from the intermediate axle.
Lower the hydraulic jack completely, thus removing the propeller shaft.
Disconnect the air hoses and electrical connections from the differential locking control and the reduction gear unit control.
Unscrew the bottom plug and drain the oil.
Draw out the half shafts as described in the relevant section.

Figure 7



In the two threaded holes (⇒), insert two suitable screws to act as puller for the differential-reduction gear unit.

Figure 8



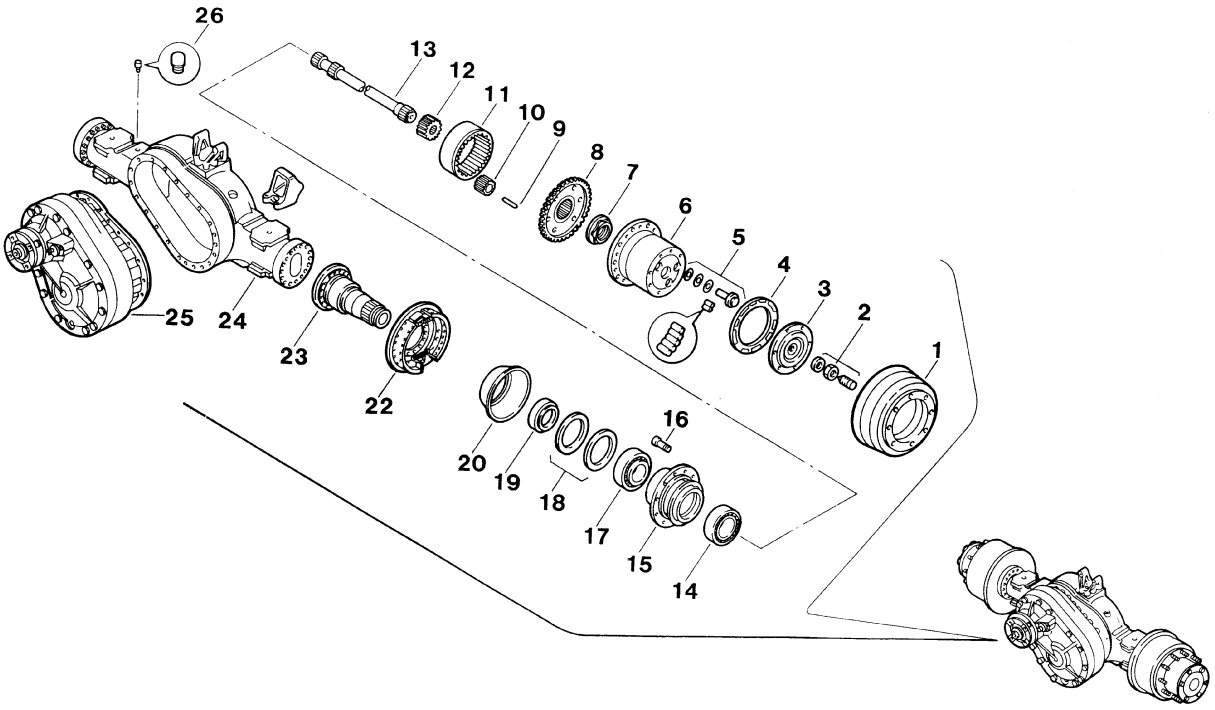
Using the hydraulic jack (1) place bracket 99370630(2) with device 99370329 (4) underneath the differential-reduction gear unit (3); remove the fastening screws, tighten the two counteracting screws to pull out the unit from the axle casing.

Re-fitting

Repeat the removal operations in reverse, taking the following precautions:

- ❑ Clean with care and spread LOCITE 573 on the contact surfaces of the differential housing and the half-shaft covers, replace the seal gaskets;
- ❑ check that the differential locking control fork engages on the sleeve;
- ❑ tighten all screws to prescribed torque;
- ❑ connect air hoses and electric cables;
- ❑ restore the oil in axle housing.

Figure 9



40409

WHEEL HUB COMPONENTS

1. Brake drum – 2. Adjusting nut and screw – 3. Cover – 4. Gasket – 5. Planetary gear pin and rollers – 6. Planetary gear carrier – 7. Adjusting nut – 8. Crown wheel carrier – 9. Shoulder pin – 10. Planetary gear – 11. Crown wheel – 12. Crown wheel gear – 13. Half-shaft – 14. Bearing – 15. Wheel hub – 16. Bolt – 17. Bearing – 18. Seal ring – 19. Support ring – 20. Oil cup – 22. Brake assembly – 23. Bearing shaft – 24. Axle casing – 25. Differential-reduction gear unit assembly – 26. Bleeder

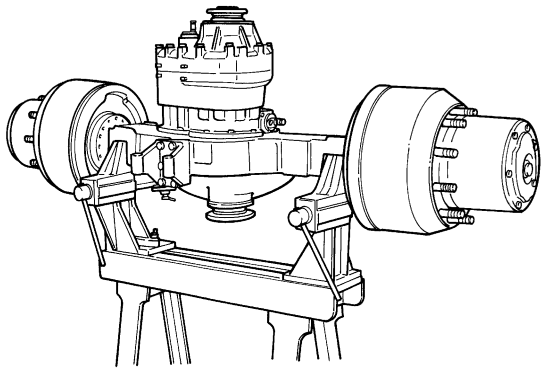
INTERMEDIATE AXLE ASSEMBLY REPAIR OPERATIONS

Removal

The removal/re-fitting in place operations on the half-shafts - brake drums and shoes - air bleeder - differential reduction gear unit - wheel hubs and epicyclic reduction gears can all be carried out with the unit fitted on the vehicle.

Before setting the axle assembly on the stand to overhaul, unscrew the bottom plug on the axle casing and drain the oil.

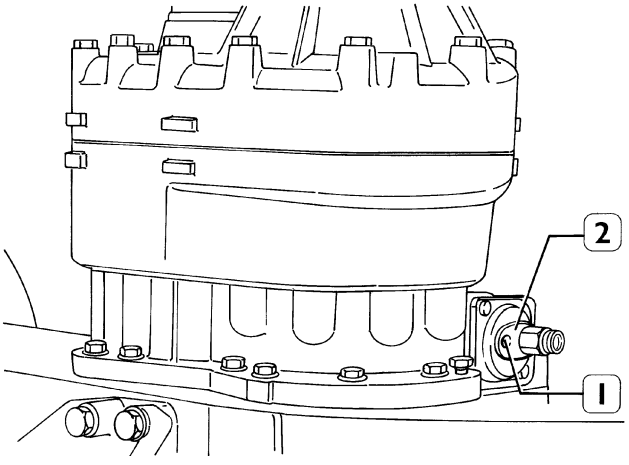
Figure 10



40052

Set up the axle assembly on stand 99322215.

Figure 11

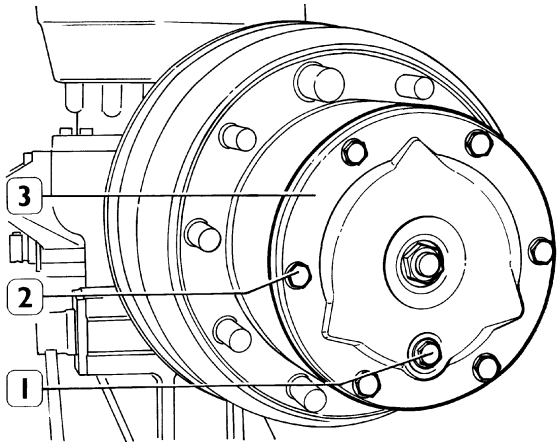


40337

Lock the sliding sleeve of the differential locking device with a screw.
To do this, remove the threaded coupling from the control cylinder (2) and in its place (1) fit a screw (M14x1.5).
At the same time, turn the axle mechanism to obtain the engagement between the sliding sleeve and the engaging sleeve; this will prevent accidental movement of the sleeve while removing the half-shaft.

Removing the epicyclic reduction unit

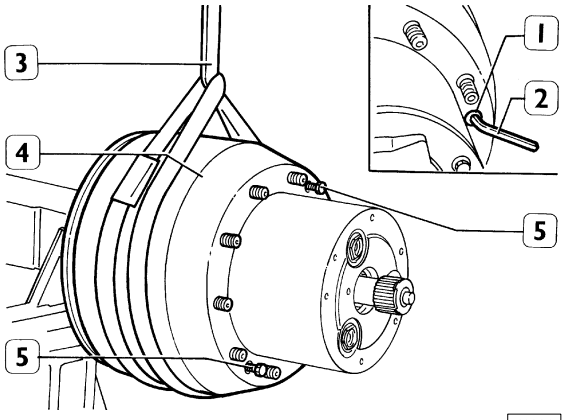
Figure 12



40053

Place a container under the wheel hub. Remove the screws (2): remove the cover (3) and collect the oil.

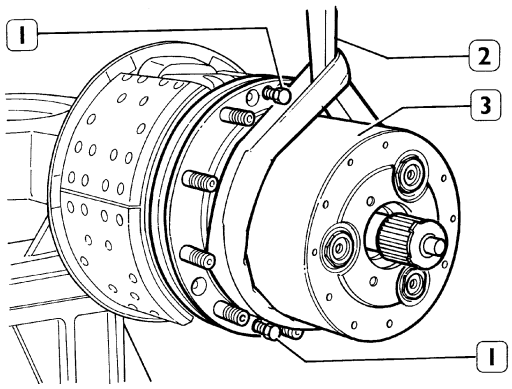
Figure 13



40338

Using a socket wrench (2) remove the 2 drum stop screws (1); fit the counteracting screws (5) in their place, tighten them, releasing the drum (4) from the hub, then with a rope (3) and lifting device, remove it.

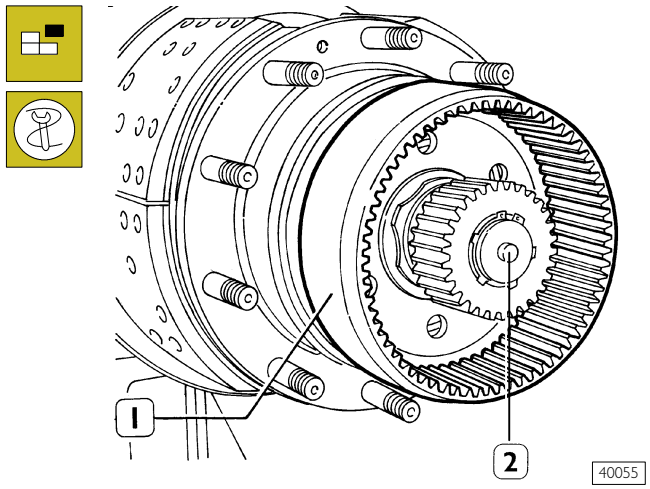
Figure 14



40054

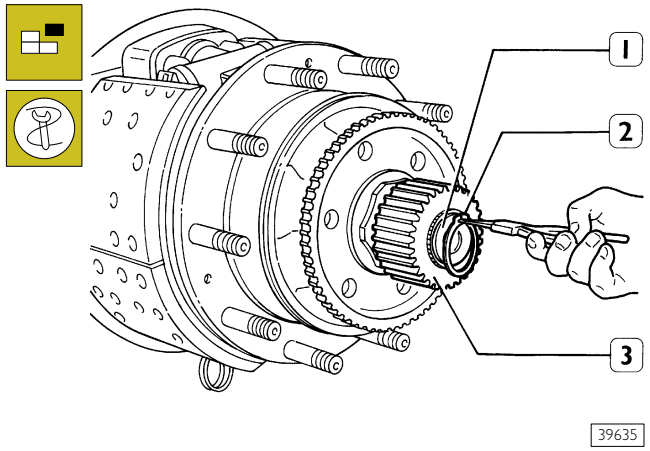
Remove the 3 planetary gear carrier stop screws (3); tighten the counteracting screws (1) and use a rope (2) to remove the carrier (3).

Figure 15



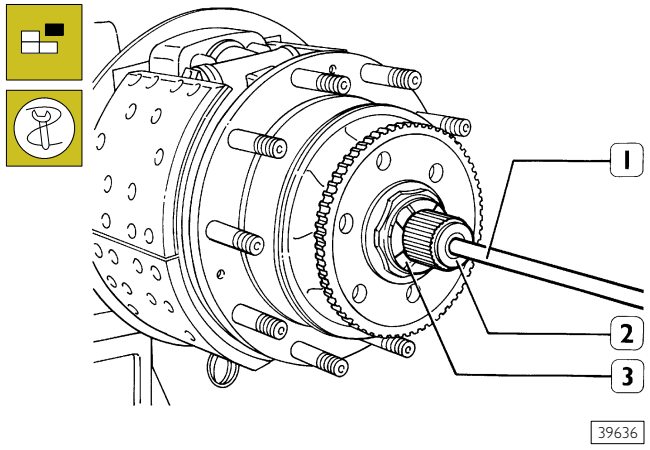
Draw out the crown wheel (1) from the crown carrier.
Remove the shoulder pin (2)

Figure 16



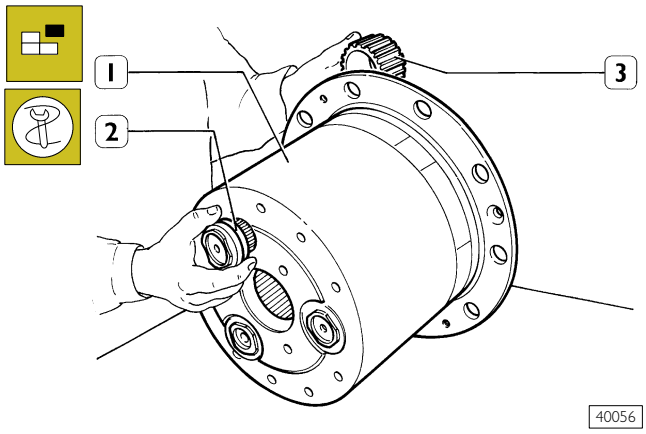
Using suitable pliers remove the circlip (2), withdraw the planetary gear (3) from the half-shaft (1).

Figure 17



Screw tool 99374451 (1) into the shoulder pin seat and withdraw the half-shaft (2) from the bearing shaft.
Remove the spacer ring (3)

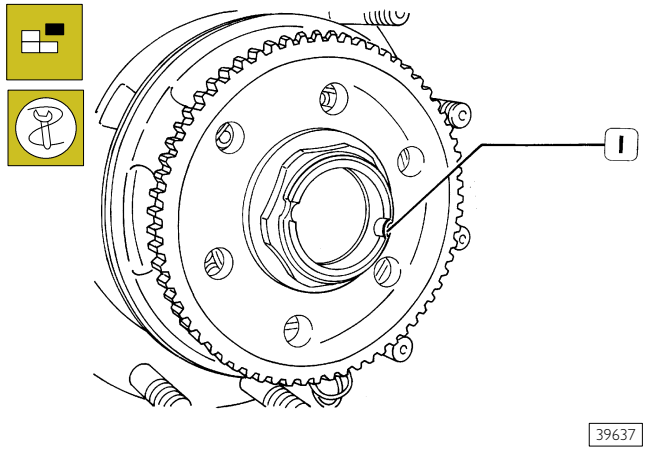
Figure 18



Extract the support pins (2) from the planetary carrier (1). Remove the planetary gears (3) from the support (1) and recover the needles and spacer rings.

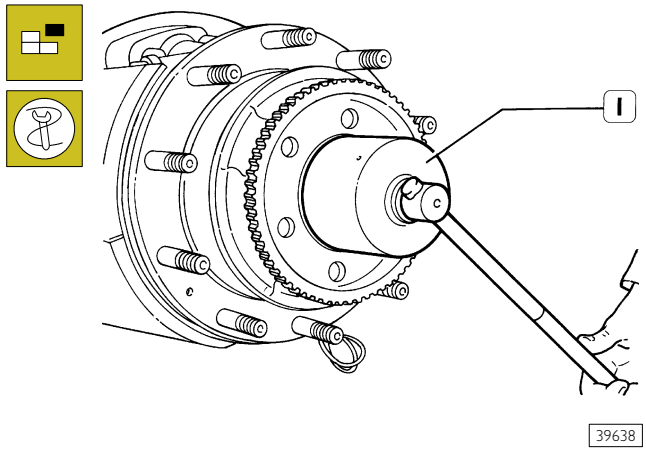
Removing the wheel hubs

Figure 19



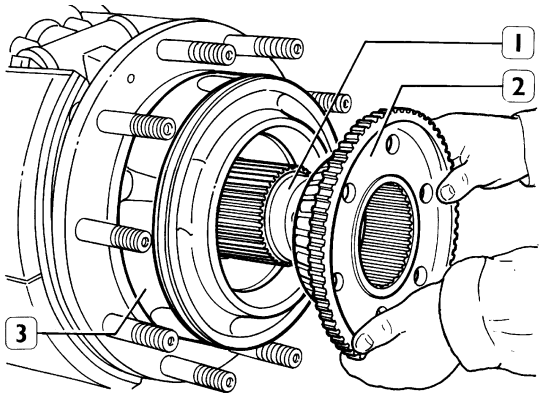
Using a suitable punch straighten the dents (1) on the adjusting nuts.

Figure 20



Using socket wrench 99354207 (1) unscrew the adjusting nut.

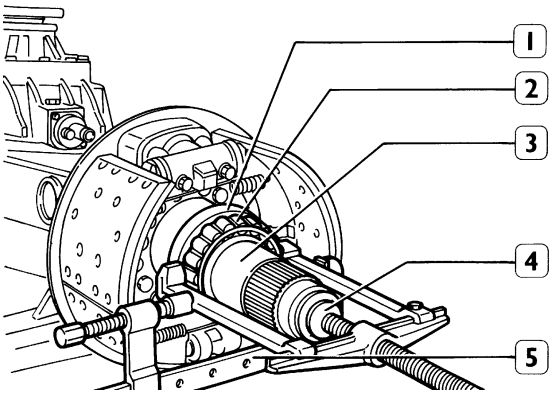
Figure 21



39639

Withdraw the bearing shaft (1), the crown wheel carrier (2) with relevant bearing and wheel hub (3)

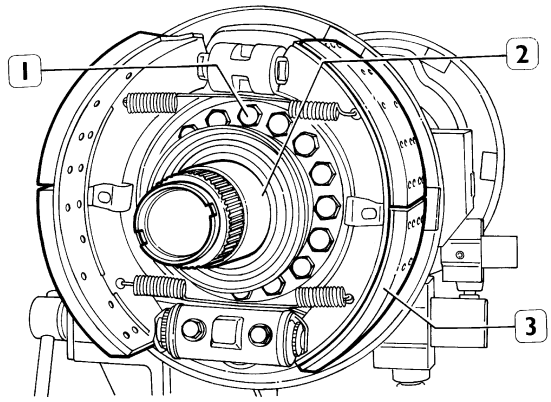
Figure 22



39640

Using a puller and clamp (5) and counteracting block 99345055 (4), remove the gasket ring (1) with the taper roller bearing (2) from the bearing shaft (3).

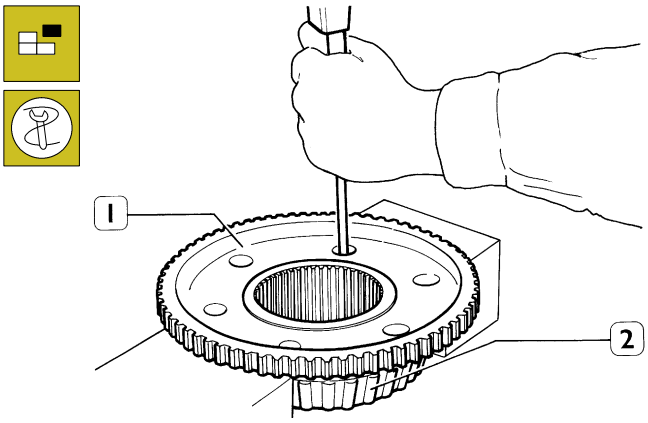
Figure 23



40060

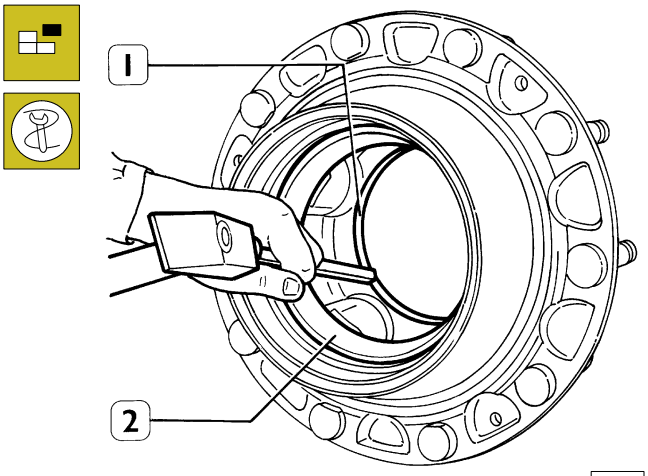
Check the bearing shaft (2) and if it is damaged replace it. Use the suitable tool to release the brake shoes (3) and after unscrewing the hexagonal screws (1) glued with LOCTITE, remove the brake carrier plate with bearing shaft.

Figure 24



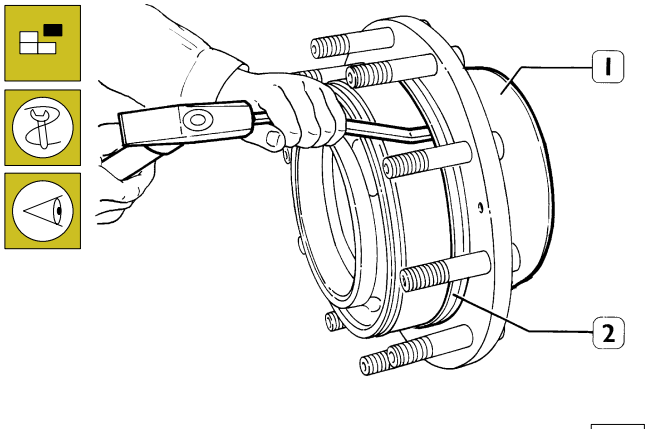
Using the appropriate beater fitted through the 3 holes on the crown carrier, eject the outer taper roller bearing (2) from the crown wheel carrier (1).

Figure 25



Using the appropriate tools, eject the outer and inner seal rings from the wheel hub. Use a bronze beater to release the cups (2 and 1) for the inner and outer bearings from the wheel hub.

Figure 26



Check the oil manifold (1) and if it is damaged, replace it. Use a beater inserted through the hub slots (2) to eject it.

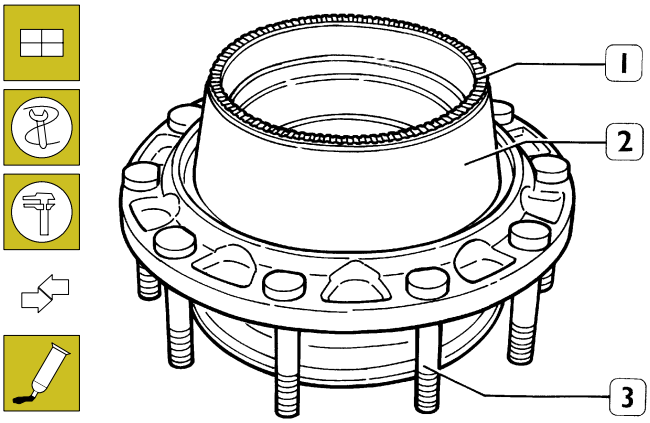
Checks on the wheel hubs and epicyclic reduction gear components

Carefully clean the wheel hub components. Check the half-shafts to ensure they are not strained. If necessary straighten the half-shafts on a hydraulic press; if this operation does not give satisfactory results, replace them. Check the wheel fastening bolts; if they are strained or the threads are damaged, replace them. After fitting in place check under the press that the orthogonality error does not exceed 0.3 mm.
Lubricate the bearings and rotate the roller cage freely, the rotation must be even with no stiffness.

Check the hub bearing adjustment nuts and the threads on the bearing shafts; if necessary replace the nuts. Check the oil manifold, if it is damaged, replace it.
All sealing elements must be replaced with new ones.
Carefully clean all the epicyclic reduction gear components.
Make a visual check on the crown wheel teeth, the crown, the planetary wheels and planetary gears.
Check the spacer rings, shims, bearing rollers and support pins.
If any of these components are damaged or worn, replace them.

Fitting in place the wheel hubs

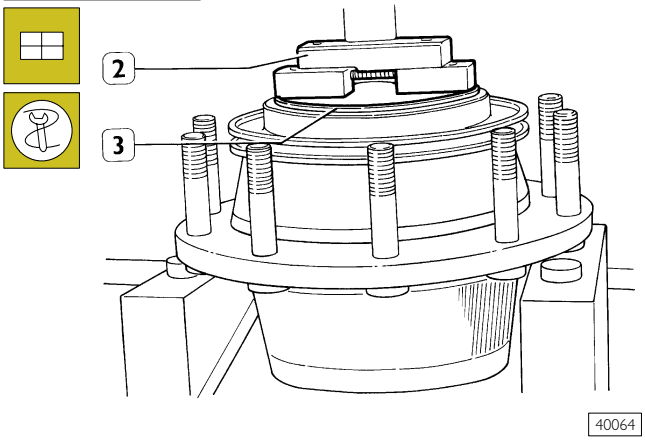
Figure 27



39645

If it is necessary to replace the bolts (3), before fitting in place the new ones, check that the bolt head contact surface is free from swarf, burrs and dents.
After driving in the bolts, check that they are perfectly flush with the hub and that the orthogonality error does not exceed 0.3 mm.
When replacing the oil cup (1), before fitting in place the new one, spread LOCTITE 573 on the contact surface between the hub and the cup housing.

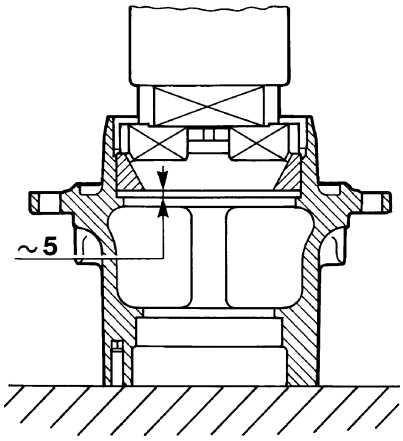
Figure 28



40064

Using beater 99374094 (2) to fit (under the press) the outer ring of the outer bearing (3) leaving it approx 5 mm from the stop plate.

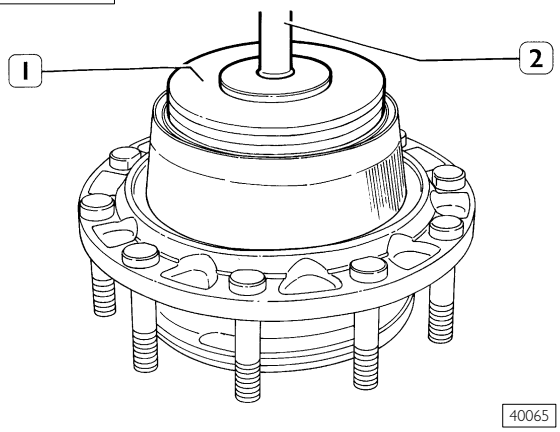
Figure 29



40410

Finish driving in by hand, using handle 99370007. Repeat the operation for the outer ring of the inner bearing.

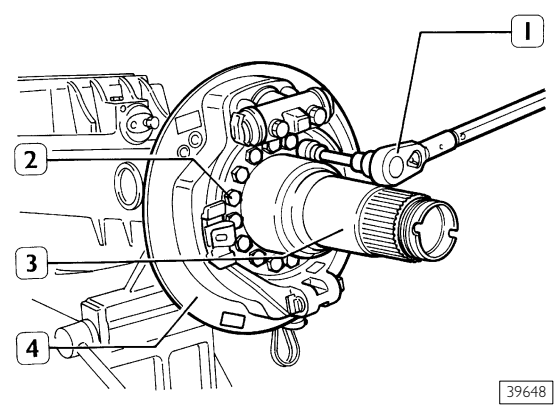
Figure 30



40065

Use element 99374025 (1) with intermediate ring and handle 99370005 (2) to fit the internal seal ring. Fit the external seal ring using the same element but without the intermediate ring.

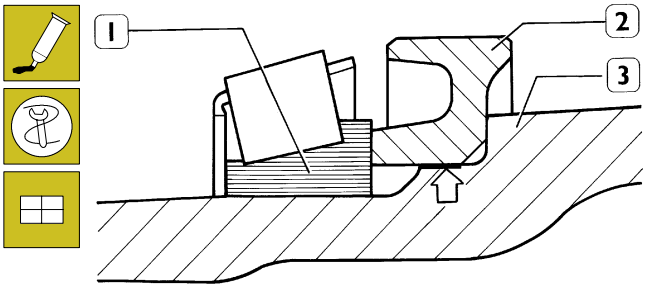
Figure 31



39648

Set the seal ring on the bearing shaft, spread LOCTITE AVX on the contacting areas between the axle housing and bearing shaft. Fit in place the bearing shaft (3) with the brake carrier plate (4) and dust guard disk. Apply LOCTITE AVX to the screws (2) then lock them with a dynamometric wrench (1) to a torque of 280 ± 15 Nm.

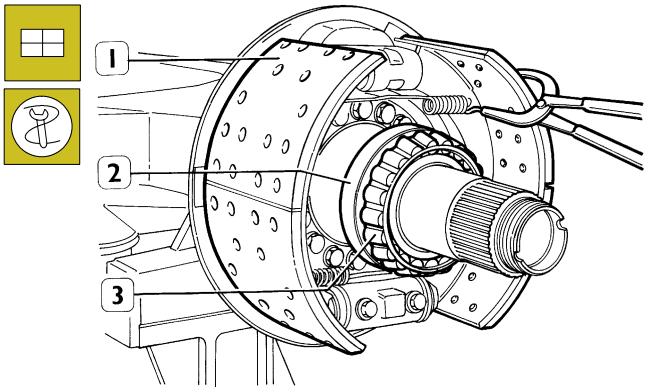
Figure 32



40375

Spread Hylomar SQ32IM sealer on the bearing shaft (3) seal ring (2) seat (⇒). Heat the ring (2) and connect it on the bearing shaft (3). Heat the taper roller bearing inner ring (1) to approx 100°C and fit it on the bearing shaft.

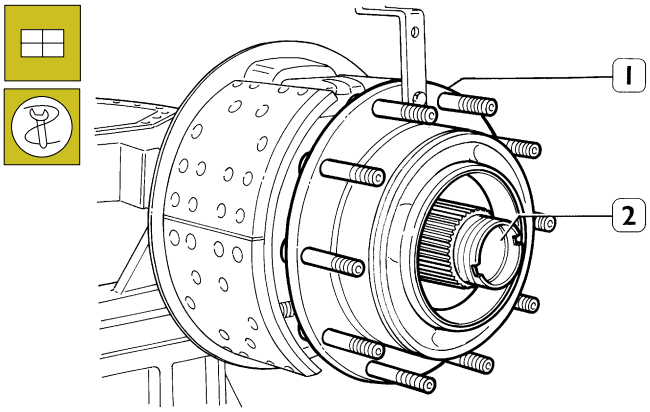
Figure 33



40067

Re-fit in place the brake shoes (1) using tool 99372217.

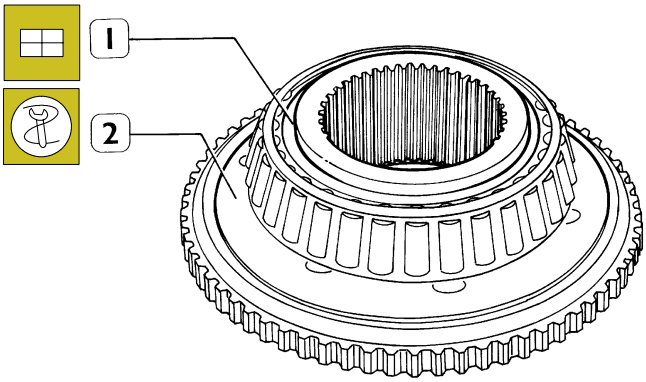
Figure 34



40068

Using the suitable tool set the complete hub (1) on the bearing shaft (2).

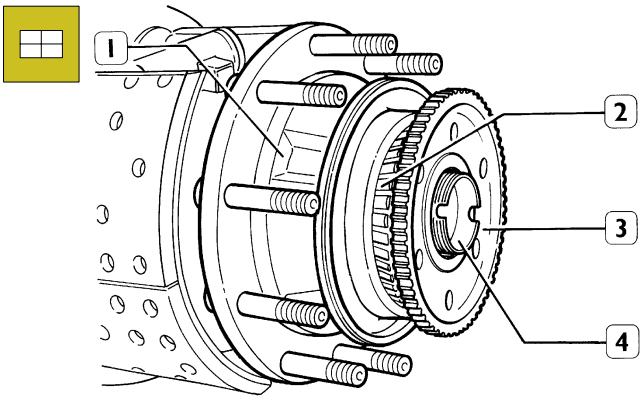
Figure 35



40377

Heat the taper roller bearing (1) to approx.100°C and use a suitable beater to fit it in its seat on the crown wheel carrier (2)

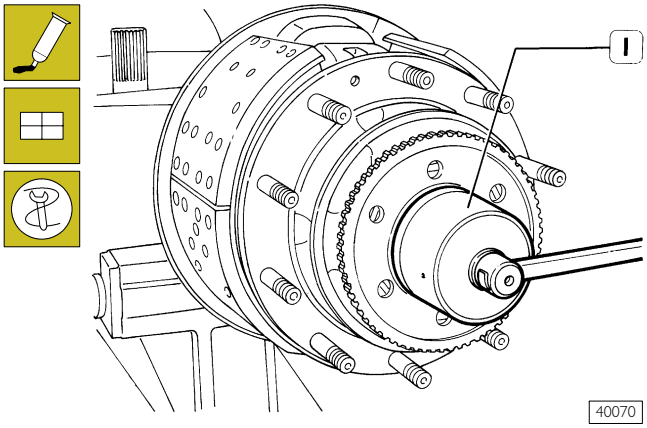
Figure 36



39650

Connect the crown carrier (3) with the taper roller bearing (2) on the bearing shaft (4)

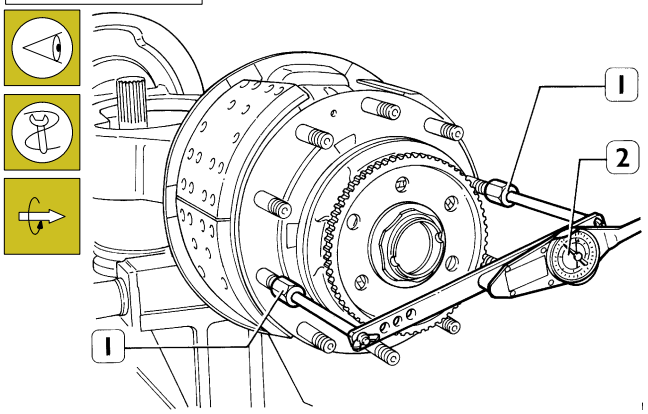
Figure 37



40070

Apply a thin coating of Molycote to the adjusting nut contact surfaces, fit in the nut and use wrench 99354207 (1) to tighten until it becomes difficult to turn the hub. Release the hub by hammering it axially in both directions.

Figure 38



40071

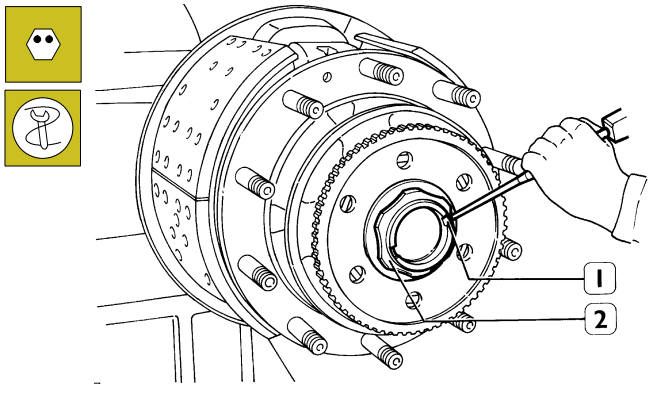
Set up equipment 99395026 (1) and with a torque wrench (2) find the rolling torque of the wheel hub

During the operation to find the rolling torque of the wheel hub, the rotation must not eexceed 40 r.p.m.

The hub rolling torque values vary according to the following conditions:

- ❑ new bearings with surface protection — 3 + (12 ÷ 16) Nm
- ❑ run-in bearings and new lubricated seal rings — 3 + (5 ÷ 7) Nm
- ❑ run-in bearings and seal rings — 3 + (2,5 ÷ 4,5) Nm

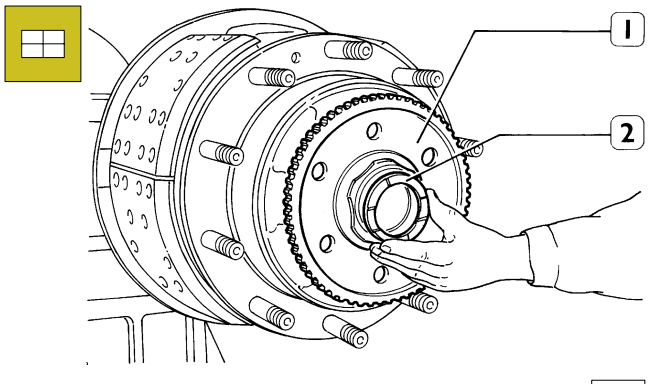
Figure 39



40072

After the specified rolling torque has been obtained, use an appropriate punch to dent the adjusting nut (2) in the grooves on the bearing shaft (1)

Figure 40

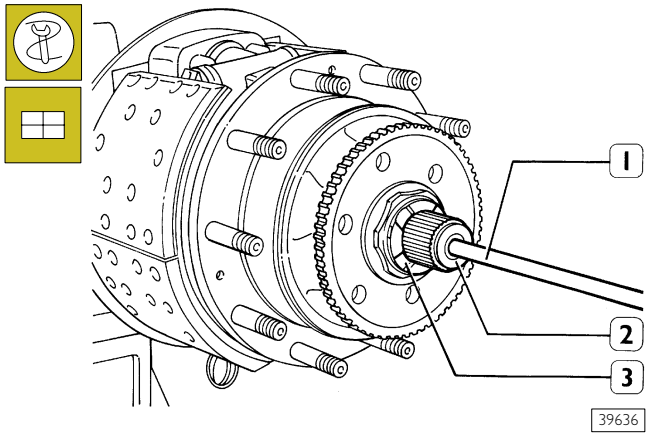


40069

Fit the spacer ring (2) in the bearing shaft

Fitting in place the epicyclic reduction unit

Figure 41

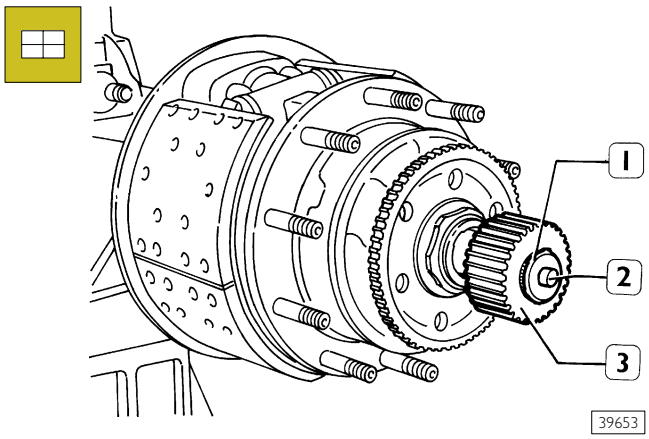


39636

Using tool 99374451 (1) fit the half-shaft (2) in the bearing shaft (3)

Fit the short half-shaft with twin teeth in the bearing shaft on the differential locking side.

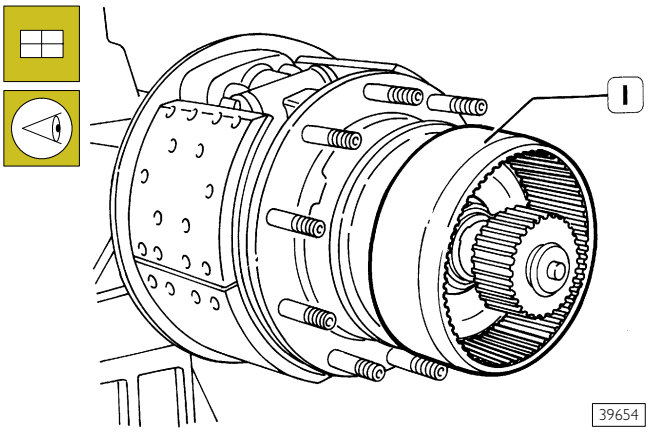
Figure 42



39653

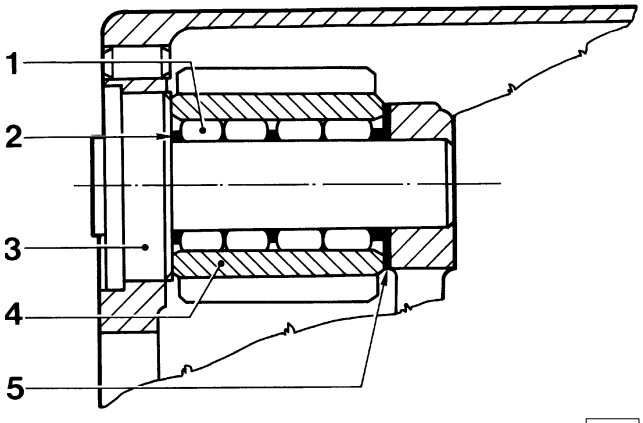
Set the planetary gear (3) on the splined section of the half-shaft and the circlip (1) in its seat. Force the shoulder pin (2) into its seat on the half-shaft.

Figure 43



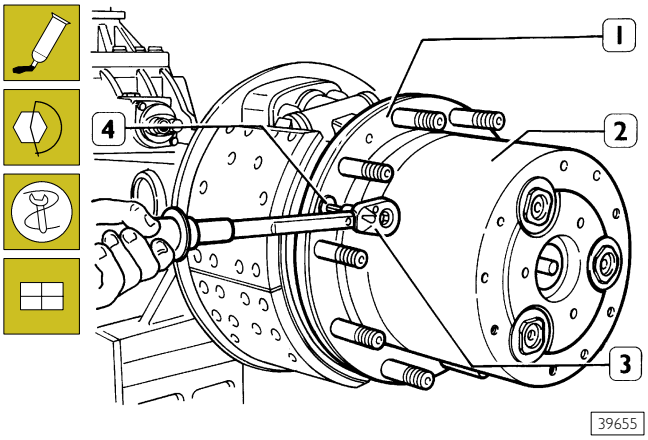
Position the crown wheel (1) with the chamfer outwards then set it on the crown wheel carrier.

Figure 44



Grease the needles (1) set them with three spacer rings (2) in the planetary gear (4) as shown in the figure.
Insert the planetary wheel (4) and the spacer washer (5) in the planetary carrier support.
Insert the support pin (3) from the cover side, pushing it fully into its seat.
Repeat the same operation for the other two planetary gear units.

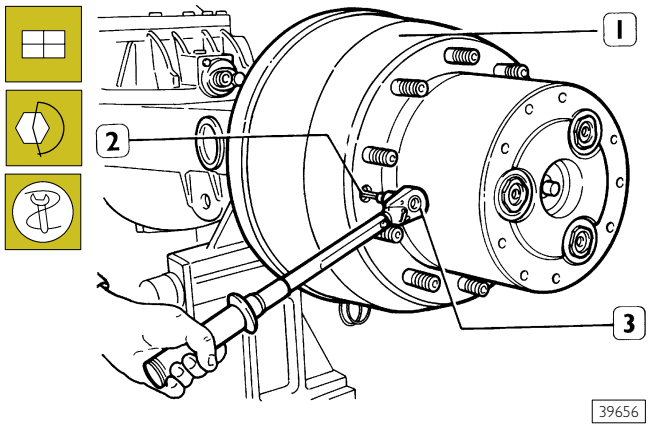
Figure 45



Spread a thin coating of Hylomar SQ 321 M or Reinzoplast sealant paste on the planetary gear support (2) and wheel hub (1) contact surfaces.

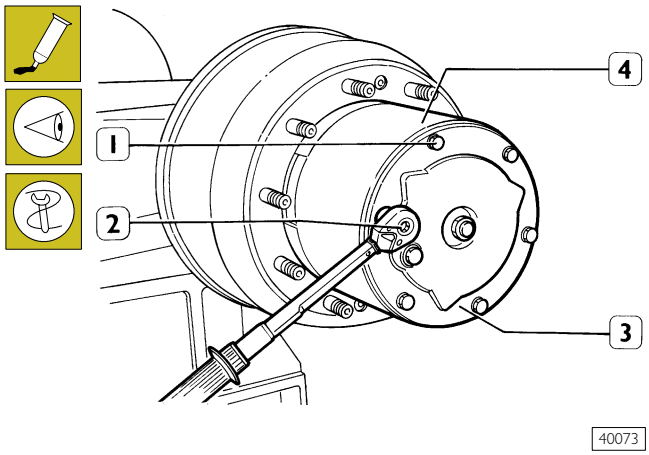
Push the planetary gear support (2) onto the hub; to mesh the teeth more easily, move the coupling flange alternately in both directions. Take care that the holes to fasten the planetary supports to the hub coincide.
Insert the three flathead screws (4) and tighten with a dynamometric wrench (3) to a torque of 25 ± 3 Nm.

Figure 46



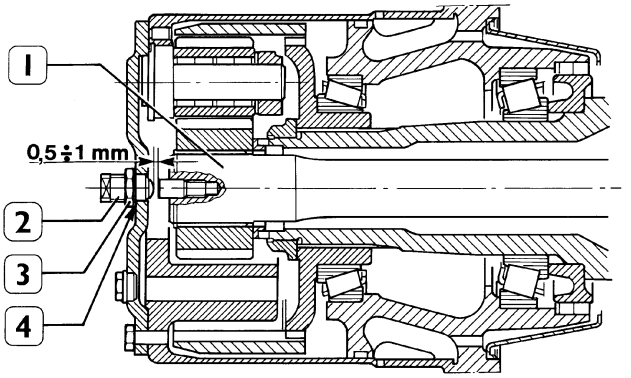
Fit in place the brake drum (1) on the planetary gear support.
Clamp down the brake drum with the two flathead screws (2) and use a dynamometric wrench (3) to obtain a torque of 25 ± 3 Nm.

Figure 47



Spread a thin coating of Hylomar SQ 321 M sealant paste on the contact surfaces of the cover (3) and the planetary gear support (4).
Position the cover so that the support pin chamfers coincide with the cover grooves.
Apply sealant paste to the screw (1) threads and tighten the screws with a dynamometric wrench (2) to a torque of 50 ± 5 Nm.

Figure 48



26924

The half-shaft (1) end play should be within the range of 0.5 - 1 mm.
To adjust, tighten the adjusting screw (2) to the stop then return half a turn and lock it with the hexagonal nut (3)

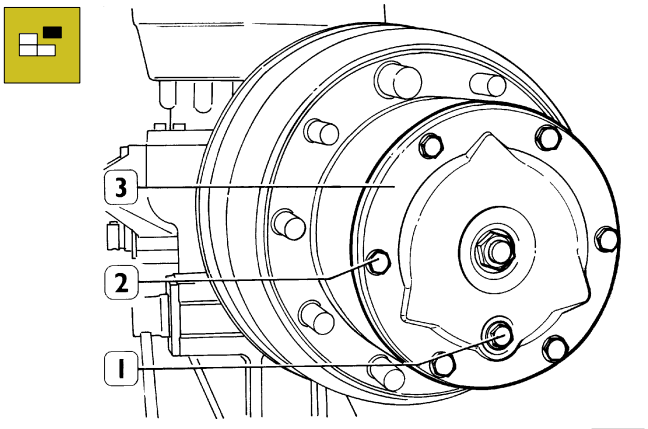
The flat surface of the hexagonal nut must be directed toward the seal ring (4).

REMOVAL-RE-FITTING IN PLACE OF THE DIFFERENTIAL-REDUCTION GEAR UNIT (with axle on stand 99322215)

Removal

Place the axle assembly on stand 99322215

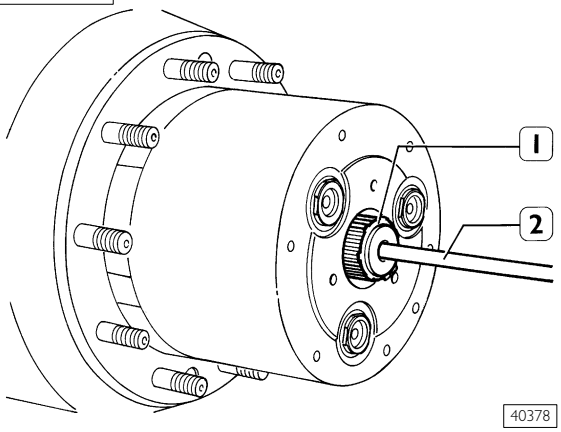
Figure 49



40053

Place a container under the wheel hub; remove the screws (2) and the cover (3), collect the oil.

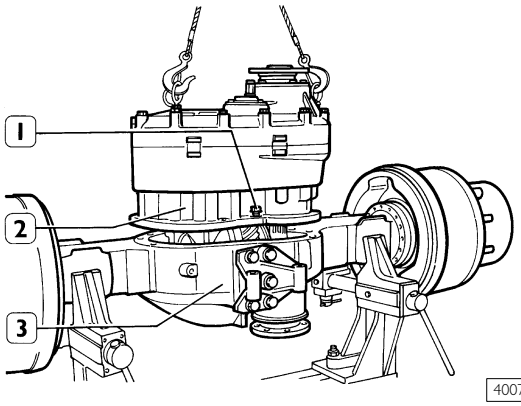
Figure 50



40378

Remove the shoulder pin and fit tool 99374451 (2) in its place, partially withdraw the half-shaft (1). Repeat the operation on the other side.

Figure 51



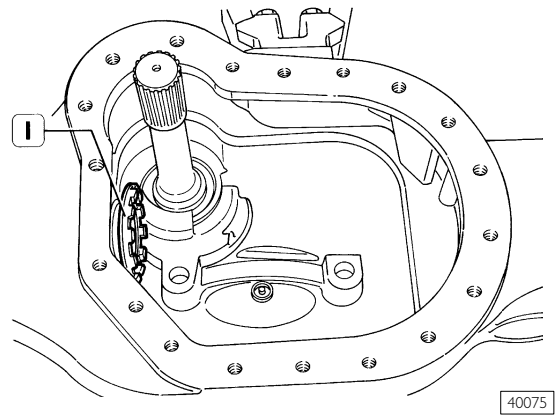
40074

Remove the screws that fasten the differential-reduction gear unit (2) to the axle casing (3), tighten the counteracting screws (1). With lifting device, eye bolts and steel ropes withdraw the unit from the axle casing.

Re-fitting in place

To re-fit in place, follow the removal steps in the reverse order taking the following precautions:

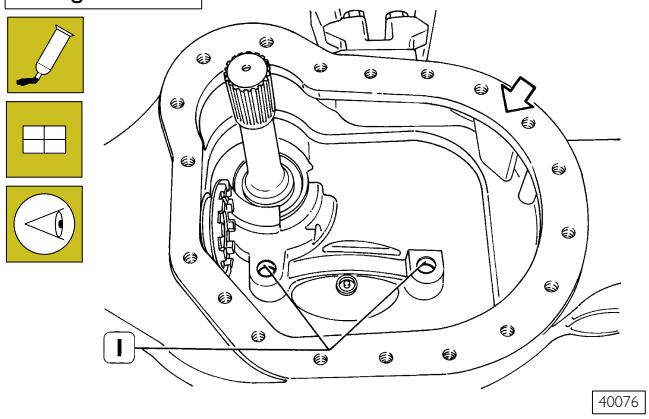
Figure 52



40075

- to engage the differential locking, the sliding sleeve (1) must be placed on the twin-tooth half-shaft.

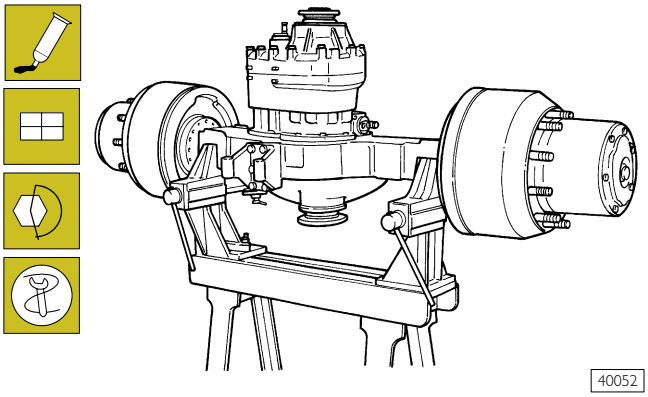
Figure 53



40076

❑ clean carefully, spread LOCTITE 573 on the contact surface (⇒), position the differential-reduction gear unit taking care that the fork engages the sleeve (1, Figure 52) and that the centering pins enter into the holes (1, figure 53)

Figure 54



40052

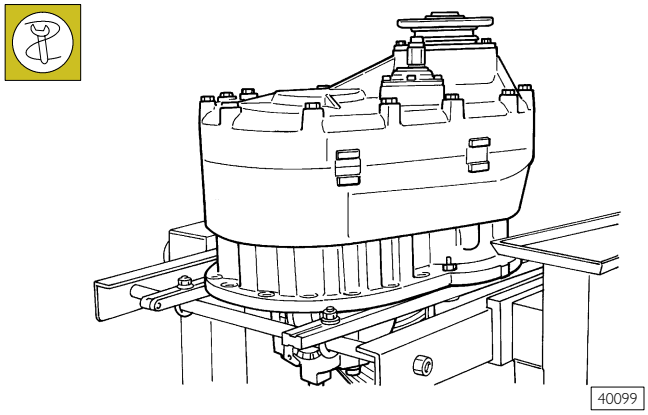
❑ spread LOCTITE 573 on the thread and the contact surfaceof the screws, tighten them with a dynamometric wrench to a torque of 260 ± 25 Nm.

❑ re-fit in place the half shafts and shoulder pins; fit in place the cover using LOCTITE 573 and tighten the screws to the prescribed torques. Adjust the half-shafts backlash as described in figure 48.

DIFFERENTIAL-REDUCTION GEAR UNIT REPAIR OPERATIONS

Removal

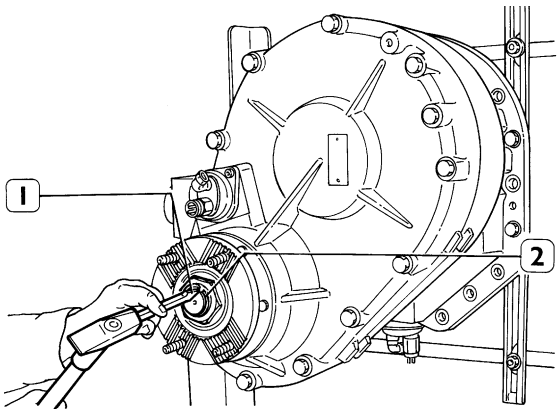
Figure 55



40099

Place the differential-reduction gear unit assembly on stand 99322205 with appropriate brackets

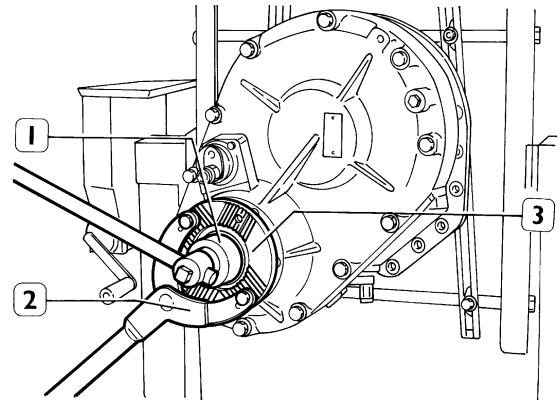
Figure 58



40116

Using a suitable punch (1) remove the dent from the nut (2)

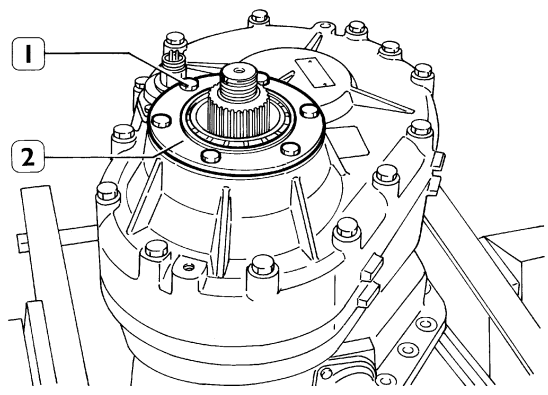
Figure 56



40117

With counteracting lever 99370317 (2) and socket wrench 99355081 (1) unscrew the locking nuts and withdraw the coupling flange (3)

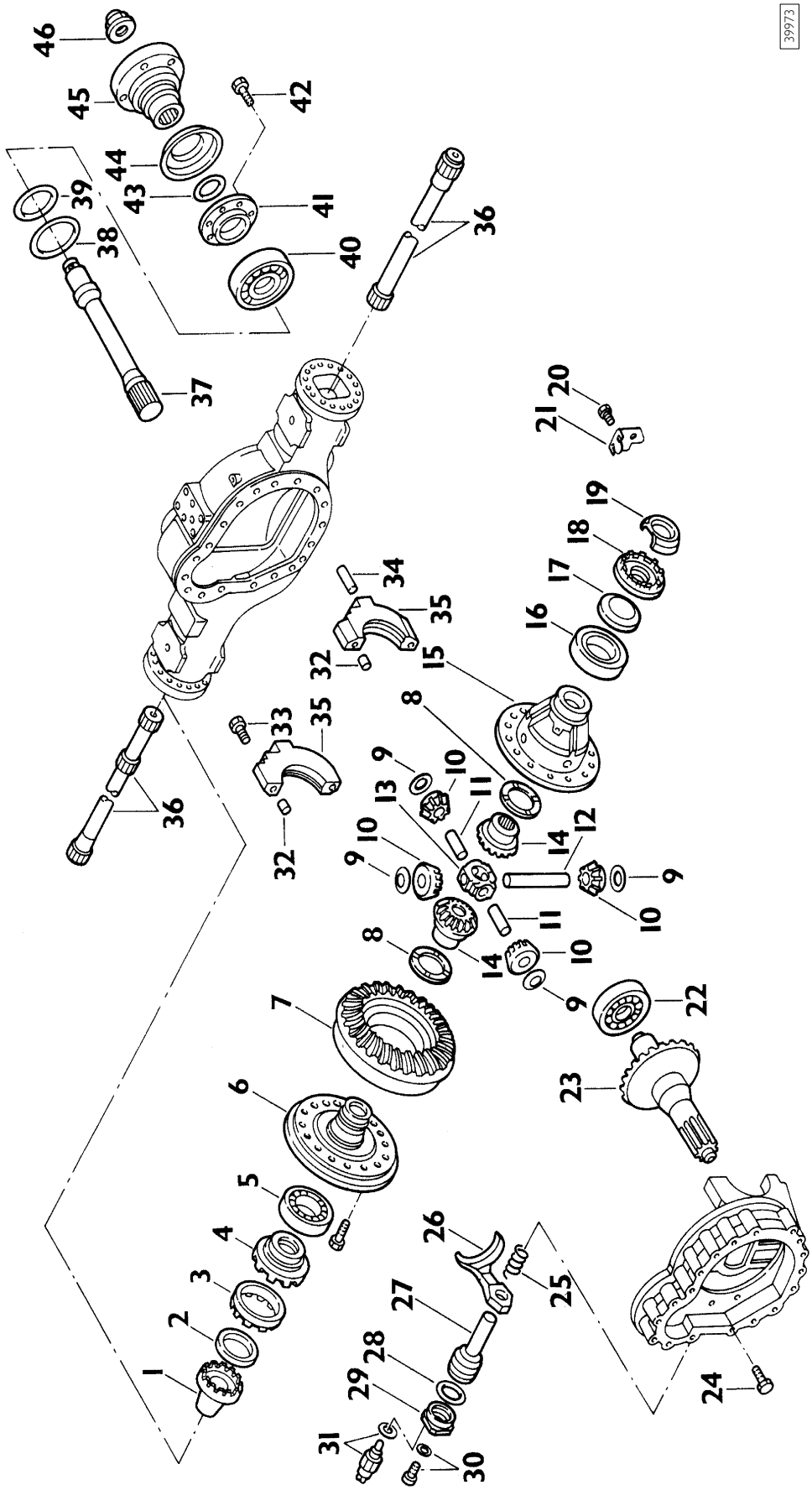
Figure 57



40118

Remove the screws (1) and the cover (2) together with its seal ring.
Remove the reduction gear unit control cover.

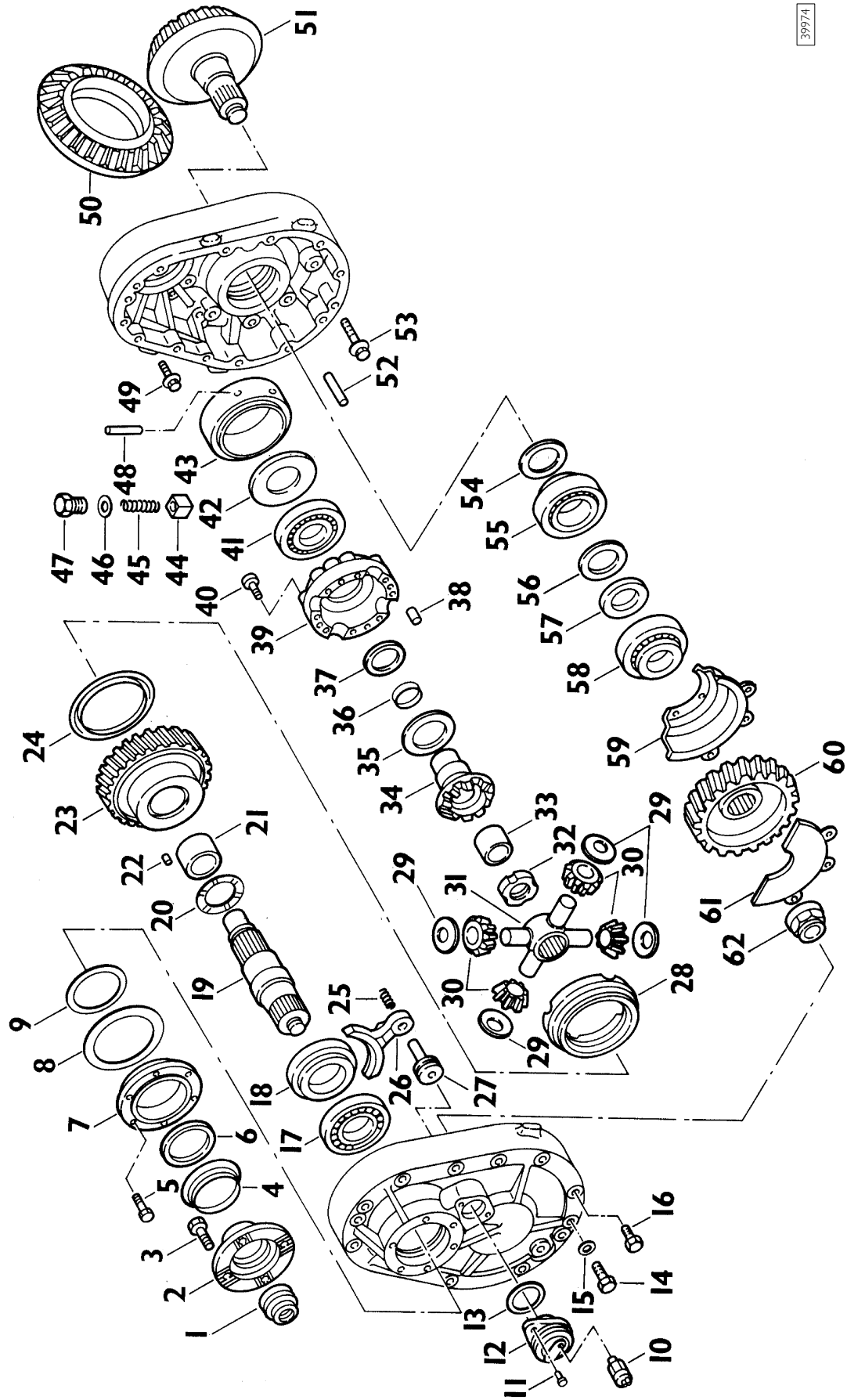
Figure 59



DIFFERENTIAL COMPONENTS

1. sleeve - 2. ring - 3. Ring nut - 4. Ring nut - 5. Bearing - 6. cover - 7. Crown wheel - 8. Washer - 9. Collar - 10. Planetary wheel - 11. Pin - 12. Pin - 13. Spider - 14. Planetary wheel - 15. Gear housing - 16. Bearing - 17. Oil seal - 18. Ring nut - Oil baffle - 20. Screw - 21. Plate - 22. Bearing - 23. Pinion - 24. Screw - 25. Spring - 26. Fork - 27. Piston - 28. Ring - 29. Cover - 30. Screw - 31. Switch - 32. Pin - 33. Screw - 34. Pin - 35. Caps - 36. Half shaft - 37. Shaft - 38. Seal ring - 39. Seal ring - 40. Bearing - 41. Cover - 42. Screw - 43. Seal ring - 44. Splashguar -45. Control side flange - 46. Nut

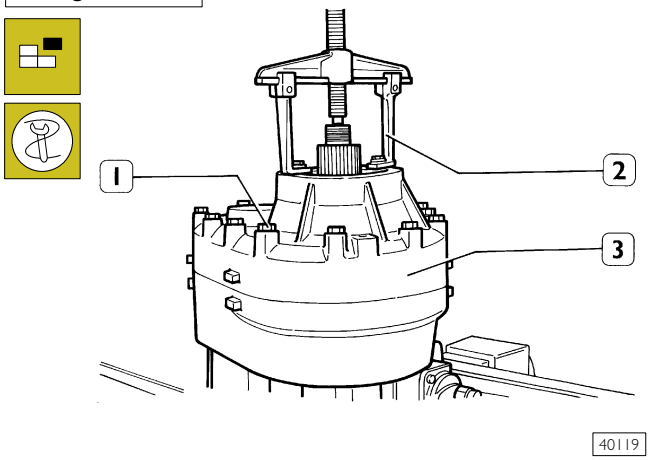
Figure 60



DIFFERENTIAL-REDUCTION GEAR UNIT COMPONENTS

. Nut - 2. Control side flange - 3. Hex screw - 4. Splash guard - 5. Screw - 6. Sealing gasket - 7. Cover - 8. Seal ring - 9. Seal ring - 10. Switch - 11. Pin - 12. Cover - 13. Ring - 14. Plug - 15. Ring - 16. Screw - 17. Bearing - 18. Sleeve - 19. Shaft - 0. Washer - 21. Bush - 22. Pin - 23. Gear - 24. Seal ring + 25. Spring - 26. Fork - 27. Piston - 28. Half-box - 29. Washer - 30. Planetary wheels - 31. Spider - 32. Ring nut - 33. Bush - 34. Crown wheel gear - 35. Washer - 36. Oil seal - 37. Seal ring - 8. Pin - 39. Half-box - 40. Screw - 41. Bearing - 42. Washer - 43. Eccentric ring - 44. Adjusting piston - 45. Compressed spring - 46. Ring - 47. Threaded plug - 48. Pin - 49. Self-locking screw - 50. Crown wheel - 51. Pinion - 52. Pin - 3. Self-lock ring screw - 54. Shim - 55. Bearing - 56. Shim - 57. Shim - 58. Bearing - 59. Oil drain - 60. Gear - 61 Oil drain cover - 62. Nut

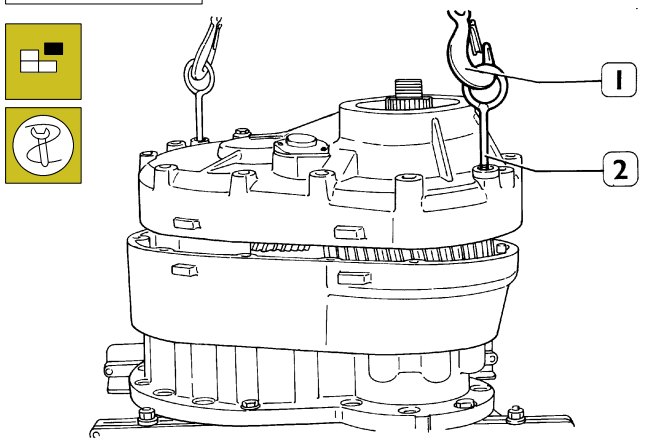
Figure 61



40119

Remove the cover screws (1), using puller (2) lift the cover (3) to withdraw the bearing from the shaft.

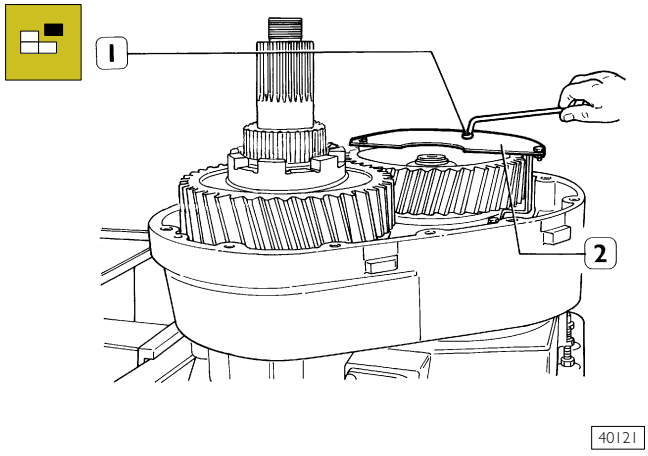
Figure 62



40120

Using eye bolts (2) and hooks with ropes (1) remove the cover. Move the reduction gear unit locking engagement fork to avoid damaging it.

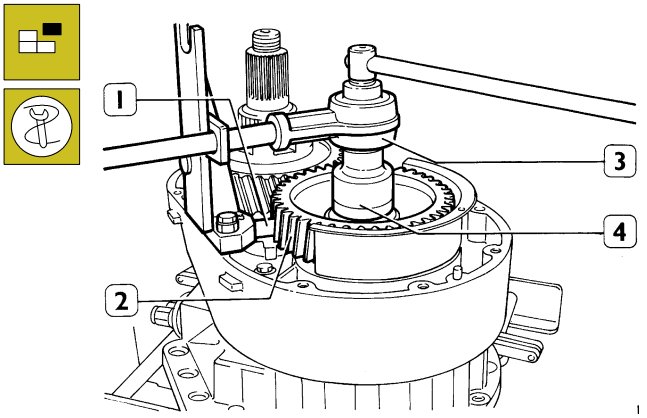
Figure 63



40121

Remove the screws (1) and take away the upper part of the oil drain (2)

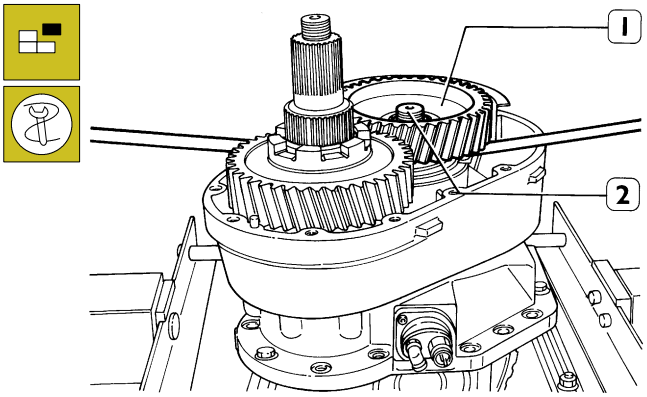
Figure 64



40122

Remove the dents on the gear nut (2)
Apply tool 99363310 (1) to lock the gear rotation (2); with multiplier 99389816 (3) and socket wrench 99355081 (4) unscrew the securing nut.

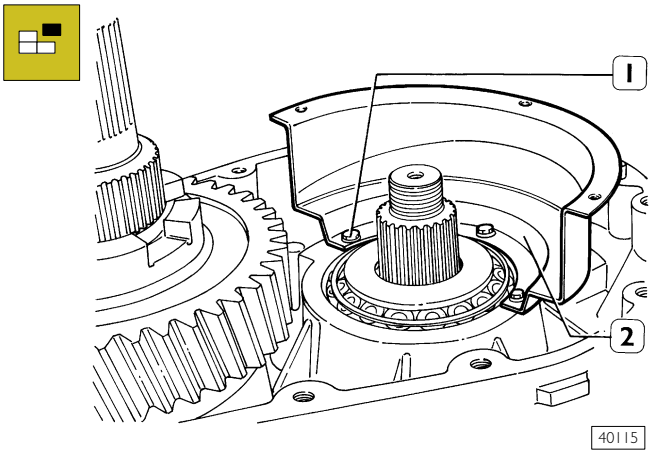
Figure 65



40114

Using two levers, withdraw the idle gear (1) from the bevel pinion (2)

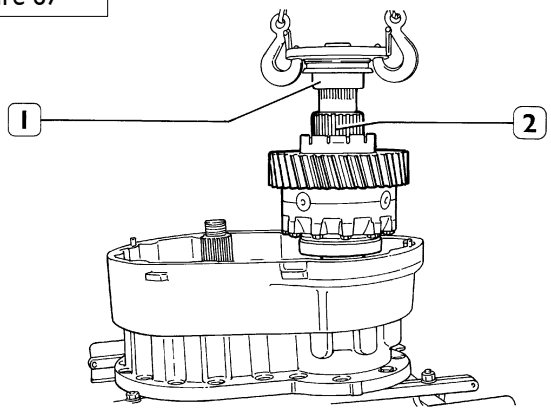
Figure 66



40115

Remove the three screws (1) and then the oil drain (2).

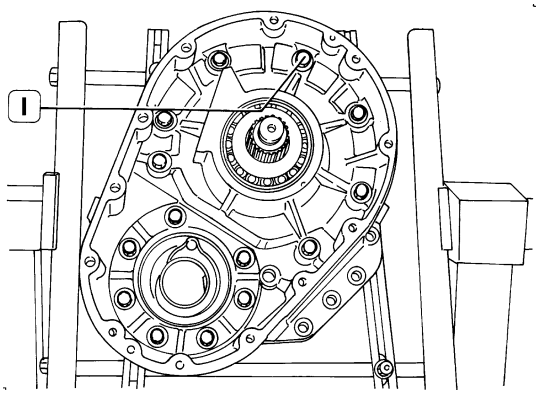
Figure 67



40116

Re-fit the flange (1) and fasten it with the nut, using hooks and ropes lift the differential-reduction gear unit (2)

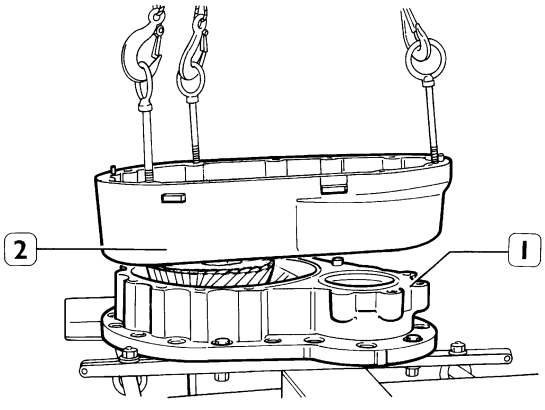
Figure 68



40117A

Remove the 14 screws (1) that fasten the half-shaft to the differential housing

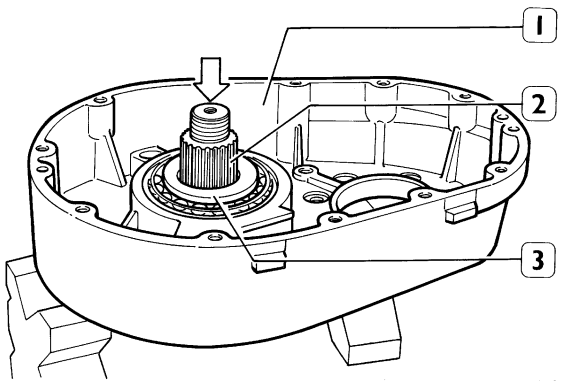
Figure 69



40119A

Using eye bolts, hooks and ropes lift and remove the half-box (2) with the bevel pinion from the differential housing (1).

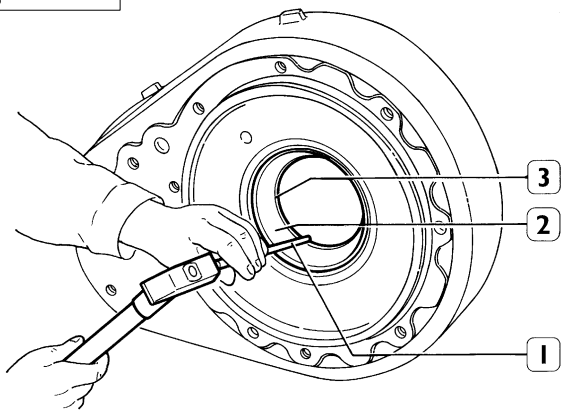
Figure 70



40376

Rest the half-box (1) on two parallel bars, using an appropriate beater remove the bevel pinion (2); remove the taper roller bearing (3).

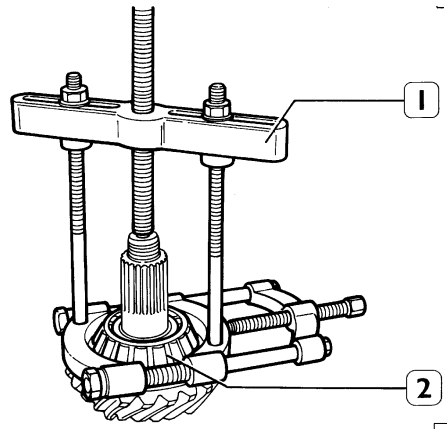
Figure 71



40079

Using an appropriate beater (1) expel the taper roller bearing outer rings (2-3) from the half-box

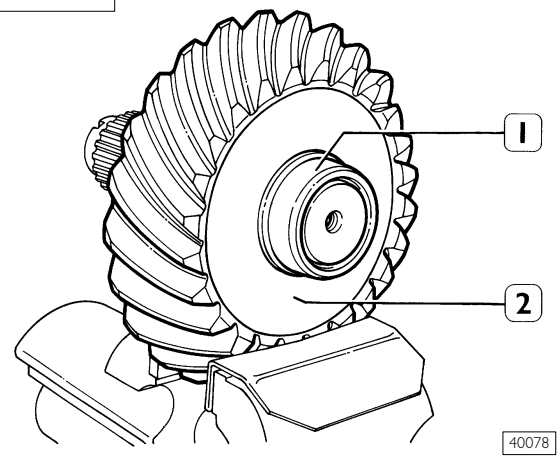
Figure 72



470077

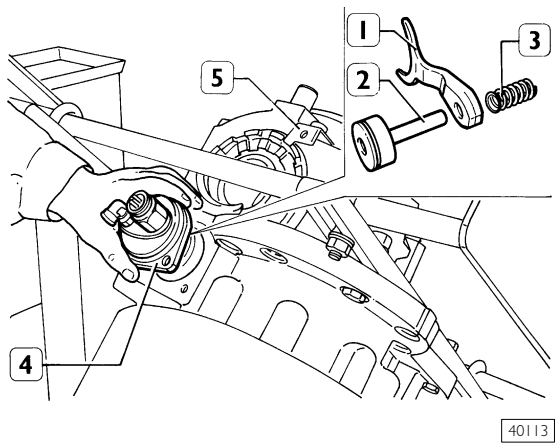
Using puller 99348001 (1) remove the intermediate bearing (2) from the bevel pinion.

Figure 73



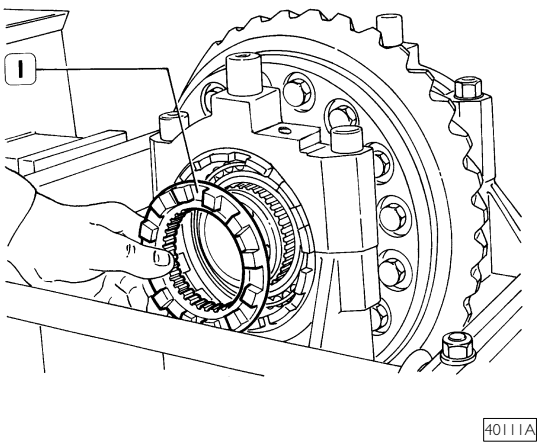
Using suitable equipment remove the rear bearing inner ring (1) from the bevel pinion (2). This is a destructive operation.

Figure 74



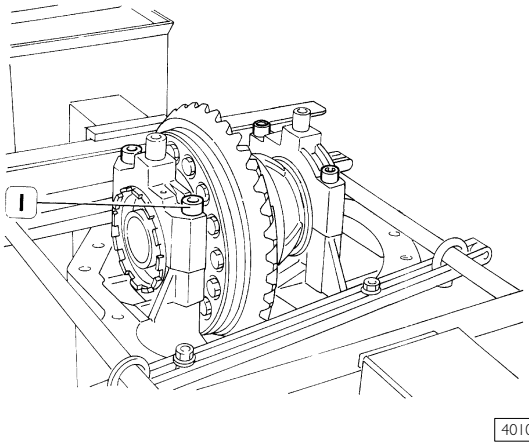
Rotate the stand 180°
Remove the two screws, then the cover (4), the piston (2), the fork (1) and the spring (3). Remove the screw and take away the safety plate (5).

Figure 75



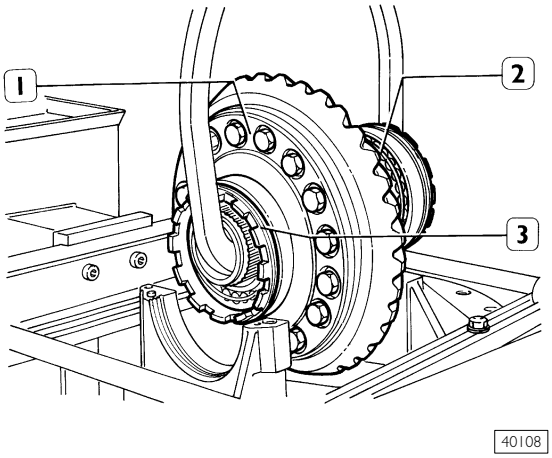
Remove the circlip and withdraw the differential locking sleeve (1).
Mark the assembly position of the caps with reference to the differential housing.

Figure 76



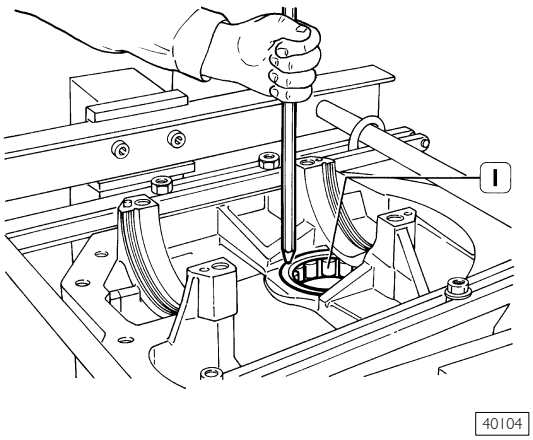
Slightly loosen the adjusting ring nuts. Remove the screws (1) locked with LOCTITE, remove the caps.

Figure 77



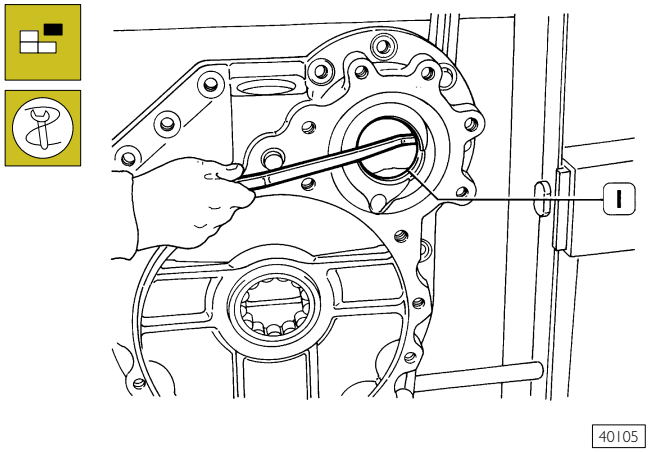
Using a suitable hook remove the gear housing (1) with its bearings (2) and adjusting ring nut (3)

Figure 78



Using a beater extract the bevel pinion roller bearing (1) from its seat on the differential housing.

Figure 79

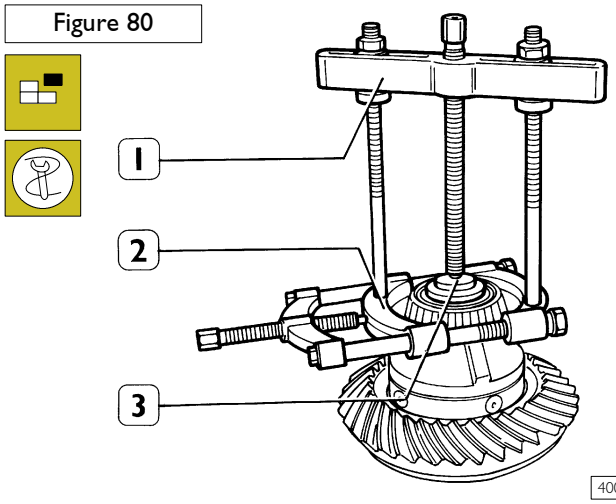


40105

Using the appropriate tool, remove the seal ring (1).
Take away the metal plate and the oil pump.

Removing the gear housing

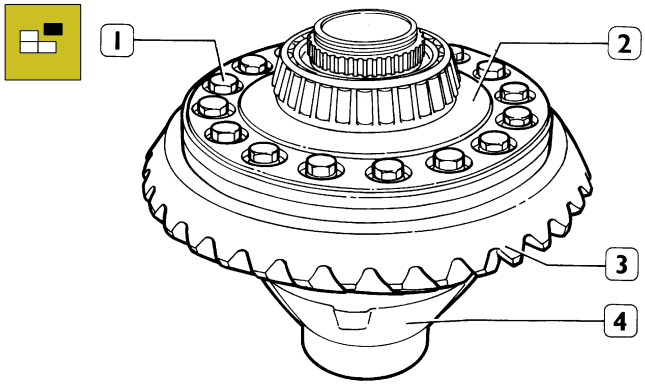
Figure 80



40086

Using puller 99348001 (1-2) and counteracting block 99345055 (3) remove the bearing and taper rollers from the gear housing. Repeat this operation on the other side.

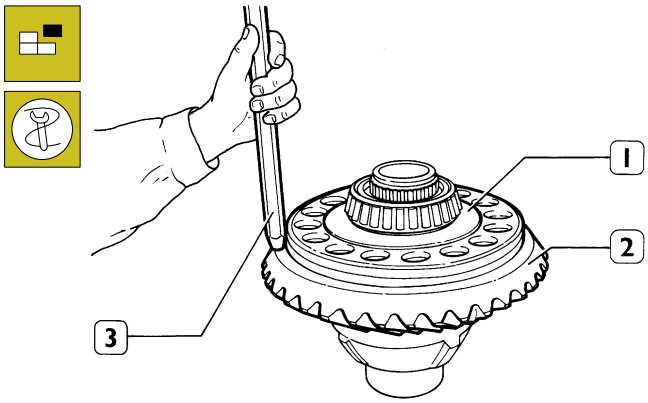
Figure 81



40087

Loosen and remove the screws (1) that fasten the ring bevel gear (3) and cover (2) to the half-box (4)

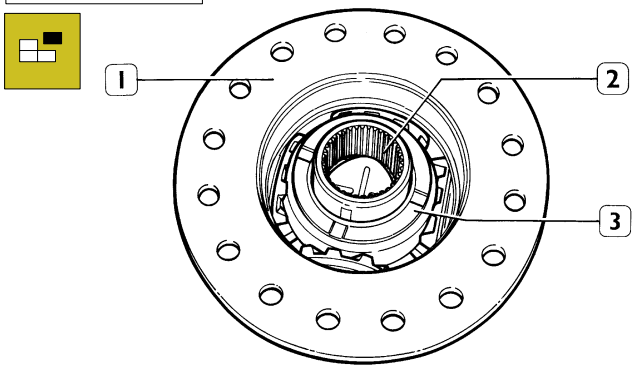
Figure 82



40088

Mark the cover and the gear housing.
Remove the gear housing cover (1) and release the ring bevel gear (2) with a suitable beater (3).

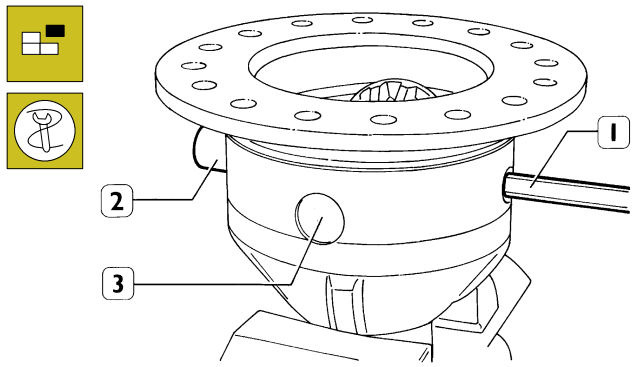
Figure 83



40089

Remove the crown wheel gear (2) and shoulder washer (3) from the gear housing (1).

Figure 84

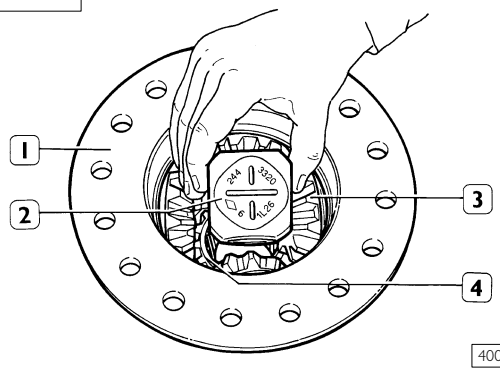


400910

Using a suitable beater (1) first withdraw the long pin (2), then the two short pins (3).

The exact position of the pins is marked on the spider (2, figure 85) by a long stripe for the long pin and two short stripes for the short pins.

Figure 85

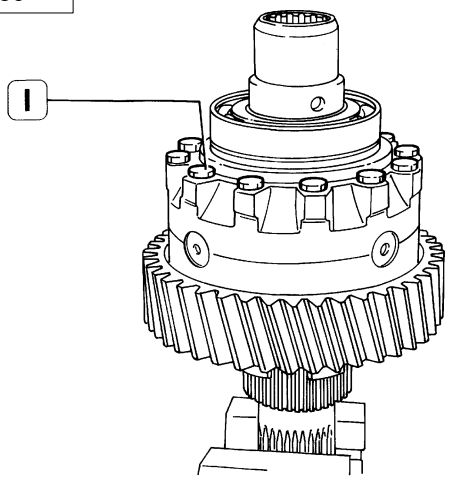


40091

Remove the spider (2), the planetary gears (3) together with the shoulder washer and crown wheel (4) from the gear housing.

Removing the differential-reduction gear unit

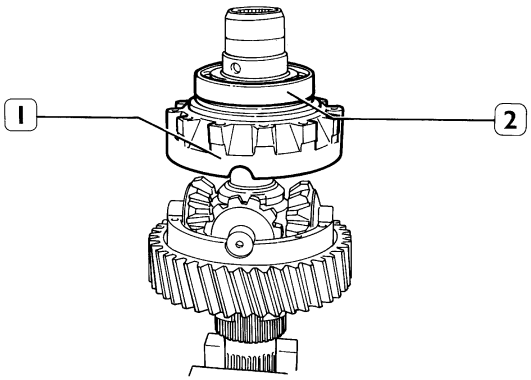
Figure 86



40135

Set the differential- reduction gear unit in a vice, remove the screws (1)

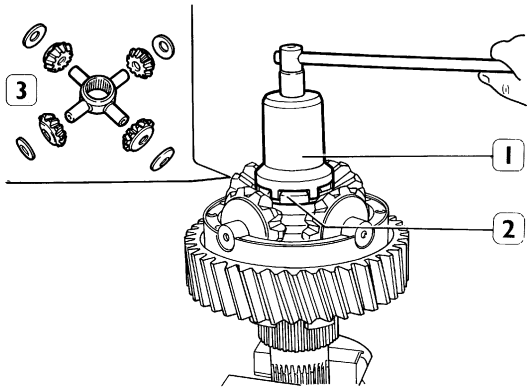
Figure 87



40136

Remove the half-boxes (1) and relevant bearing (2).

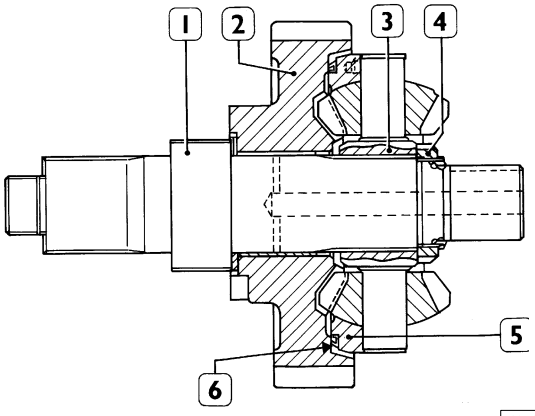
Figure 88



40138

Using a suitable punch remove the dent from the ring nut (2). Using wrench 99355121 (1) unscrew the ring nut (2), remove the spider (3), planetary wheels and shoulder washers.

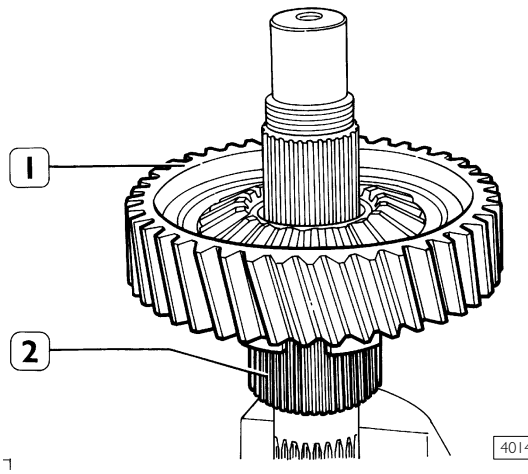
Figure 89



40139

1. Input shaft - 2. Driving gear - 3. Spider - 4. Ring nut - 5. Differential half box - 6. Seal ring

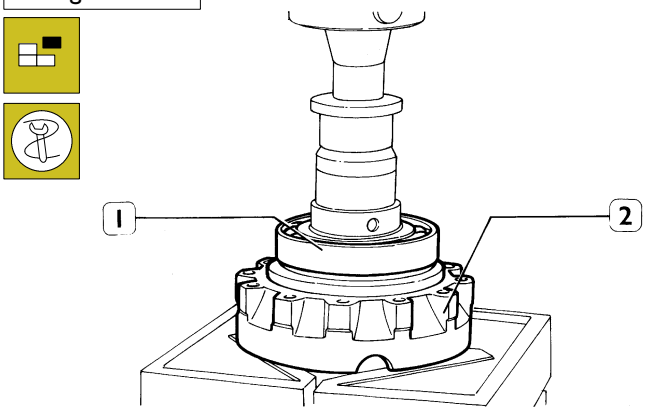
Figure 90



40140

Withdraw the driving gear (1) from the input shaft (2),, remove the shoulder ring.

Figure 91



40137

With a hydraulic press withdraw the bearing (1) from the half-box (2) operating on the crown wheel gear

Checks on differential-reduction gear unit components

Clean and carefully check the individual components, replacing any that are strained. Replace all the seal rings.

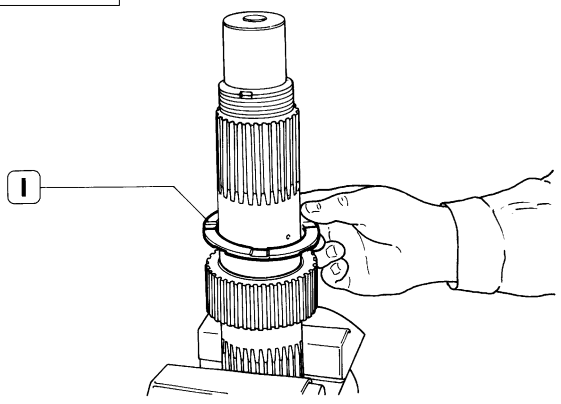
If it should be necessary to replace the crown or the pinion, both parts have to be replaced since they are supplied as a pair.

If it should be necessary to replace the crown or the pinion, both parts have to be replaced since they are supplied as a pair.

Check the bushes on the driven gear and in the crown wheel. If they are strained, replace them using a press.

REFITTING THE DIFFERENTIAL-REDUCTION GEAR UNIT

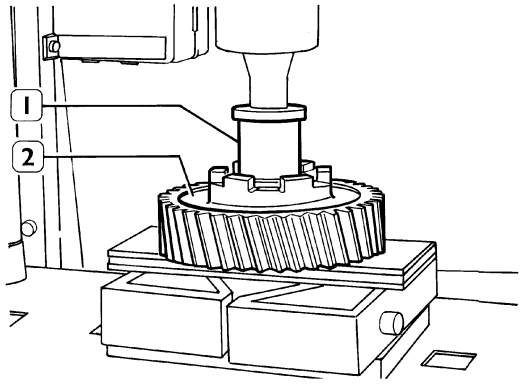
Figure 92



40141

Place the input shaft in a vice, fit in place the shoulder ring (1)

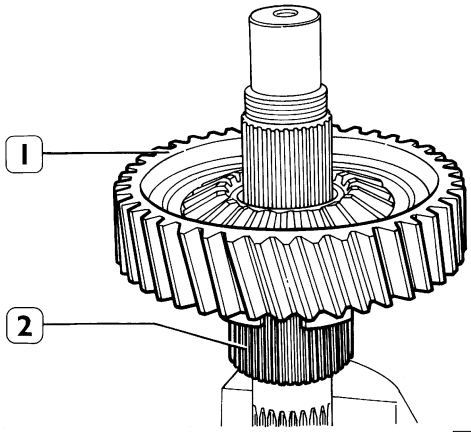
Figure 93



40411

If the bush has been removed, fit it in place in the idle gear (2) using the appropriate tool (1).

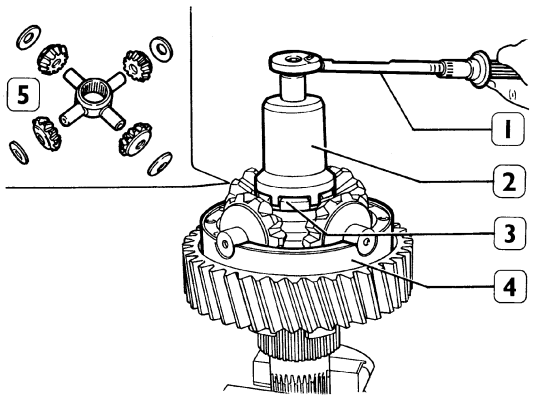
Figure 94



40140

Fit in place the idle gear (1) on the input shaft (2).

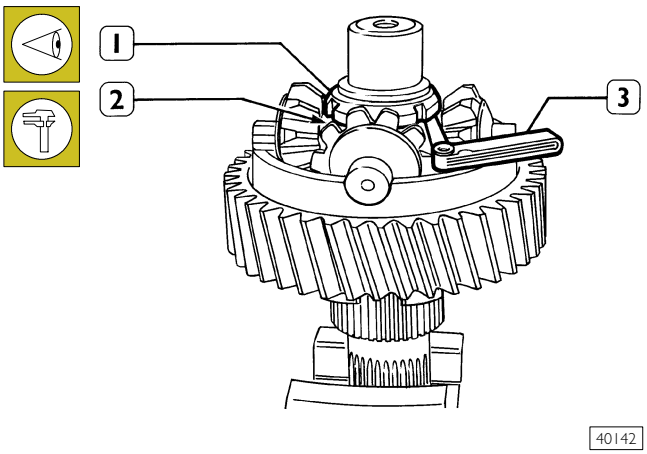
Figure 95



40138

Fit in place the half box (4) and its seal ring
Fit in place the spider (5) and its planetary wheels. With wrench 99355121 (2) and dynamometric wrench (1) tighten the ring nut (3) to a torque of 230 ± 20 Nm

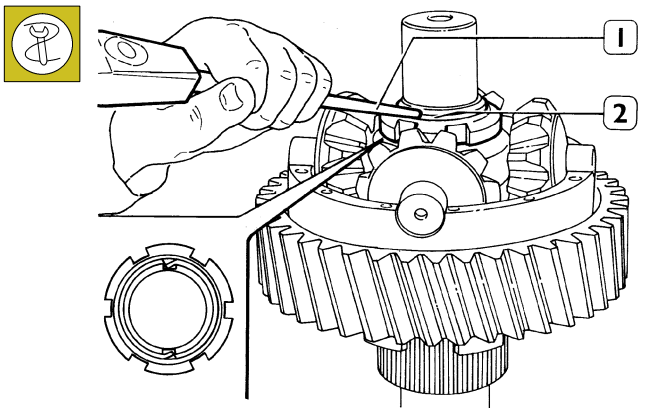
Figure 96



40142

After locking the ring nut (1) use a feeler gauge (3) to check that there is a clearance of 0.1 mm between the ring nut (1) and spider (2). If this is not so, replace the relevant parts.

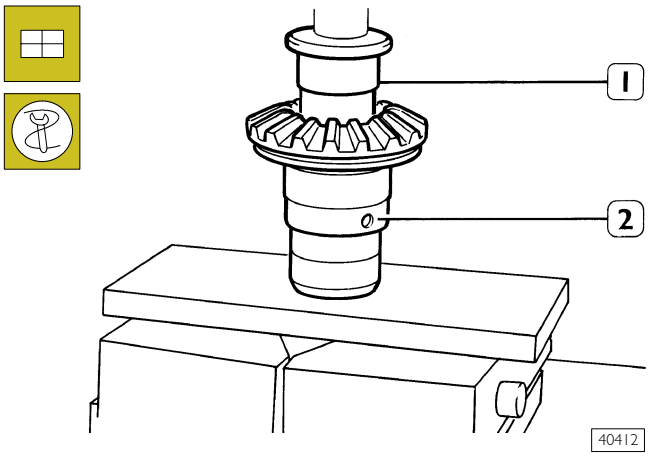
Figure 97



40143

Using a suitable punch (1) dent the ring nut (2) as shown in the detail

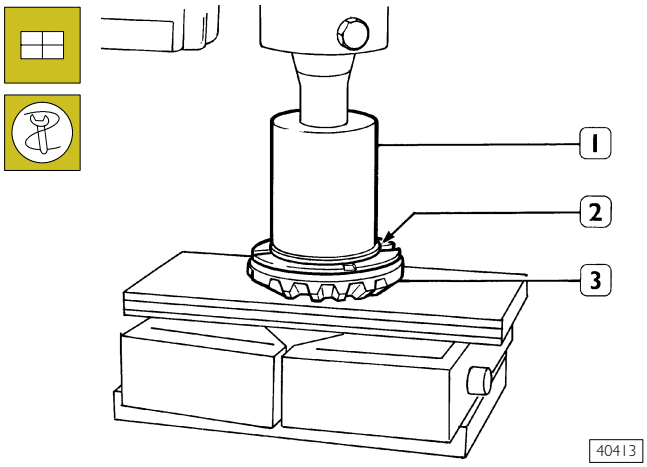
Figure 98



40412

With the suitable connection element (1) and press, fit in place the bush in the crown wheel gear (2)

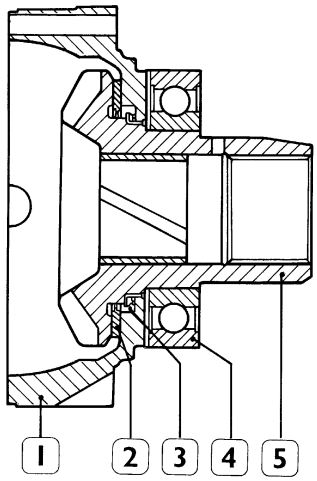
Figure 99



40413

Fit in place the shoulder ring on the crown wheel gear (3), then using the appropriate tool (1) fit in place the seal ring (2)

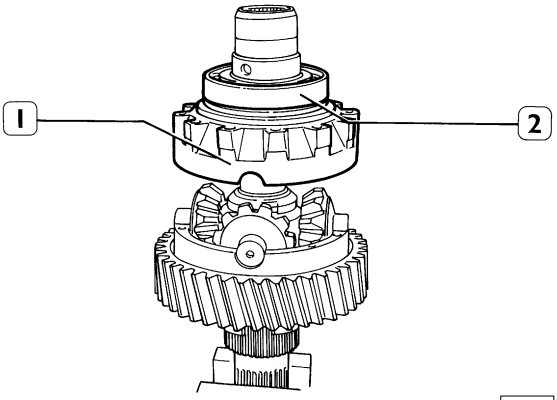
Figure 100



40414

In the half-box(1), fit in place the crown wheel (5) then fit the ball bearing (4) on the crown wheel.

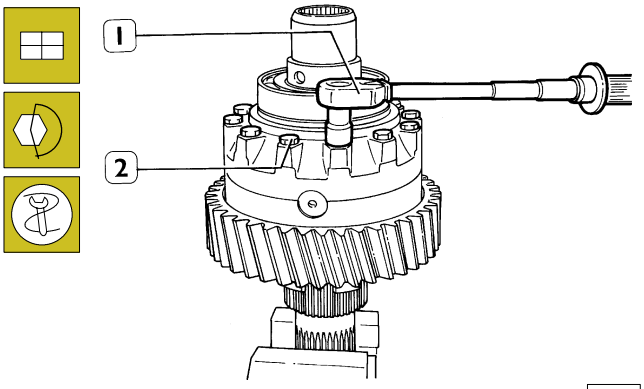
Figure 101



40136

On the lower half-box fit in place the half-box assembly (1) with its relevantbearing (2) and crown wheel

Figure 102

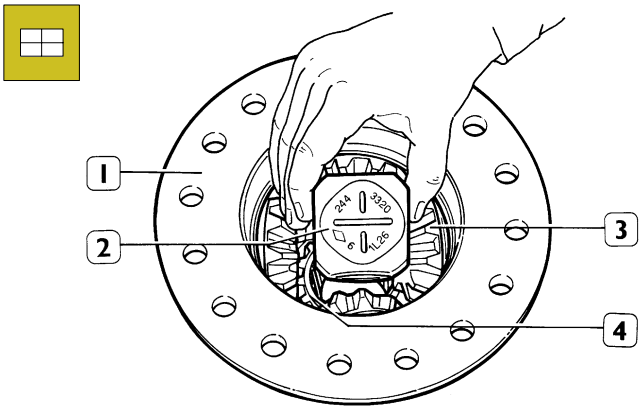


40144

Tighten the fastening screws (2) and with the dynamometric wrench (1) lock them to a torque of 67 ± 8 Nm

Fitting in place the gear housing

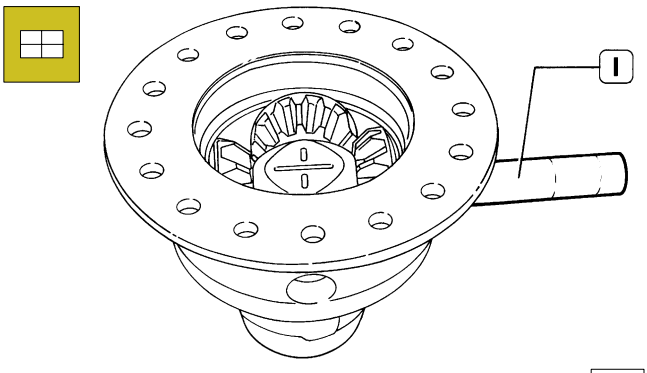
Figure 103



40091

Place the gear housing (1) on a suitable stand, fit the crown wheel (4) in its seat with its shoulder ring. Fit in place the 4 planetary wheels (3) and shoulder rings then insert the spider (2).

Figure 104

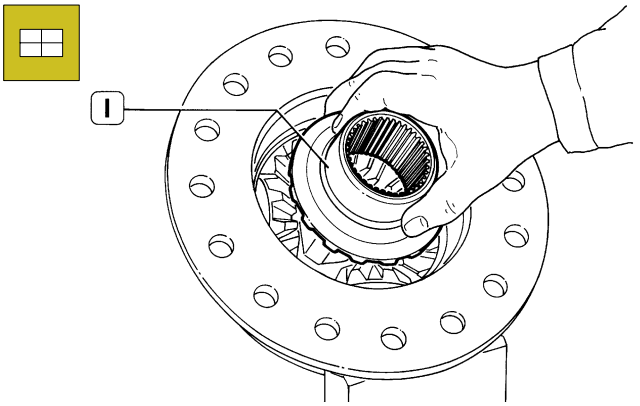


40092

Insert the long pin (1) and the two short pins

The long pin (through pin) must be inserted first. The exact position of the pins is marked on the spider by a long stripe for the long pin and two short stripes for the short pins.

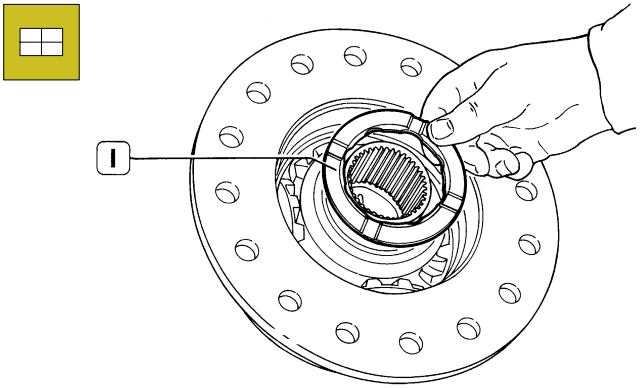
Figure 105



40093

Fit in place the crown wheel (1)

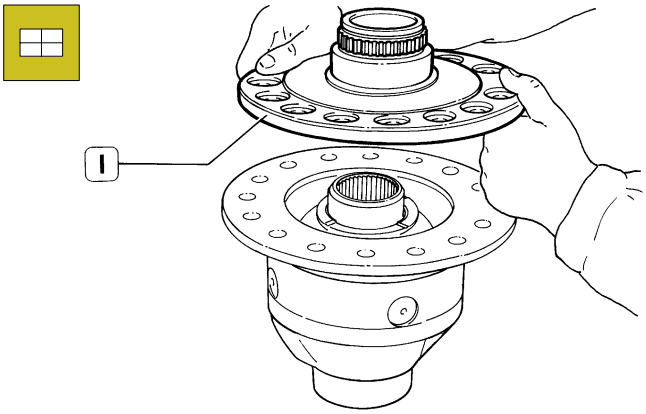
Figure 106



40094

Fit in place the shoulder washer (1)

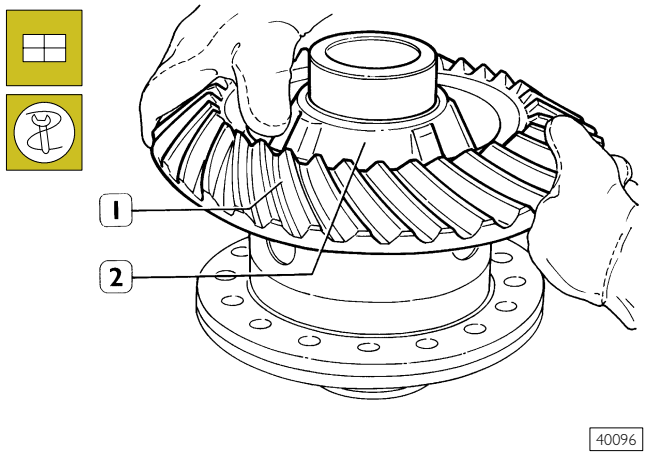
Figure 107



40095

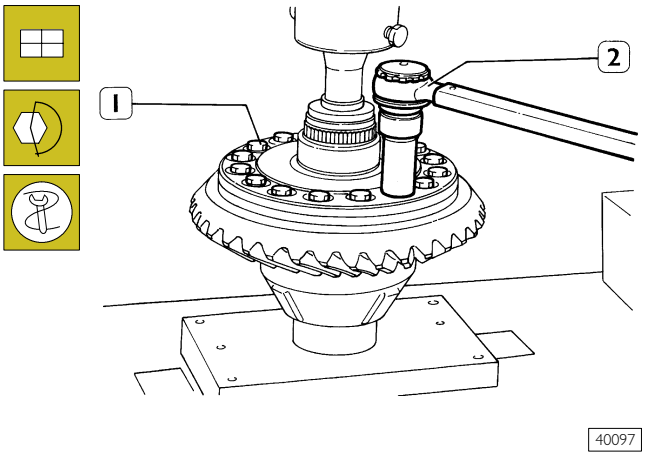
Fit in place the gear housing cover (1).

Figure 108



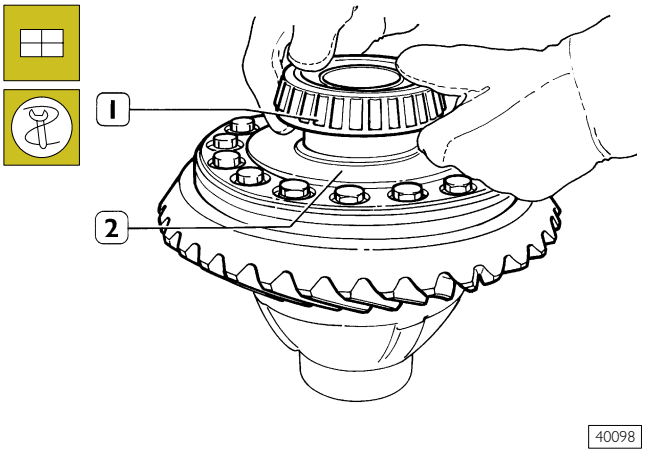
Heat the crown wheel (1) to 80 °C, fit it in place in its seat in the gear housing (2) and lock it immediately with two screws.

Figure 109



Insert the other screws (1); lock the gear housing rotation through the press and with a dynamometric wrench (2) tighten the screws (1) to a torque of 300 ± 10 Nm.

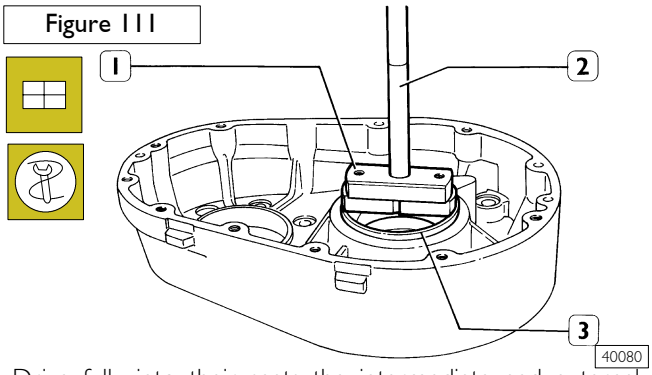
Figure 110



Heat the bearing (1) for about 15 minutes at a temperature of approx 100 °C and fit it in place on the gear housing (2). Repeat the same operation on the other side.

Fitting in place the bevel pinion housing

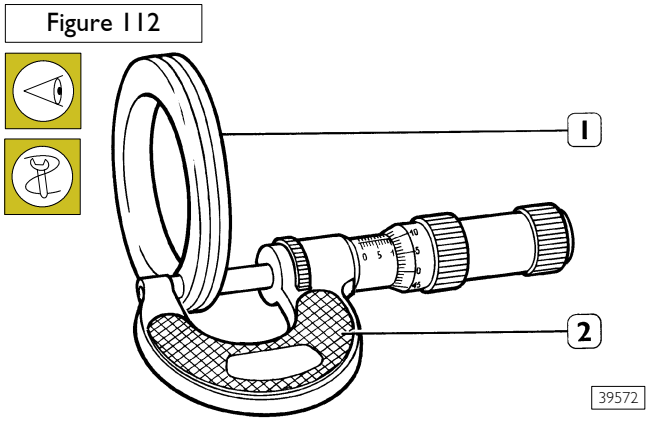
Figure 111



Drive fully into their seats the intermediate and external bearing outer rings (3) using beater 99374094 (1) and handle 99370007 (2).

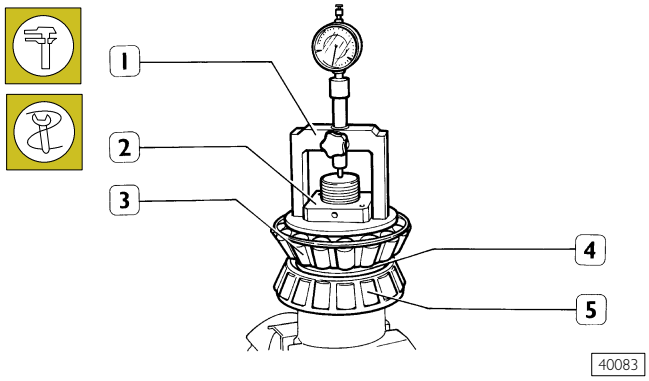
Procedure to determine the adjusting ring thickness for the bevel pinion rolling torque

Figure 112



With a micrometer (2) measure the adjusting ring (1) thickness found when removed and make a note of the value (value A).

Figure 113



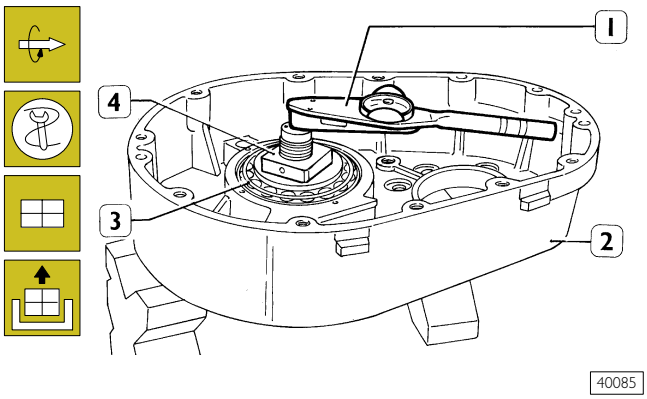
Fit tool 99395027 in a vice and place on it:

- ❑ the pinion side bearing (5)
- ❑ Adjusting ring (4), already measured, the spacer and bearing (3)

Screw the ring nut (2) and lock it tightly. Position the dial gauge fitted to element (1) of tool 99395027 on the bearing and set the gauge to zero on the end of the tool. Remove from the tool:

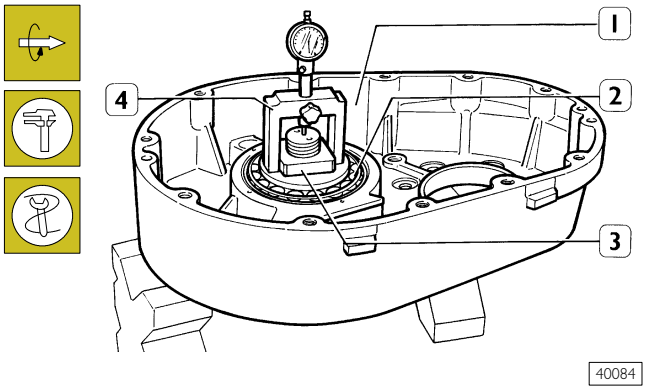
- ❑ element (1), ring nut (2), bearing (3) adjusting ring (4) and the spacer.

Figure 114



In the half-box (2) set tool 989395027 with the bearing (5, figure 113), position the bearing (3, figure 114).
Manually tighten the ring nut (4) and check the rolling torque with a dynamometer (1). It should be 1.5 - 3.5 Nm; if it is not, adjust through the ring nut (4).

Figure 115



Set up element (4) again with the dial gauage already set to zero on the bearing (2) and find the deviation, if any (value B). Remove the elements from tool 99395027.

Adjusting ring thickness "**S**" is obtained through the following formula:

S = A - (± B) + C

where:

A = Thickness of adjusting ring fitted to set the dial gauage to zero;

B =Deviation value found;

C =0.05 mm coefficient that takes into account the bearings dilation cause by assembling interference on the bevel pinion;

First example

A = 13.12 mm
B = + 0.13 mm
C = 0.05 mm

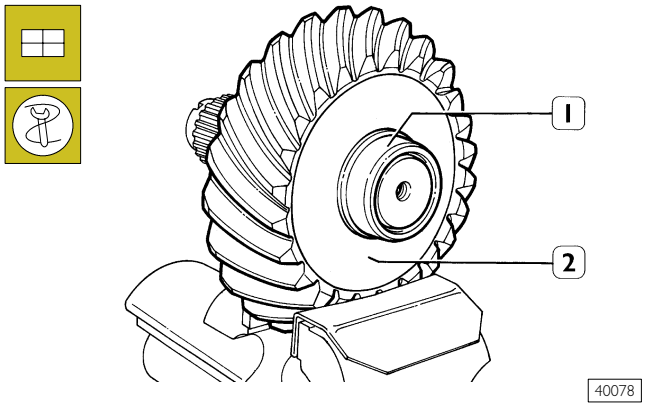
S = 13.12 - (+ 0.13) + 0.05 =
S = 13.12 - 0.13 + 0.05 = 13.04 mm.

Second example

A = 13.12 mm
B = - 0.13 mm
C = 0.05 mm

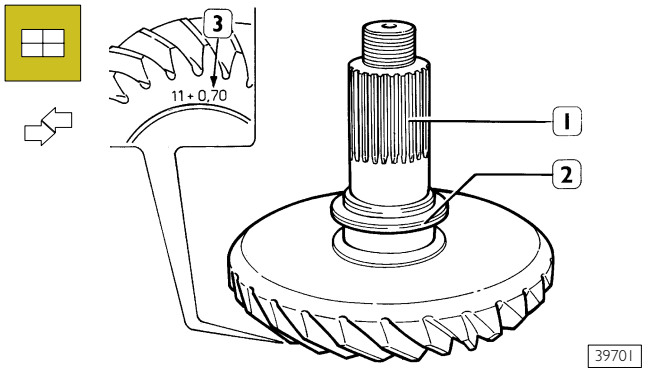
S = 13.12 - (-0.13) + 0.05 =
S = 13.12 + 0.13 + 0.05 = 13.35 mm

Figure 116



Heat the rear bearing inner ring (1) and connect it to the bevel pinion (2)

Figure 117



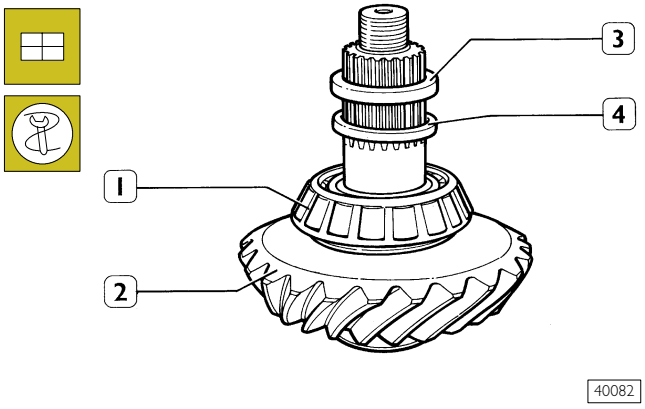
On the bevel pinion (1) fit in place the adjusting ring (2) to set the pinion with reference to the crown wheel placing the chamfer downwards. The thickness of the adjusting ring depends on the reference value (3) engraved on the bevel pinion. See table in figure 118

Figure 118

Value engraved on pinion	Adjusting ring thickness
0	4,6
0,1	4,5
0,2	4,4
0,3	4,3
0,4	4,2
0,5	4,1
0,6	4,0
0,7	3,9
0,8	3,8
0,9	3,7
1,0	3,6

Table to determine the thickness of adjusting rings, bevel pinion position with reference to the crown wheel.

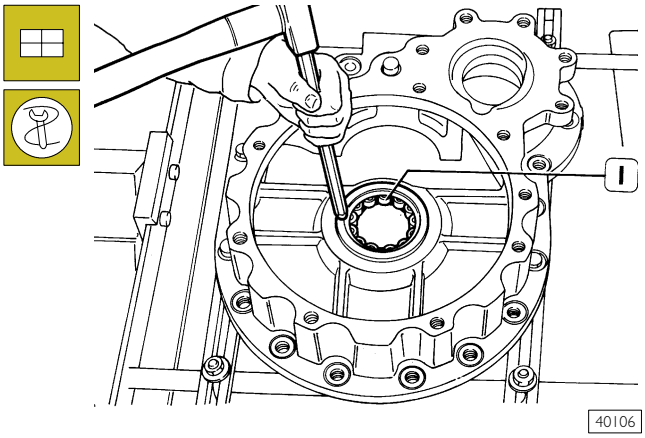
Figure 119



Heat the intermediate bearing (1) to approx. 100°C and fit in place on the bevel pinion (2).
Fit in place the spacer ring (4) and an adjusting ring (3) with the previously found thickness.

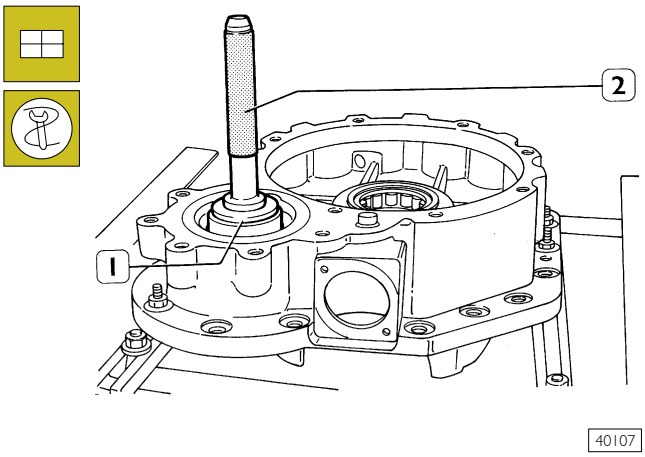
Fitting in place the differential housing

Figure 120



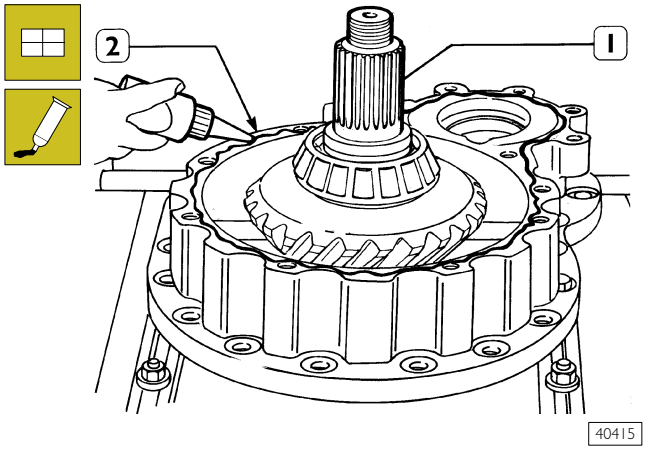
Set up the differential housing on a stand, using a suitable beater fit in place the roller bearing (1)

Figure 121



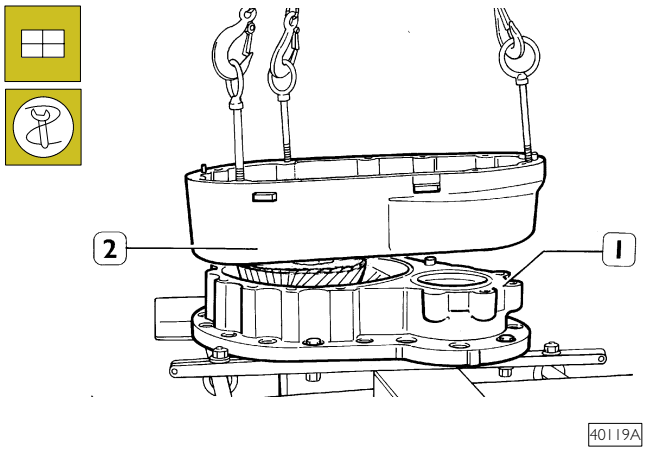
Using element 99374372 (1) and handle 99370006 (2) fit in place the seal ring.

Figure 122



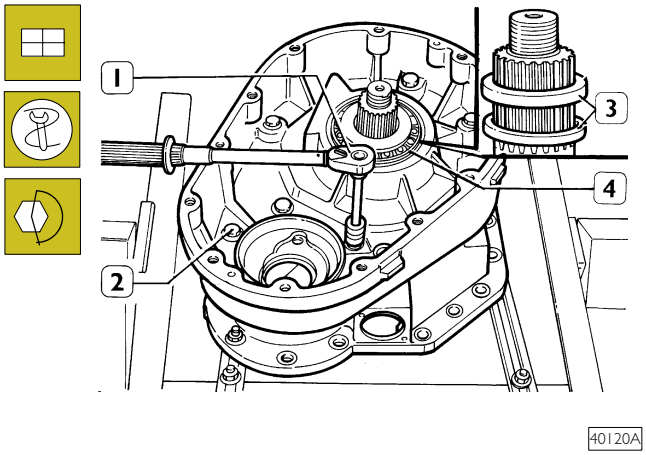
Fit the bevel pinion (1) on the roller bearing (1 figure 119). Spread LOCTITE 573 (2) on the contact surface.

Figure 123



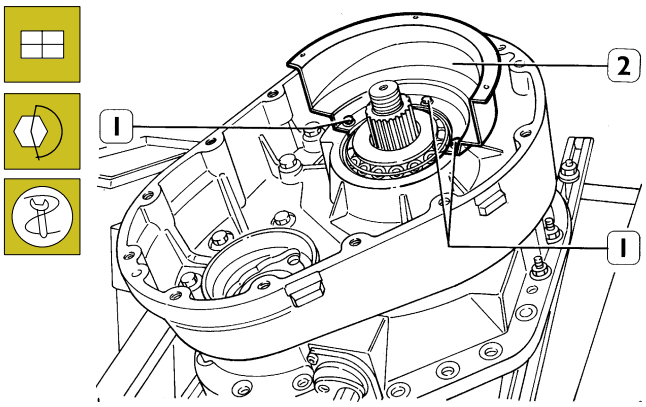
Lift and fit in place the half-box (2) on the differential housing (1)

Figure 124



Use a dynamometric wrench (1) to tighten the screws (2) to a torque of 260 ± 25 Nm. Heat the bearing (4) and connect it on the bevel pinion.

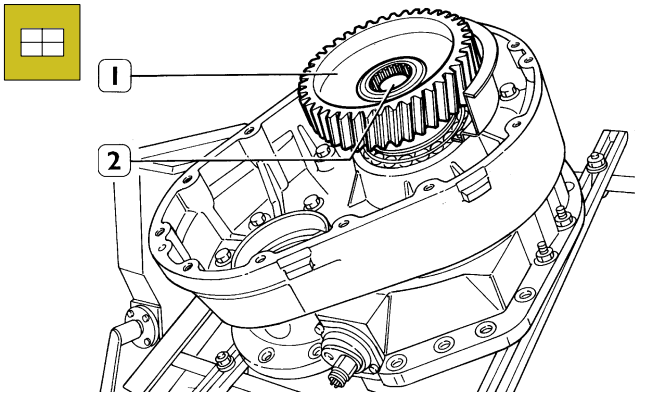
Figure 125



40121A

Fit in place the oil drain (2), locking it with the screws (1) to a torque of 16 ± 2 Nm

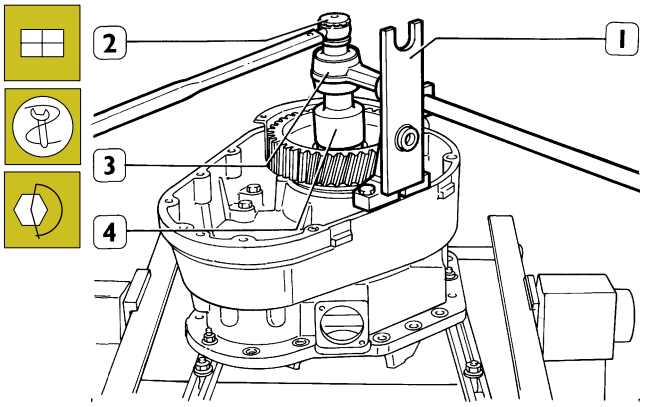
Figure 126



40122A

Fit in place the driven gear (1) on the bevel pinion (2)

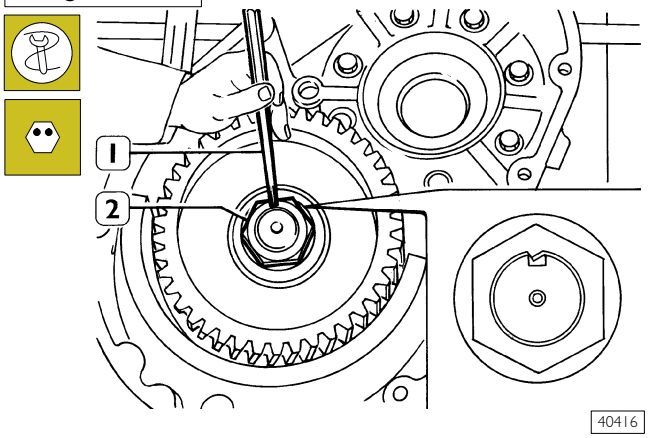
Figure 127



40123

Set up tool 99363310 (1) and with socket wrench 99355081 (4), multiplier 99389816 (3) and dynamometric wrench (2) tighten the driven gear nut to a torque of 700 ± 50 Nm

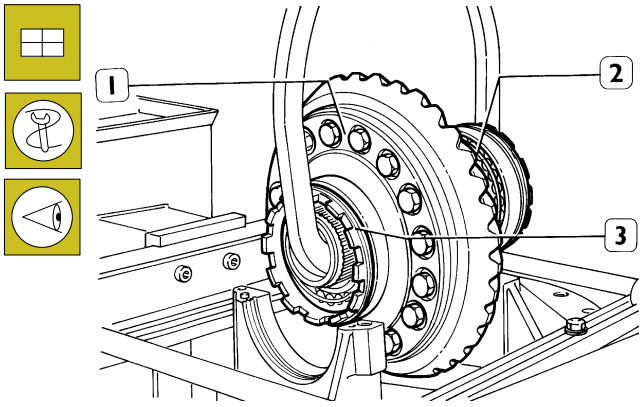
Figure 128



40416

Using a suitable beater (1) dent the driven gear nut (2)

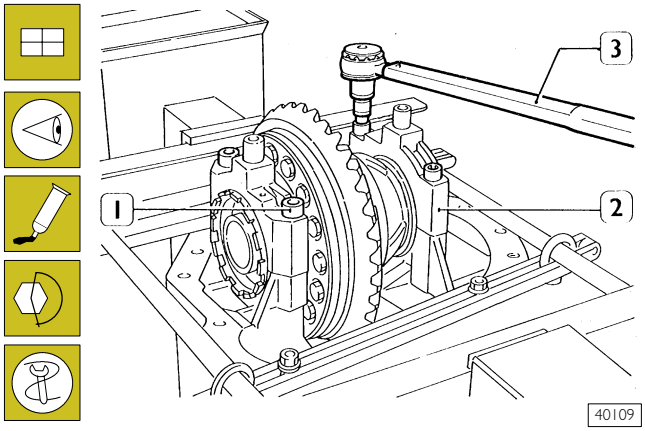
Figure 129



40108

Using an appropriate hook, lift the gear housing (1) together with bearings (2) and adjusting ring nuts (3). Set it on the differential housing. Carefully arrange the adjusting ring nuts on the threads of the differential housing.

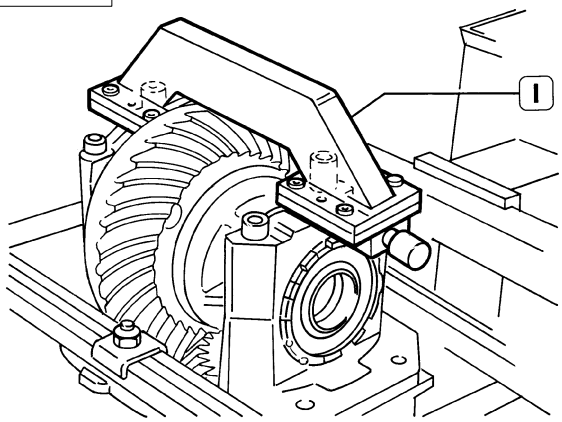
Figure 130



40109

Fit in place the caps (2), insert the screws (1) for the moment and check that the adjusting ring nuts screw in easily. Remove the screws one by one, spread LOCTITE AVX on the thread then tighten them with a dynamometric wrench (3) to a torque of 270 ± 10 Nm.

Figure 131

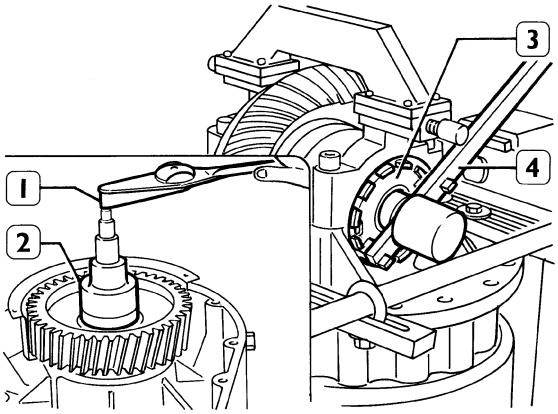


39585

Set up tool 99370133 (1) as shown in the figure to avoid angle deviation of the caps during adjustment

Adjusting the rolling torque for the gear housing bearings

Figure 132



40417

Gear housing bearings rolling torque adjustment is obtained by measuring the total rolling torque.
Find in the table , the total rolling torque value (this value varies according to the bevel pair ratio).
Using torque wrench 99354001 (1) and appropriate socket wrench (2) find the prescribed rolling torque, operating on the bearing adjustment ring nuts (3), through wrench 99354001 (4).

from the following table find the rolling torque total value; this varies according to the bevel pair ratio;

No. teeth	Ratio	Rolling torque total Nm
21/40	1,905	3,1 ÷ 6,1
19/33	1,737	3,3 ÷ 6,4
23/36	1,565	3,4 ÷ 6,7

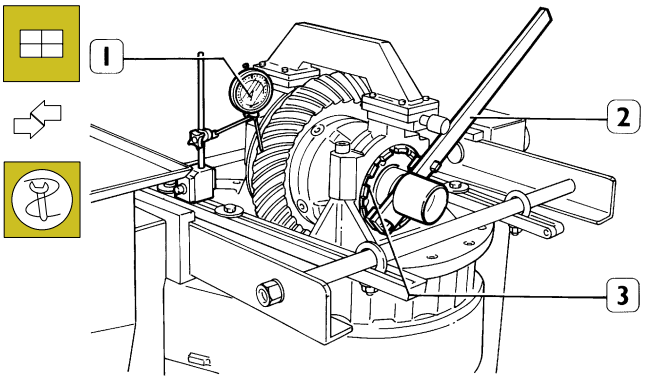
Adjusting the end play between bevel gear pair an dpinion

Adjust the backlash between the teeth of the bevel pair pinion-crown wheel operating as follows:

- From the table in figure 133 find the backlash value between the teeth; this varies according to the bevel pair ratio;

No. teeth	Ratio	Backlash between teeth
21/40	1,905	0,20 ÷ 0,28
19/33	1,737	0,25 ÷ 0,33
23/36	1,565	0,20 ÷ 0,29

Figure 133



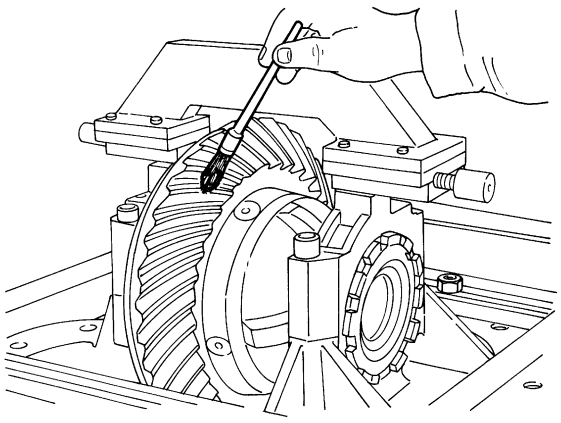
40114A

- ❑ Set the dial gauge (1) with magnetic base as shown in figure 133.
- ❑ Lock the bevel pinion rotation and rotate alternatively the crown wheel; with the dial gauage (1) find the backlash between the teeth of the two gears.
  If it is not satisfactory, operate on the adjusting ring nuts (3) using wrench 99354001 (2)

To leave the previously obtained rolling torque unaltered, when adjusting the backlash between the teeth of the pinion andcrown wheel, the adjusting ring nut can be tightened using wrench 99354001 in the same proportion as the ring nut on the other side has been loosened.

After the adjustment has been completed, check that the two adjusting ring nuts permit the mounting of the safety plates.

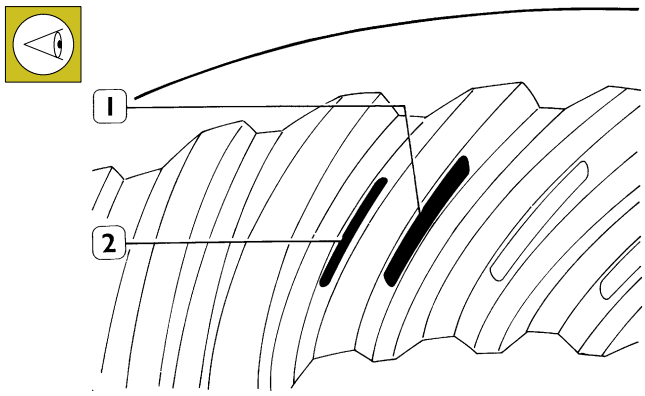
Figure 134



40159

Using a brush apply a thin coating of lead oxide to the crown wheel teeth.
Rotate the crown wheel in both directions.

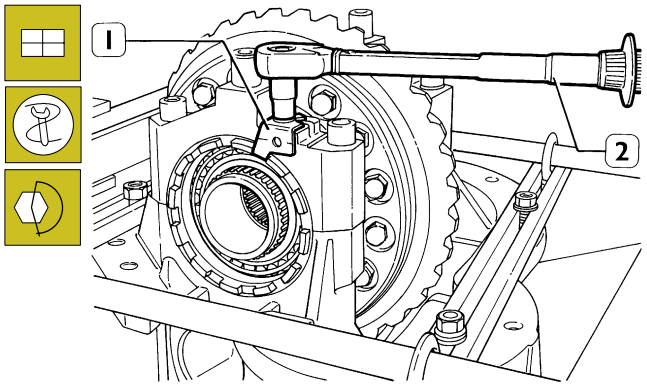
Figure 135



40160

The lead oxide should mark both the drawn surface (1) and the thrusting surface (2) approximately along the centreline of the tooth width. Without load, both meshing areas that contact are slightly displaced with reference to the crown wheel outer diameter.

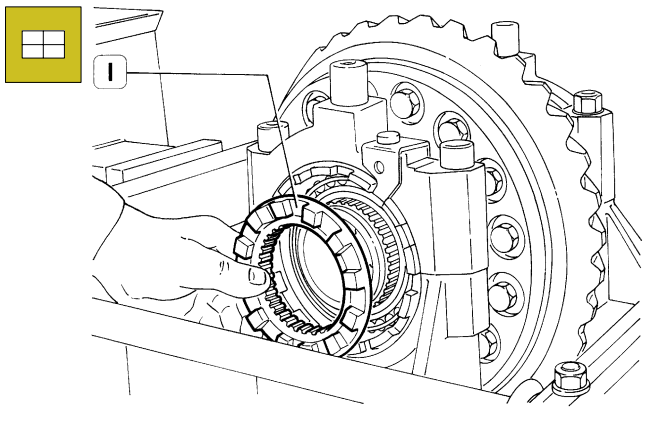
Figure 136



40110

Fit in place the safety plates (1); tighten the screws with dynamometric wrench (2) to a torque of 51 ± 5Nm.

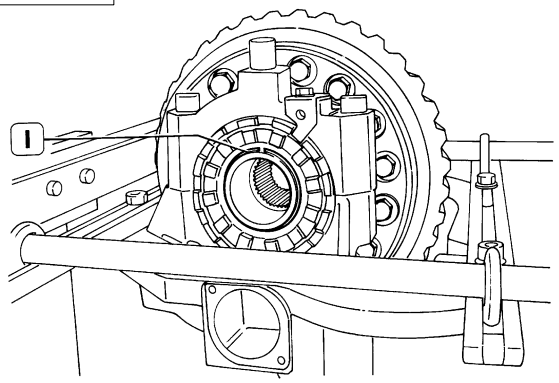
Figure 137



40111

Fit in place the differential locking sleeve (1)

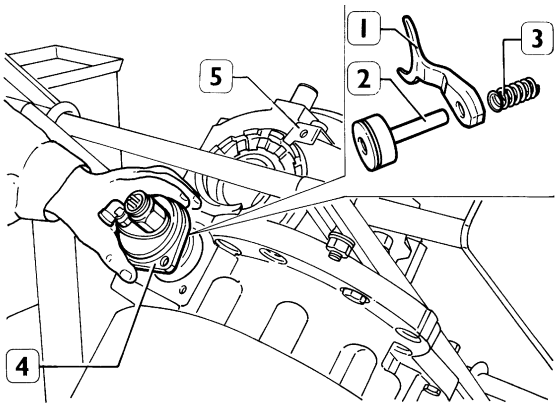
Figure 138



40078

Hold it in position by means of the circlip (1)

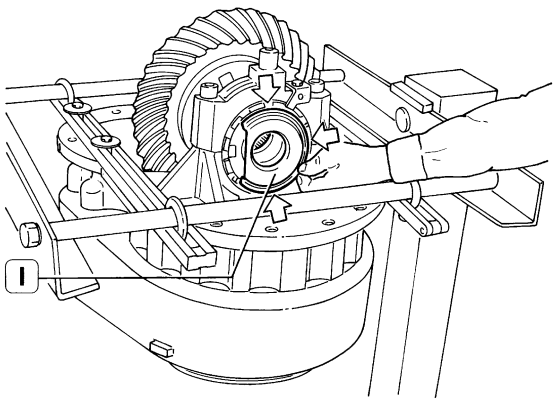
Figure 139



40113

Fit in place the differential locking enagagement assembly (1-2-3-4) and tighten the fastening screws to a torque of 25 ± 2 Nm

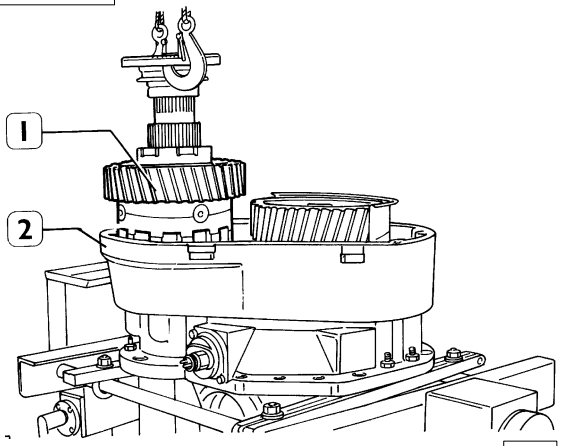
Figure 140



40115A

Fit in place the oil baffle (1) vertically as shown in figure 140. Dent the three points indicated by the arrows to ensure there is no counter rotation.

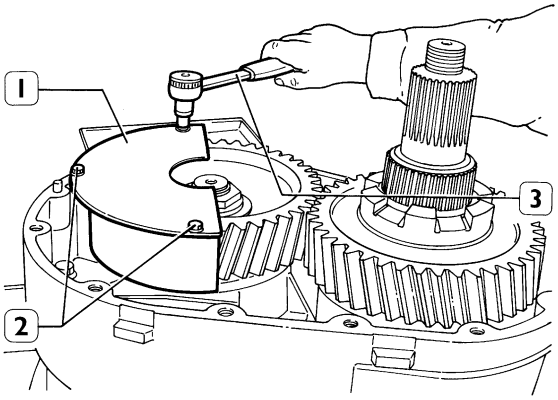
Figure 141



40124

Fit in place the differential-reduction gear unit (1) in the half-box (2)

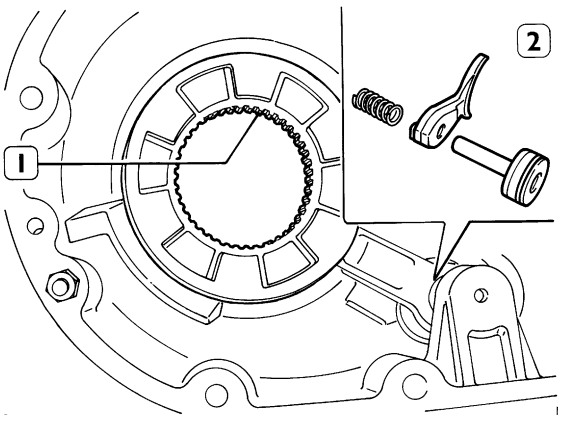
Figure 142



40125

Fit in place the upper part (1) of the oil drain, lock the screws (2) with a wrench (3).

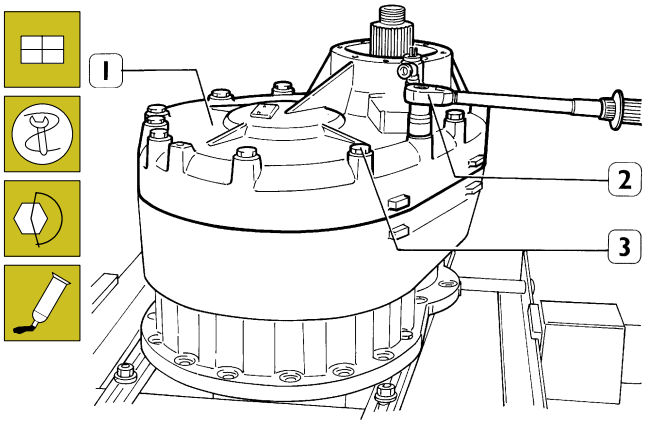
Figure 143



40126

In the internal part of the cover fit in place the sliding sleeve (1) and the control assembly (2)

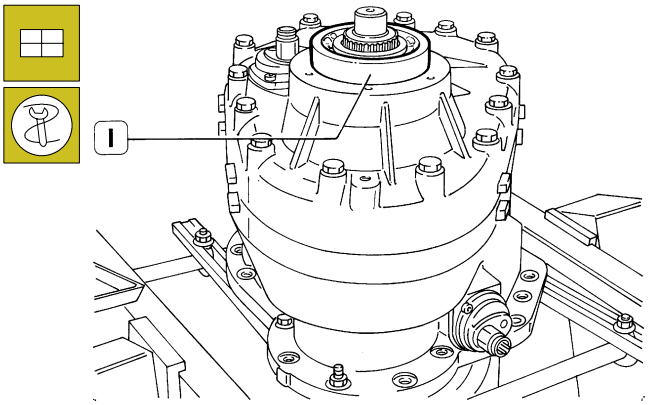
Figure 144



40127

Spread LOCTITE AVX on the contact surface.
Fit in place the cover (1) and using a dynamometric wrench (2) tighten the screws (3) to a torque of 182.5 Nm

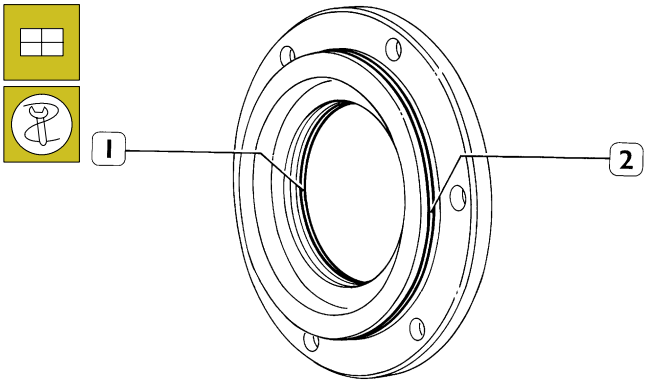
Figure 145



40128

Using an appropriate beater, fit in place the input shaft ball bearing (1)

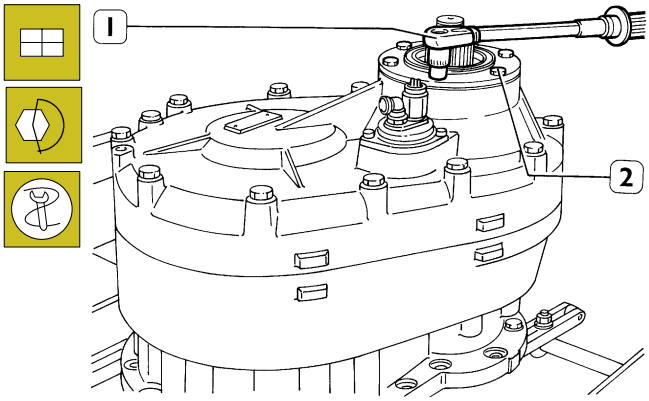
Figure 146



40129

Using element 99374233 fit in place the seal ring (1) in the cover; replace the seal ring (2).

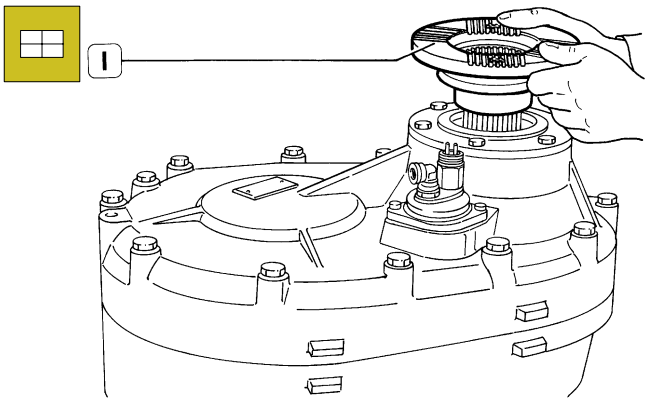
Figure 147



40131

Fit in place the cover and with dynamometric wrench (1) tighten the screws (2) to a torque of 62 ± 6 Nm

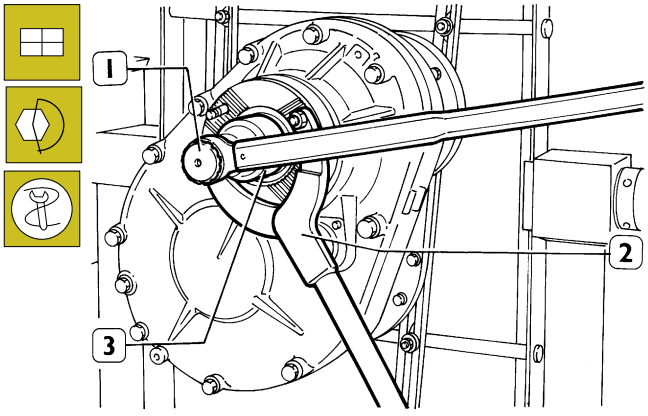
Figure 148



40132

Fit in place the flange (1) on the input shaft

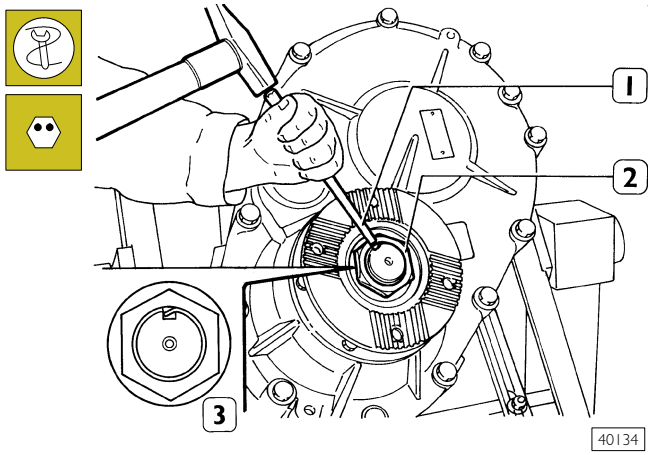
Figure 149



40133

Rotate the unit, screw the nut and with dynamometric wrench (1), counteracting lever (2) and socket wrench 99355081 (3) tighten the nut to a torque of 700 ± 50 Nm

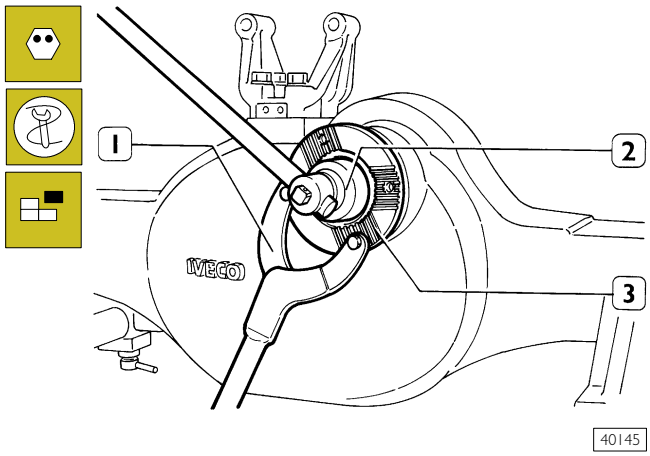
Figure 150



Using an appropriate punch (1) dent the nut (2) as shown in the detail (3)

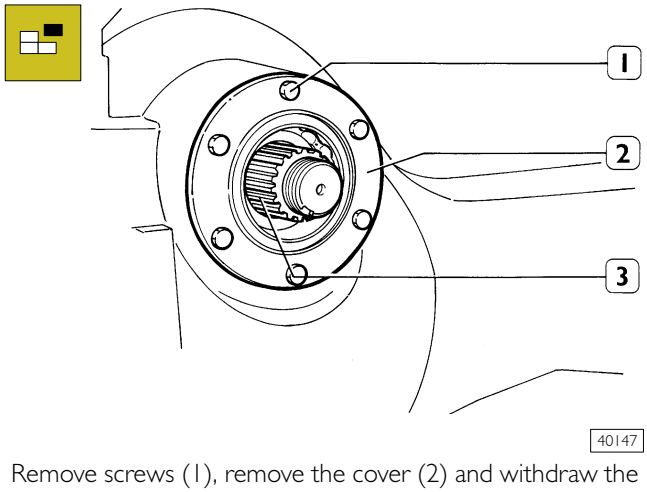
DRIVING SHAFT
Removal

Figure 151



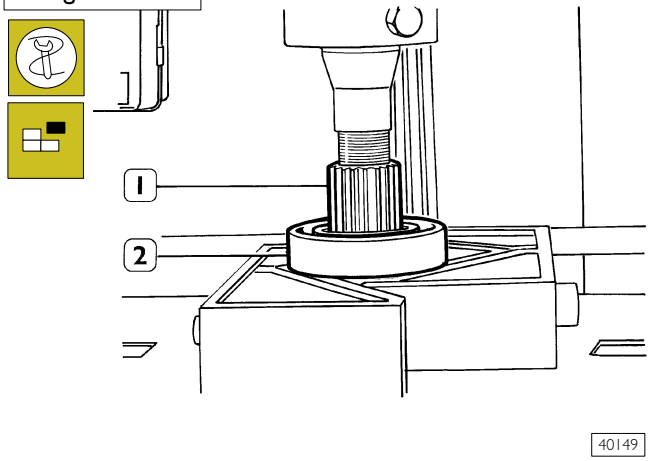
Remove the denting from the flange lock nut (3). Set up the counteracting lever (1) and using socket wrench 99355081 (2) unscrew the nut. Withdraw the flange (3)

Figure 152



Remove screws (1), remove the cover (2) and withdraw the driving shaft (3) and bearing.

Figure 153



With a press extract the ball bearing (2) from the driving shaft (1)

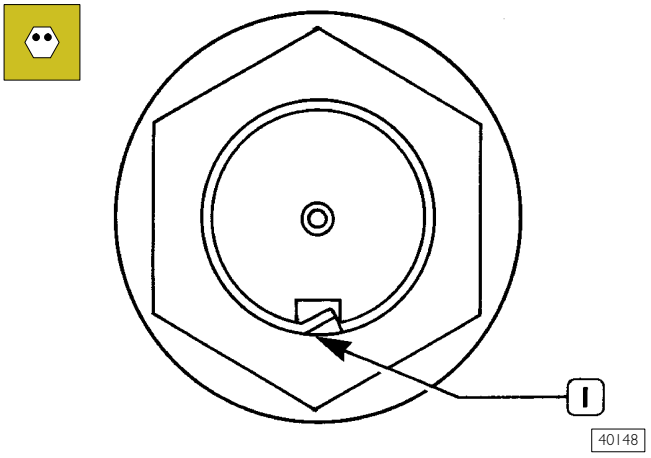
Checking components

Clean and check all the driving shaft components replacing any that are strained or broken. Always replace the seal rings.

Re-fitting in place

To re-fit in place, follow the removal instructions in reverse, denting (1) the nut as shown in figure 154.

Figure 154



REAR AXLE IN TANDEM

SECTION 12.5

SECTION 12.5

Rear axle in tandem

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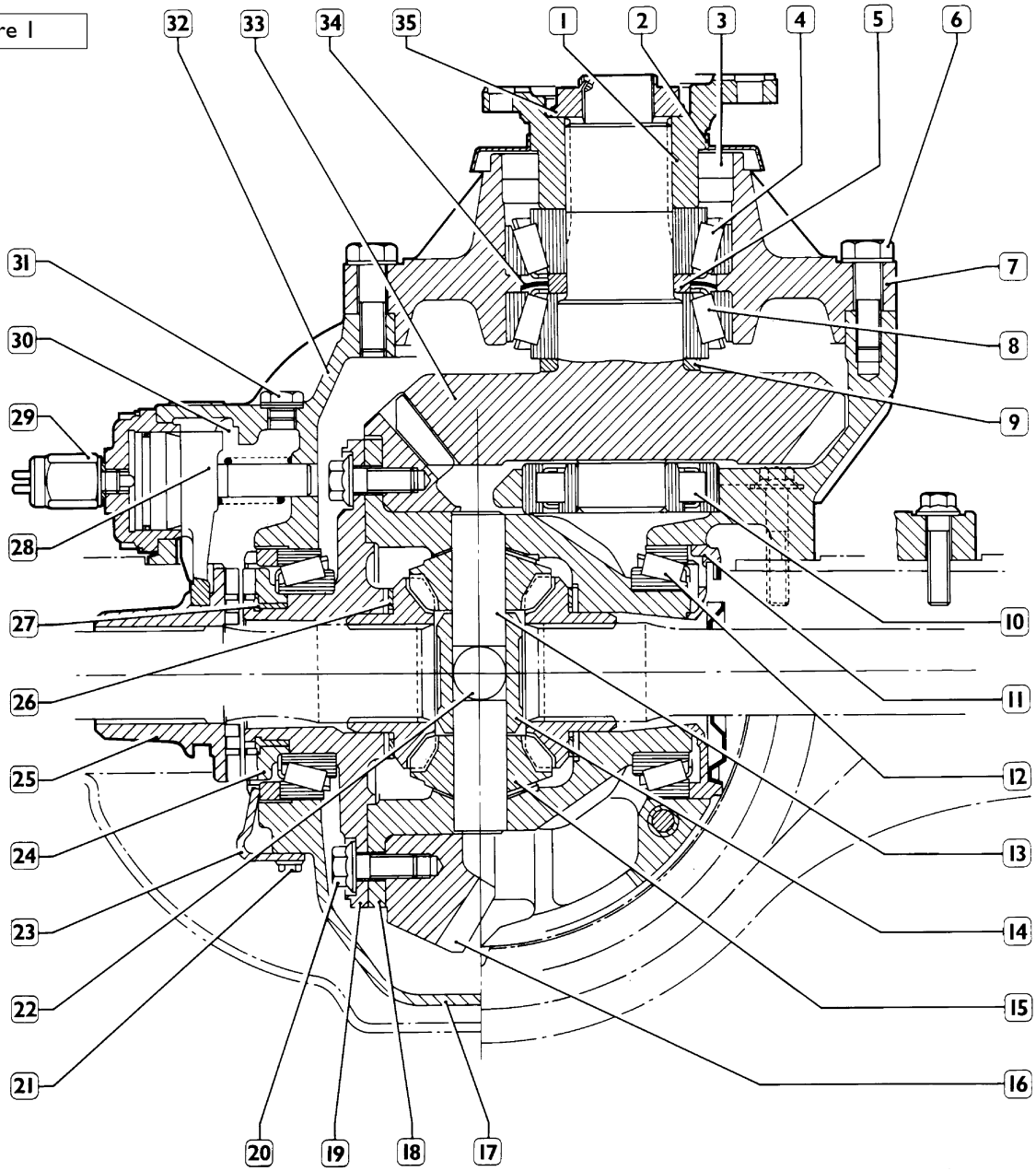
DESCRIPTION

The rear axle is a double reduction type: the first reduction is by means of the pinion - ring bevel gear unit and the second is obtained through an epicyclic unit in the wheel hubs.
The differential housing, with the ring bevel gear , is supported by two taper roller bearings that can be adjusted through two threaded ring nuts.
The pinion is supported by two taper roller bearings and a third straight roller bearing.
The bevel pinion unit is adjusted through adjusting rings that are fitted between the the two taper roller bearings.
The axle is equipped with a pneumatically controlled device to lock the differential.
The half shafts coming from the differential transmit the motion to the epicyclic gears.

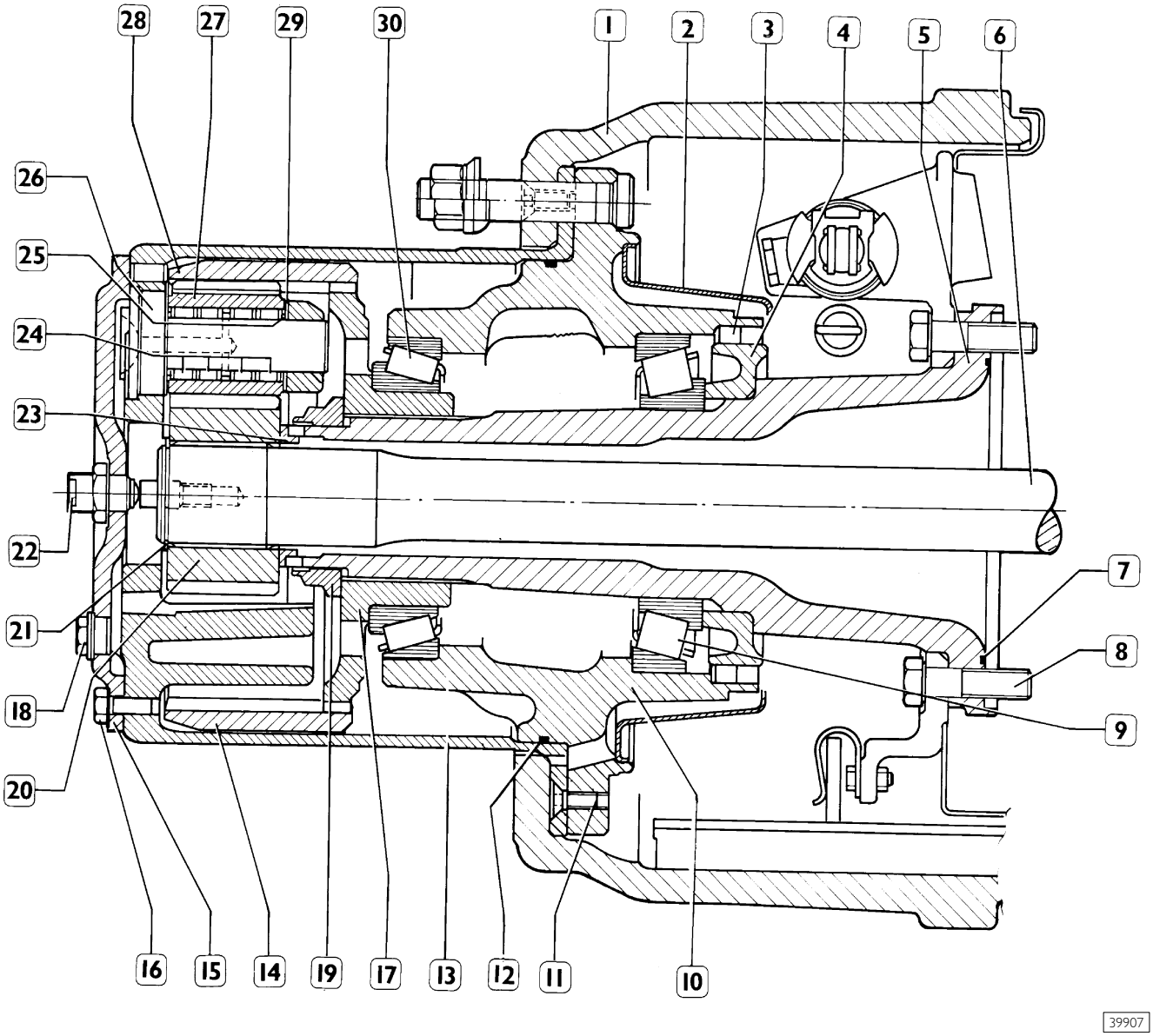
Figure 1



PICTORIAL CROSS SECTION OF THE DIFFERENTIAL

1. Coupling flange - 2.Oil seal - 3. Outer seal ring - 4. Front bearing - 5. Adjusting ring - 6. Screw - 7. Bevel pinion support - 8. Intermediate bearing - 9. Adjusting ring - 10. Rear bearing - 11. Adjusting ring nut - 12. Differential housing bearing - 13. Short pin - 14. Spider - 15. Planetary gear - 16. Crown wheel - 17. Cover - 18. Gear housing - 19. Cover - 20. Screw - 21. Screw - 22. Long pin - 23. Safety plate - 24. Engaging sleeve - 25. Sliding sleeve - 26. Shoulder washer - 27. Split ring - 28. Engaging fork - 29. Transmitter - 30. Spring - 31. Plug - 32. Differential housing - 33. Taper pinion - 34. Oil baffle - 35. Lock nut

Figure 2



PICTORIAL CROSS SECTION OF EPICYCLIC REDUCTION GEAR AND WHEEL HUB

1. Brake drum - 2. Oil manifold - 3. Seal rings - 4. Intermediate ring for sealing rings - 5. Bearing shaft - 6. Half shaft - 7. Seal ring - 8. Screw - 9. Bearing - 10. Wheel hub - 11. Screw - 12. Seal ring - 13. Planetary gear support - 14. Crown wheel - 15. Cover - 16. Screw - 17. Crown wheel carrier - 18. Plug - 19. Collar nut - 20. Planetary gear - 21. Circlip - 22. Spacer screw - 23 Spacer ring - 24. Planetary gear needles - 25. Spacer rings - 26. Pin - 27. Planetary gear - 28. Gasket - 29. Spacer washer - 30. Bearing

SPECIFICATIONS AND DATA

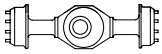
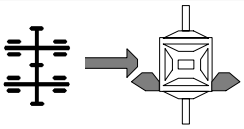
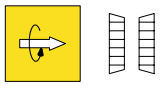
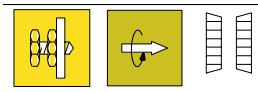
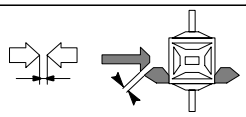
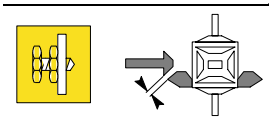
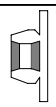
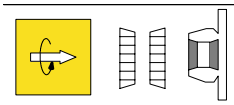
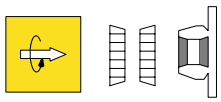
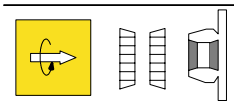
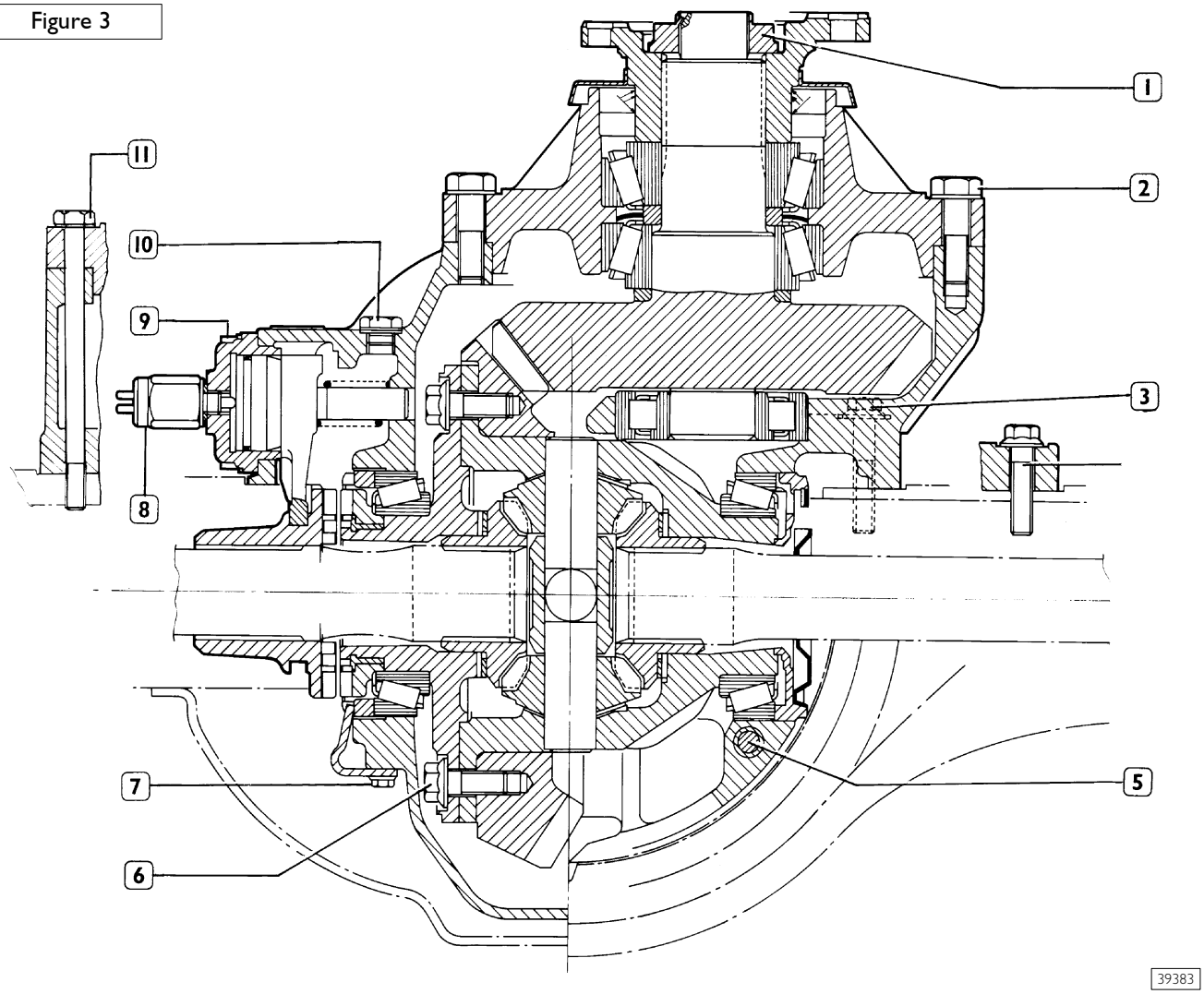
 Type of axle: Bearing with double reduction, differential is locked through pneumatic control and reduction gear unit	ASTRA 453291/2D (IVECO R 8298 D001)
 Bearings for bevel pinion	2, with taper rollers and 1 with straight rollers
 Reduction bevel gear pair ratio	23/36 (1,565) - 19/33 (1,737) - 21/40 (1,905)
 Epicyclic reduction gear ratio on the wheels	3,2
 Bevel pinion bearings rolling torque without gasket Nm	1,5 ÷ 3,5
 Bevel pinion bearings rolling torque adjustment	through adjustment rings
 Thickness of adjustment rings for bevel pinion bearings rolling torque mm	10 - 10,02 - 10,04 - 10,06 - 10,08 - 10,10 - 10,12 - 10,14 - 10,16 - 10,18 - 10,20 - 10,22 - 10,24 - 10,26 - 10,28 - 10,30 - 10,32 - 10,34 - 10,36 - 10,38 - 10,40 - 10,42 - 10,44 - 10,46 - 10,48 - 10,50
 Thickness of adjustment rings for bevel pinion fitting with reference to the crown wheel mm	3,6 - 3,7 - 3,8 - 3,9 - 4,0 - 4,1 - 4,2 - 4,3 - 4,4 - 4,5 - 4,6
 Backlash between pinion and crown wheel mm	23/36 (1,565) = 0,20 ÷ 0,29 19/33 (1,737) = 0,25 ÷ 0,33 21/40 (1,905) = 0,20 ÷ 0,28
	Through ring nuts
 **WHEEL HUBS**	
 Wheel hub bearings	Two with taper rollers
 Rolling torque of wheel hub bearings: new bearings with surface protection Nm	3 + (12 ÷ 16)
 Rolling torque of wheel hub bearings: new bearings with surface protection Nm	3 + (5 ÷ 7)
 Rolling torque of wheel hub bearings: Run-in bearings and seal rings Nm	3 + (2,5 ÷ 4,5)
 Half-shaft end play mm	0,5 ÷ 1

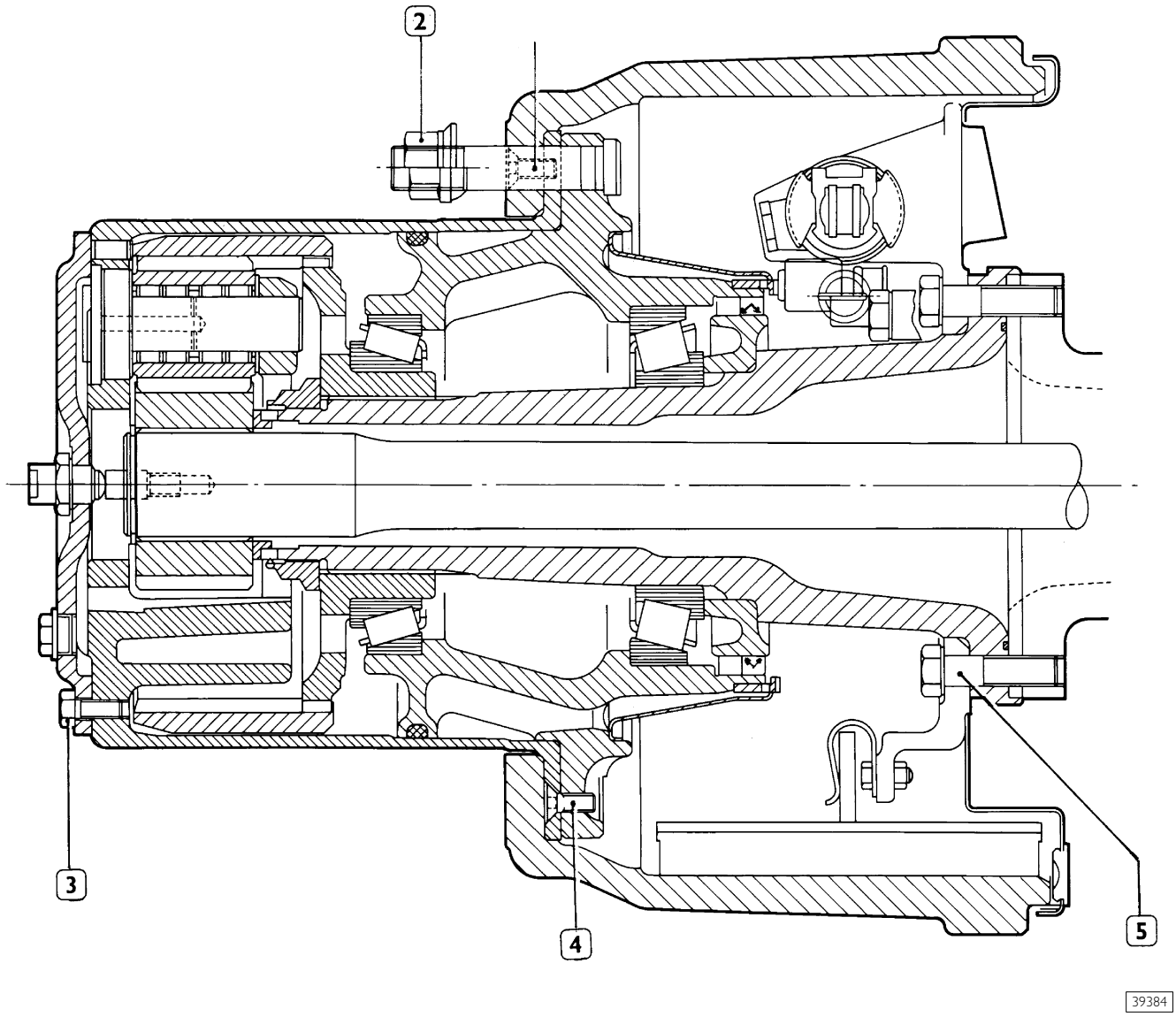
Figure 3



TIGHTENING TORQUES

	COMPONENT	TORQUE	
		Nm	Kgm
1	Bevel pinion locking nut	700 ± 50	70 ± 5
2	Bevel pinion support to differential housing fastening screw	165 ± 15	16,5 ± 1,5
3	Differential housing to axle casing fastening screw	160 ± 10	16 ± 1
4	Differential housing to axle casing fastening screw ●	160 ± 10	16 ± 1
5	Bevel pinion support to differential housing fastening screw ♦	280 ± 15	28 ± 1,5
6	Ring bevel gear to gear housing fastening screw	300 ± 10	30 ± 1
7	Safety plate to gear housing cover fastening screw	60 ± 6	6 ± 0,6
8	Pressure switch	61 ± 6	6,1 ± 0,6
9	Hexagonal socket head screw for control cylinder	25 ± 2	2,5 ± 0,2
10	Oil intake plug	40 ± 4	4 ± 0,5
11	Self locking screw	120 ± 10	12 ± 1
	● Apply LOCTITE AVX ♦ Spread LOCTITE 573 sealant		

Figure 4



	COMPONENT	TORQUE	
		Nm	Kgm
1	Drum flathead screw	25 ± 3	2,5 ± 0,3
2	Wheel nut	650	65
3	Cover to crown wheel support fastening screw ●	50 ± 5	5 ± 0,5
4	Flathead screw	25 ± 3	2,5 ± 0,3
5	Bearing sleeve screw ♦	280 ± 15	28 ± 1,5
	● Apply LOCTITE AVX ♦ Spread Hylomar SQ 32IM sealant		

TOOLS

TOOL NO.	DESCRIPTION
99305121	Hot air operated equipment
99322205	Rotary stand for unit overhaul
99322215	Stand to overhaul axles
99322225	Unit support (to use on stand 99322205)
99341003	Puller
99341015	Clamp
99341023	Grips
99345055	Counter block for pullers
99354001	Wrench for differential gearcase bearing adjustment ring nut
99354207	Wrench (94.5 mm) for wheel hubs bearing adjustment nut
99355081	Wrench (60 mm) for differental bevel pinion nut (to be used with 99370317)
99356001	Wrench for wheel brake shoes adjustment
99357111	Pliers for brake shoes return spring
99370005	Handle for interchangeable beaters
99370006	Handle for interchangeable beaters
99370007	Handle for interchangeable beaters
99370317	Lever and relevant extension bar to retain flange
99370509	Hook to remove differential gearcase half box
99370616	Support to hold differential gear during removal/re-fitting in place
99370617	Universal support to hold axles during removal/re-fitting in place
99371022	Pair of brackets to hold differential during overhaul (to be used with 99322205 and 99322225)
99372213	Tool for brake drum turning (to be used with 9930100)
99374013	Element to fit in place the differential bevel pinion gasket (to be used with 99370006)
99374025	Element to fit in place the wheel hub internal gasket (to be used with 99370005)
99374093	Beater to fit in place bearings outer tracks (91 -134) (to be used with 99370007)
99374094	Beater to fit in place bearings outer tracks (134-215) (to be used with 99370007)
99374451	Equipment for half shafts removal/re-fitting in place
99389819	Dynamometric wrench 0 to 10 kgm connection 1/4"
99389821	Dynamometric wrench 0 to 70 kgm connection 3/8"
99395026	Tool to check hubs rolling torque (to be used with dynamometric wrench)
99395027	Tool to find proper differential bevel pinion adjustment shims (to be used with 99395603)
99395603	Dial gauge (0-5 mm)

DIAGNOSTICS

Main axle faults:
1 - Wheel hubs noisy
2 - Noise
3 - Noise at release
4 - Noise during acceleration
5 - Cornering noise

1 WHEEL HUBS NOISY

Insufficient lubrication	– YES →	Check there are no leaks from gaskets or the axle casing and top up oil to correct level.
NO ↓		
Wheel hub bearings inefficient	– YES →	Remove the hub and replace inefficient parts.
NO ↓		
Bad adjustment of wheel hub bearings	– YES →	Adjust bearings
NO ↓		
Half-shaft splines to fit planetary gears of epicyclic gears are worn	– YES →	Overhaul and replace worn or damaged parts

2 NOISE

Lubricating oil level low	– YES →	Check there are no leaks from gaskets or axle casing and top up to correct level
NO ↓		
Half shaft splines to fit the differential crown wheels damaged	– YES →	Overhaul the axle and replace worn or damaged parts.

Bad adjustment of hub bearings – YES → Adjust the bearings backlash.

NO

Bad adjustment or wear on differential gears or bearings – YES → Locate the trouble and overhaul the unit.

3 NOISE AT RELEASE

Improper fitting backlash between pinion and ring bevel gear – YES → Remove the gear housing inspection cover and adjust backlash between pinion and ring bevel gear.

4 NOISE DURING ACCELERATION

Insufficient lubrication – YES → Check that there are no leaks from the gaskets or the casing and top up to the correct level.

NO

Gear housing bearings badly set or deteriorated – YES → Overhaul the unit.

NO

Bad tooth contact between pinion and ring bevel gear – YES → Adjust the contact.

5 CORNERING NOISE

Improper backlash between planetary gears and crown wheels. – YES → Overhaul or replace the unit.

REMOVING - REFITTING THE REAR AXLE

Removal

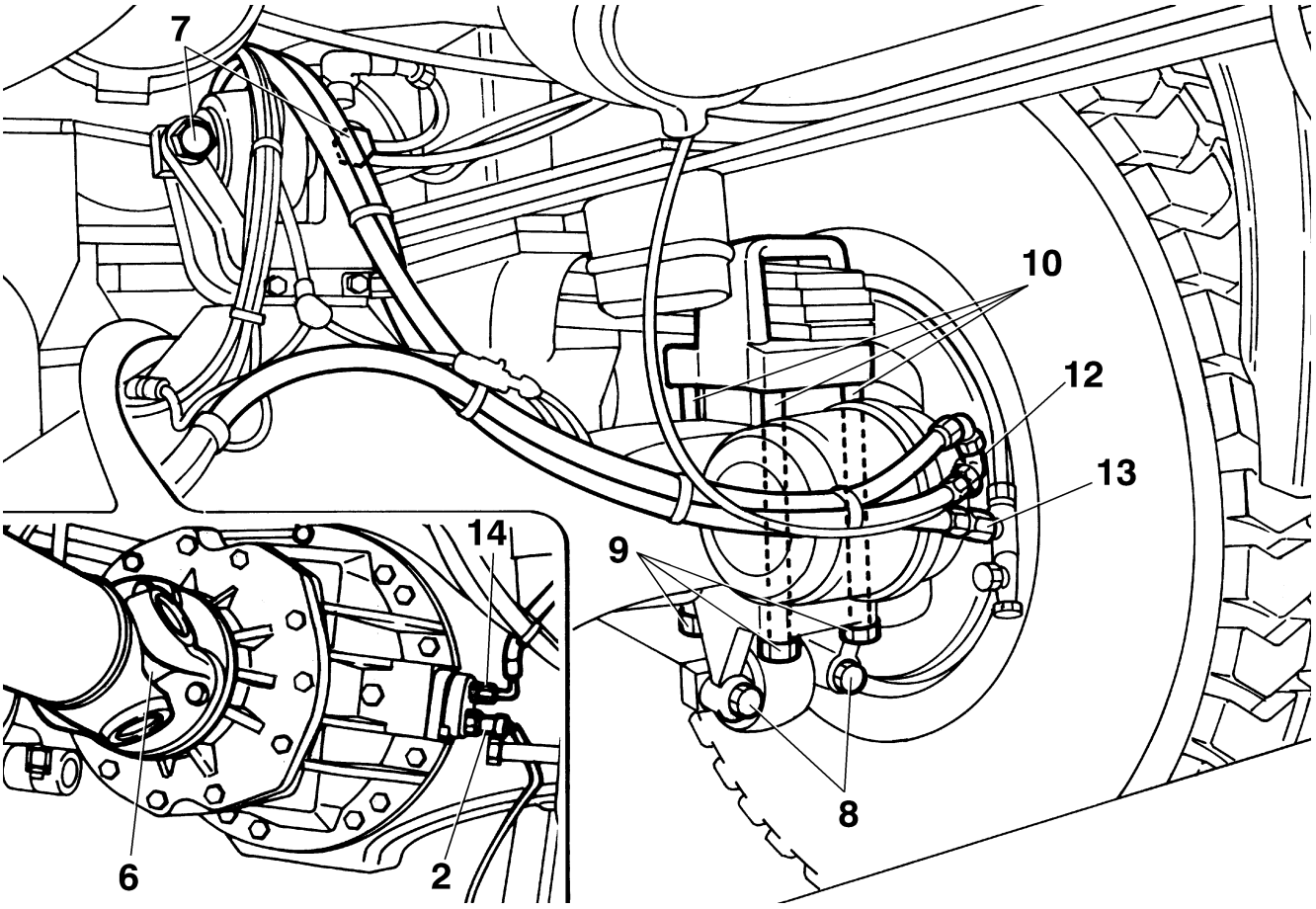
To remove the rear axle proceed as follows:

- ❑ place the vehicle on a flat ground and suitably lock the front wheels;
- ❑ loosen both rear wheel fastening nuts;
- ❑ using a hydraulic jack lift the rear part of the vehicle and rest it on two stands;
- ❑ remove both rear wheels;
- ❑ disconnect ABS transmitter electrical cables from both sides (only vehicles provided with ABS);
- ❑ disconnect the electrical cable (2) for the differential led;
- ❑ disconnect the pneumatic connections for parking brake (12), brake air delivery (13), differential locking (14);
- ❑ remove braking control lever rod (11);
- ❑ undo the screws fixing the propeller shaft flange (6), and secure temporarily the shaft to the chassis to avoid interference during next operations;
- ❑ remove the bolts (7) fixing the axle securing upper rod;
- ❑ unscrew the bolts (8) fixing the axle securing lower rod from both sides;
- ❑ set a hydraulic jack fitted with tool 99370617 under the axle;
- ❑ unscrew the nuts (9) from both sides and lift the leaf spring fixing brackets (10) then, lower the axle and take away the leaf spring.

Refitting

To refit, follow the removal operations in reverse order.

Figure 5

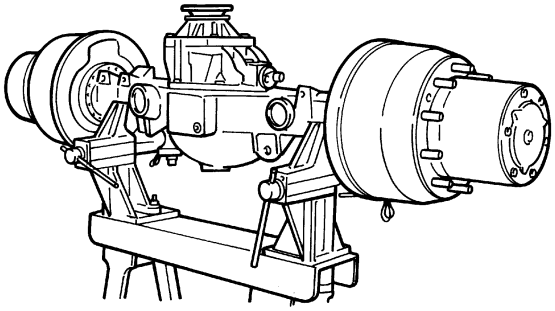


REAR AXLE ASSEMBLY REPAIR OPERATIONS

The removal and re-fitting into place operations for the half-shafts, drums and brake shoes, air bleeder, wheel hubs differential and epicyclic gears can all be carried out with the units fitted on the vehicle.

Before setting the axle assembly on the stand to overhaul, unscrew the axle casing lower plug todrain the oil.

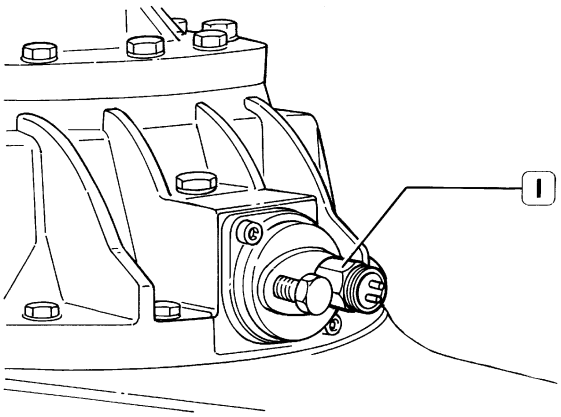
Figure 6



39627

Set the whole axle assembly on stand 99322215.

Figure 7



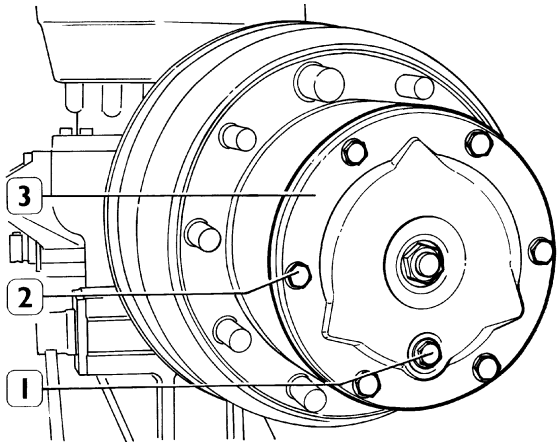
39628

Lock the sliding sleeve of the differential locking device with a screw.
To do this, remove the threaded coupling from the control cylinder and in its place (1) fit a screw (M14 x 1.5).
At the same time, turn the axle mechanism so that the sliding sleeve and enagagement sleeve are engaged. This will prevent accidental movement of the sleeve while removing the half-shaft.

Place a vessel under the wheel hub to collect the oil.

Removing the epicyclic reduction unit

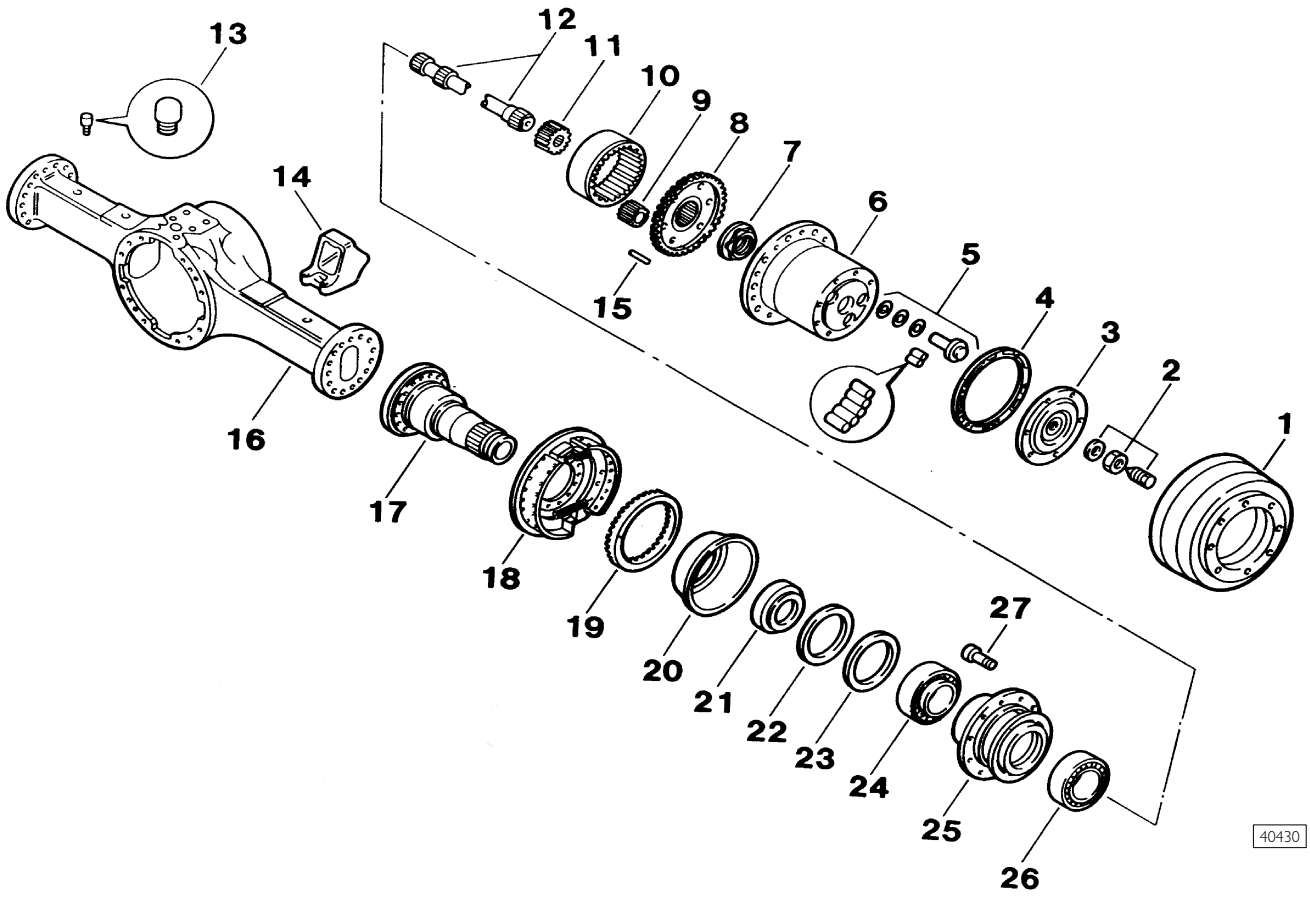
Figure 8



40053

Remove the screws (2); remove the cover (3) and collect the oil.

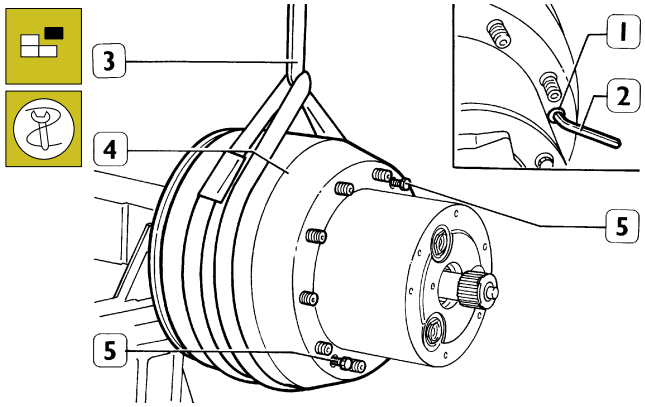
Figure 9



WHEEL HUB COMPONENTS

1. Brake drum – 2. Adjusting screw and nut – 3. Cover – 4. Gasket – 5. planetary gear pin and rollers – 6. Planetary gear carrier – 7. Adjusting nut – 8. Crown wheel carrier – 9. Planetary wheel – 10. Crown wheel – 11. Crown wheel gear – 12. Half-shaft – 13. Bleeder – 14. Bracket – 15. Shoulder pin – 16. Axle casing – 17. Bearing shaft – 18. Braking unit – 19. Phonic wheel – 20. Oil cup – 21. Supporting ring – 22. Seal ring – 23. Seal ring – 24. Bearing – 25. Wheel hub – 26. Bearing – 27. Bolt

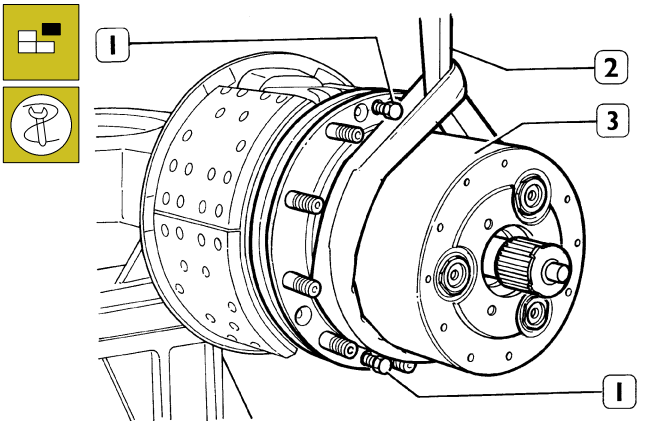
Figure 10



40338

Using a socket wrench (2) unscrew the two drum retaining screws (1); replace them with counteracting screws (5), tighten to remove the drum (4) from the hub, then take it away with a rope (3) and lifting equipment.

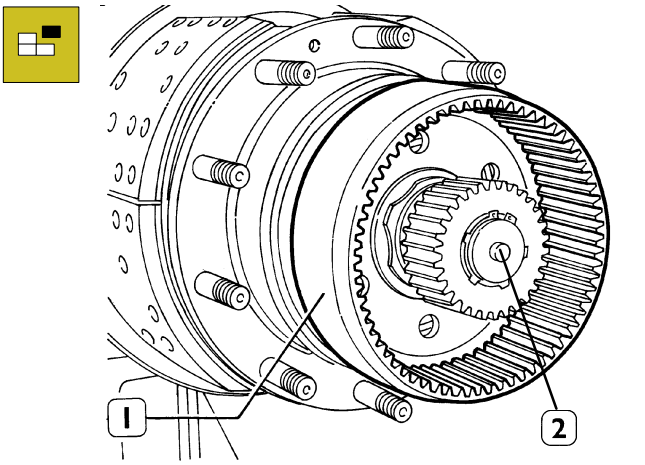
Figure 11



40054

Remove the 3 retaining screws from the planetary gear support (3); insert the counteracting screws (1) and using a rope (2) remove the support (3)

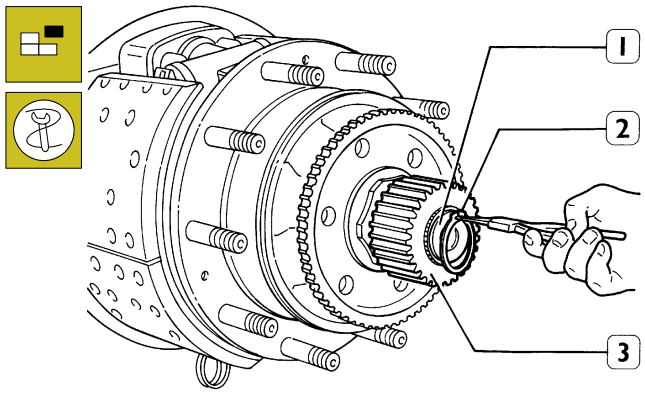
Figure 12



40055

Withdraw the crown wheel (1) from the crown wheel carrier. Take out the shoulder pin (2)

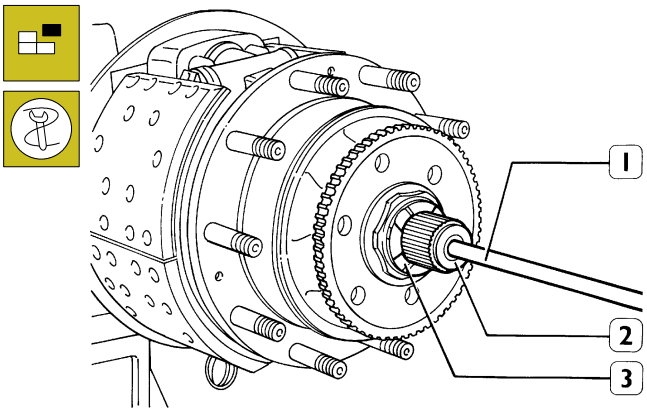
Figure 13



39635

Use appropriate pliers to remove the circlip (2) withdraw the planetary gear (3) from the half-shaft (1).

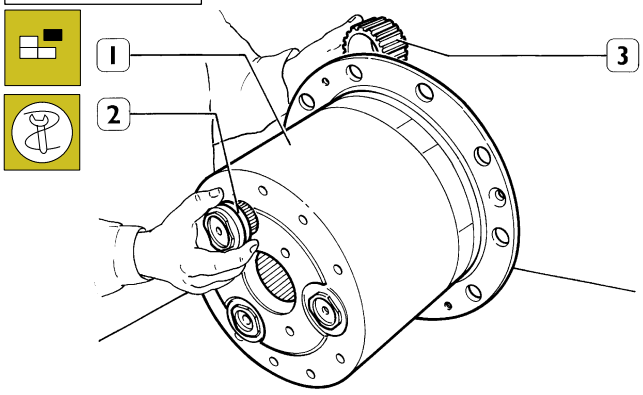
Figure 14



39636

Screw tool 9937445 (1) into the shoulder pin seat and remove the half shaft (2) from the bearing shaft.
Remove the spacer ring (3)

Figure 15

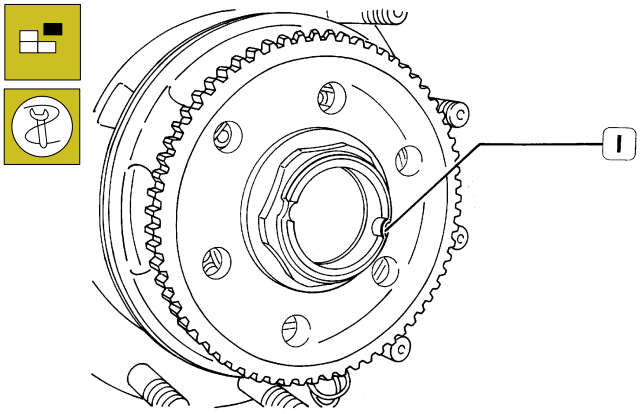


40056

Remove the pins (2) from the planetary gear support (1). Remove the planetary gears (3) from the support (1) and set aside the needles and spacer rings.

Removing the wheel hubs

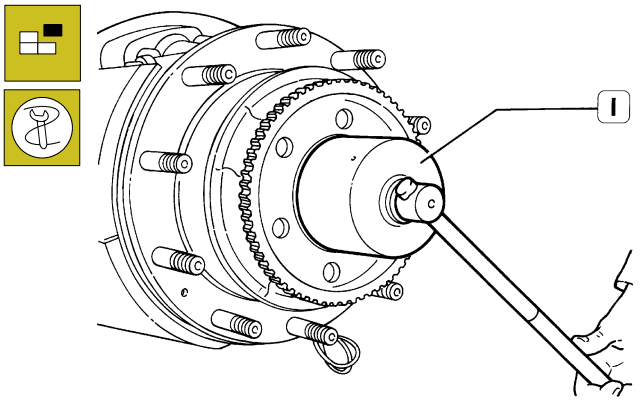
Figure 16



39637

Using a suitable punch straighten the dents (1) on the adjusting nut.

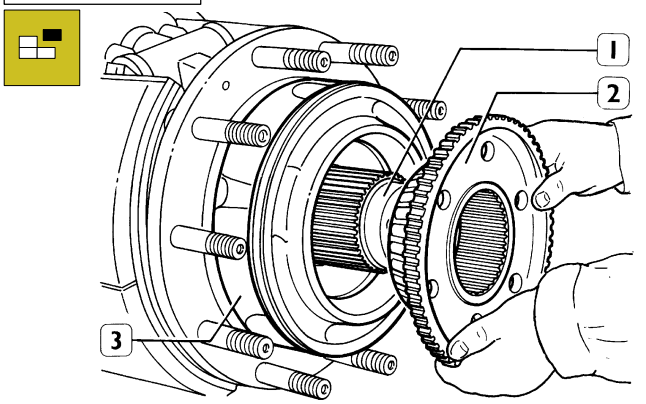
Figure 17



39638

Using socket wrench 99354207 (1) unscrew the adjusting nut.

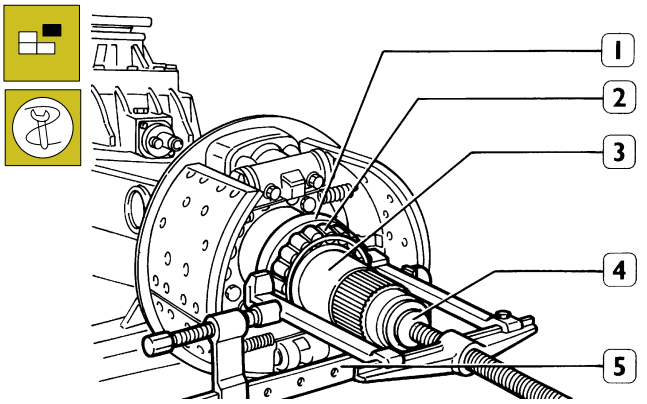
Figure 18



39639

Withdraw the bearing shaft (1), the crown wheel carrier (2) with the relevant bearing and complete wheel hub (3)

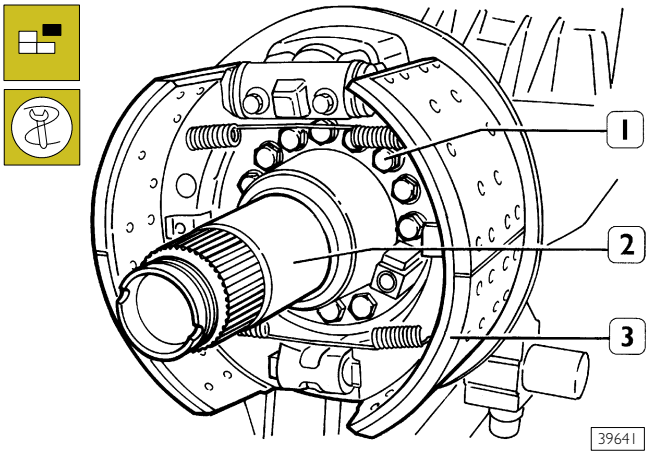
Figure 19



39640

Using a puller, clamp (5) and counter block 99345055 (4), remove the gasket ring (1) and taper roller bearing (2) from the bearing shaft (3).

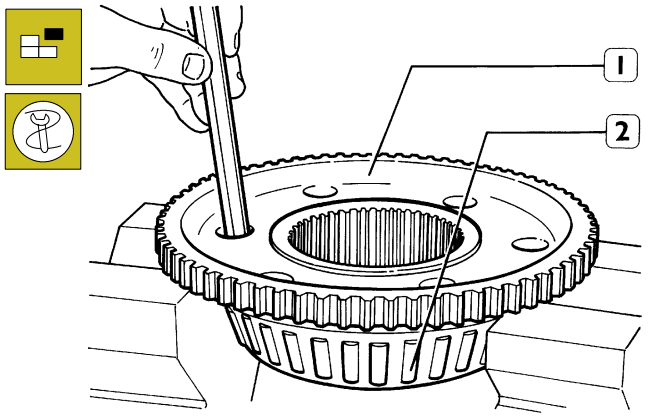
Figure 20



39641

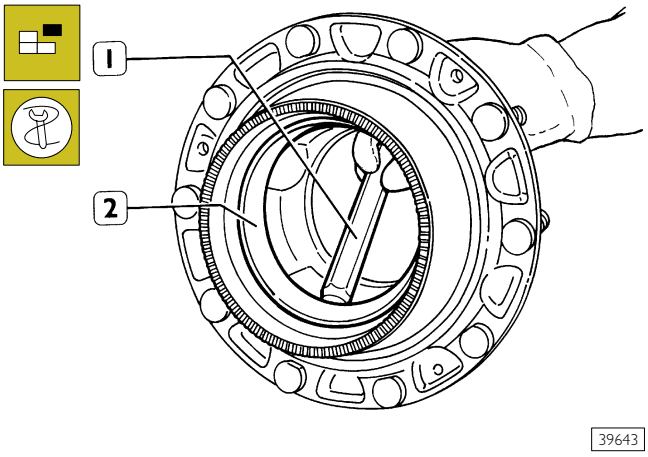
Check the bearing shaft (2) and if it is damaged, replace it. Using tool 99372217, release the brake shoes (3) and after unscrewing the hexagonal screws (1) locked with LOCTITE, remove the brake carrier plate with the bearing shaft.

Figure 21



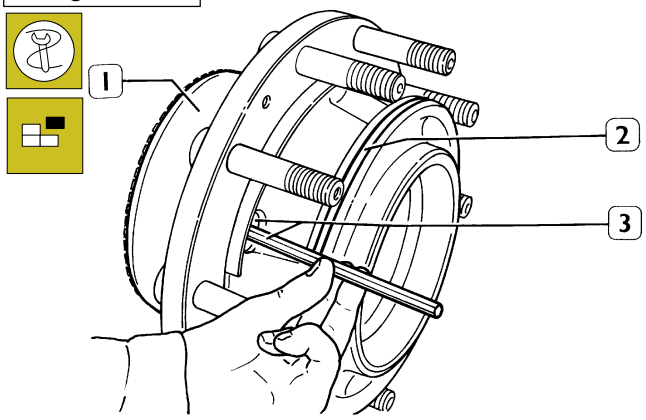
With a suitable beater fitted in the holes on the crown wheel carrier, remove the outer taper roller bearing (2) from the crown wheel carrier (1).

Figure 22



Use a bronze beater (1) to drive out the inner bearing outer ring (2).
The seal ring will come away with it.
In the same way extract the outer bearing outer ring. If necessary remove the phonic wheel.

Figure 23



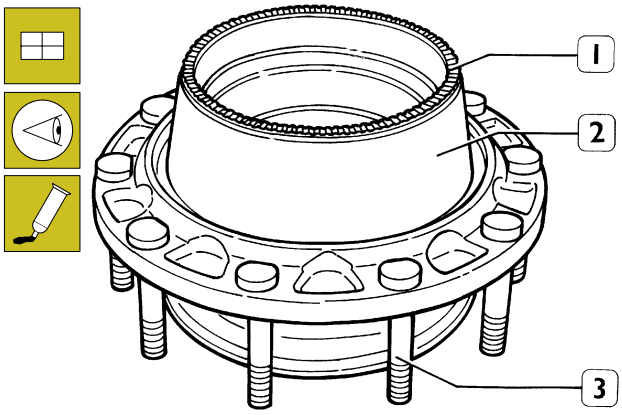
Check the oil manifold (1) and if it is damaged, replace it. To do this, extract it with a suitable beater inserted through the hub slots (3). Remove the shaped seal ring (2).

WHEEL HUBS AND EPICYCLIC REDUCTION GEAR COMPONENTS CHECK

Carefully clean the wheel hub components. Check the half shafts to ensure they are not strained. If necessary straighten the half shafts under a hydraulic press. If the results obtained are not satisfactory, replace the half-shafts. Check the wheel bolts, if the threads are strained or damaged, replace them under the press. After fitting in place check that the orthogonality error does not exceed 0.3 mm.
Lubricate the bearings and turn the roller cage freely; the rotation must be even with no signs of stiffness.
Check the threads on the bearing adjustment nut and the bearing shafts; if necessary replace the nuts.
Check the oil manifold, if it is damaged replace it.
All seal elements must be replaced with new ones.
Carefully clean all the epicyclic gear components.
Visually check the teeth of the crown wheel carrier, the crown wheel, the planetary wheels and planetary gear.
Check the spacer rings, bearing needles and support pins.
Replace any worn or damaged parts.

Fitting in place the wheel hubs

Figure 24



39645

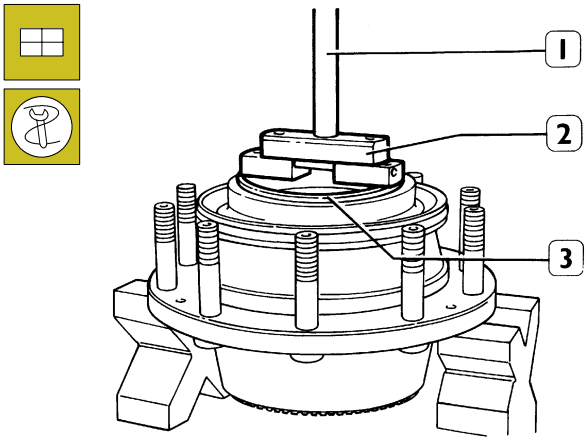
If the bolts (3) require replacement, before fitting in place the new bolts make sure that the contact surface of the bolt head is free of swarf, burrs and dents.

After the bolts have been driven in, check that they are perfectly flush on the hub and that the orthogonality error does not exceed 0.3 mm.

If it is necessary to replace the oil cup (2) before fitting in place the new one, spread LOCTITE 573 sealant on the hub to cup coupling surfaces and on the cup housing on the hub.

Re-fit in place the phonic wheel (1) making sure, after fitting, that the phonic wheel rests perfectly on the hub seat.
Use a dial gauge to check that the phonic wheel orthogonality error is not over 0.2mm.

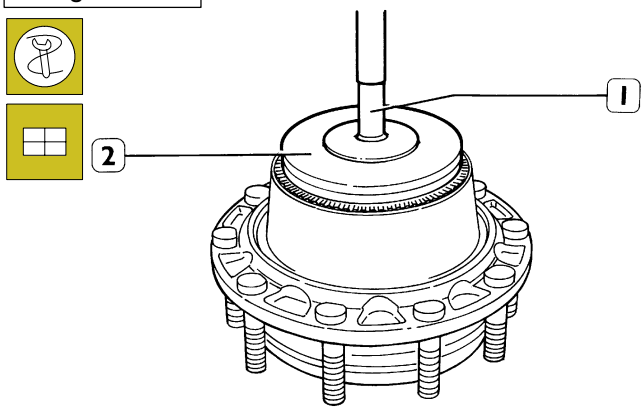
Figure 25



39646

Use beater 99374093 (2) to drive in the outer bearing outer ring (3) (under the press) leaving approx 5 mm of the stroke; finish driving in by hand using handle 99370007 (1).

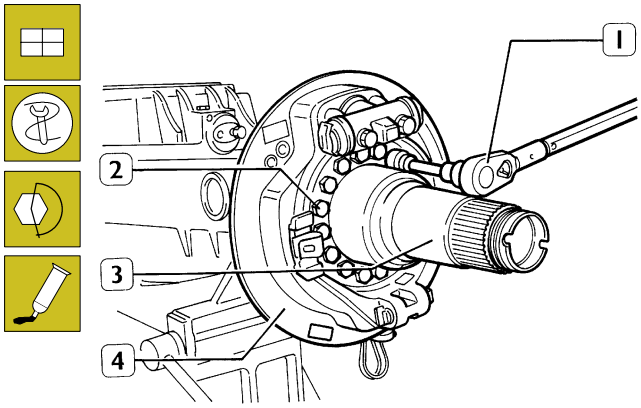
Figure 26



39647

Using tool 99374025 (2) with the relevant intermediate ring and handle 99370005 (1) drive the internal seal ring into its housing. Use the same tool but without the intermediate ring to fit the external seal ring.

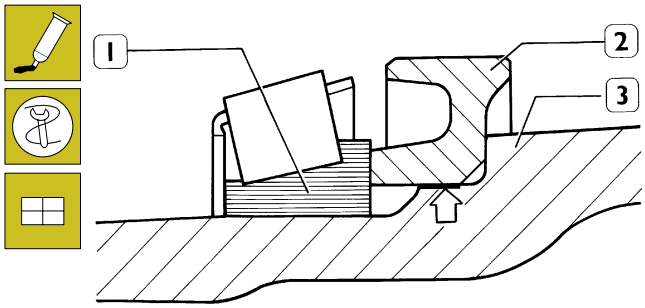
Figure 27



39648

Set the seal ring on the bearing shaft, spread LOCTITE AVX on the contacting areas between the axle housing and bearing shaft. Fit in place the bearing shaft (3) with the brake carrier plate (4) and dust guard disk. Apply LOCTITE AVX to the screws (2) then lock them with a dynamometric wrench (1) to a torque of 280 ± 15 Nm.

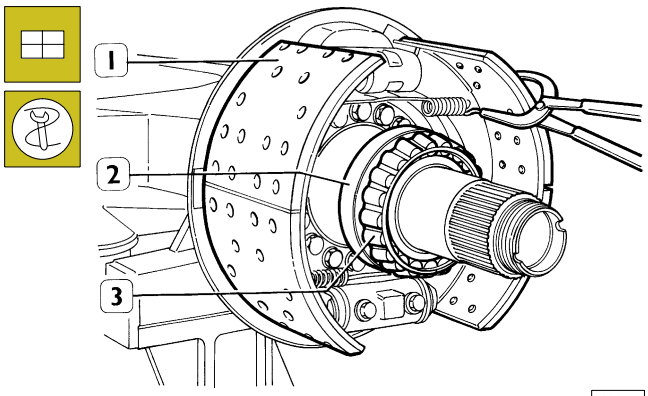
Figure 28



40375

Spread Hylomar SQ32IM sealant on the bearing shaft (3) ring (2) housing (⇒) for the seal rings. Heat the ring (2) and fit it on the bearing shaft (3). Heat the taper roller bearing inner ring (1) to approx 100°C and fit it on the bearing shaft.

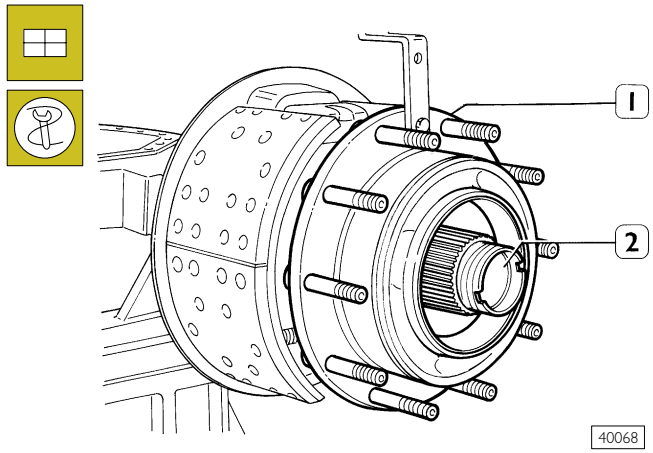
Figure 29



40067

Re-fit in place the brake shoe (1) using tool 99372217.

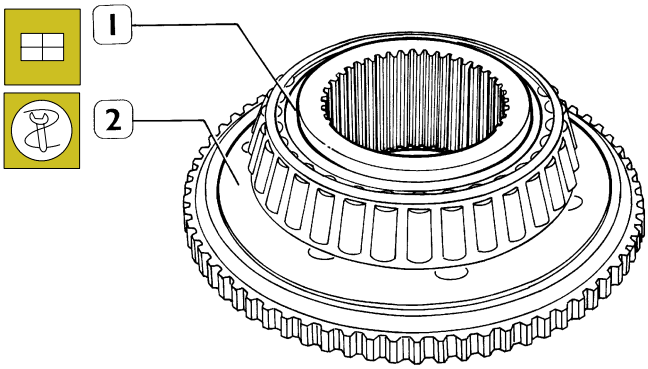
Figure 30



40068

Using the suitable tool set the complete hub (1) on the bearing shaft (2)

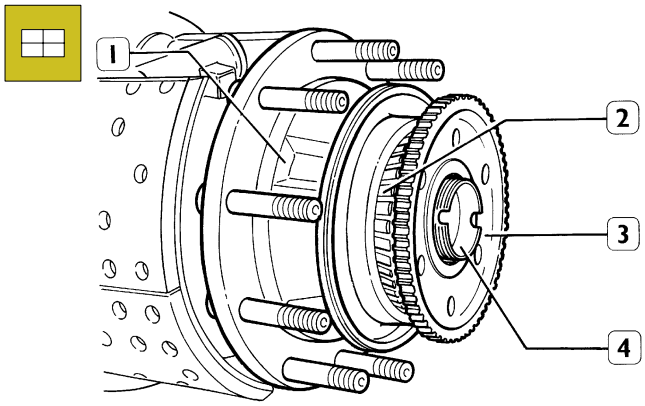
Figure 31



40377

Heat the taper roller bearing (1) to approx 100°C and with a suitable beater drive it into its seat on the crown wheel carrier (2).

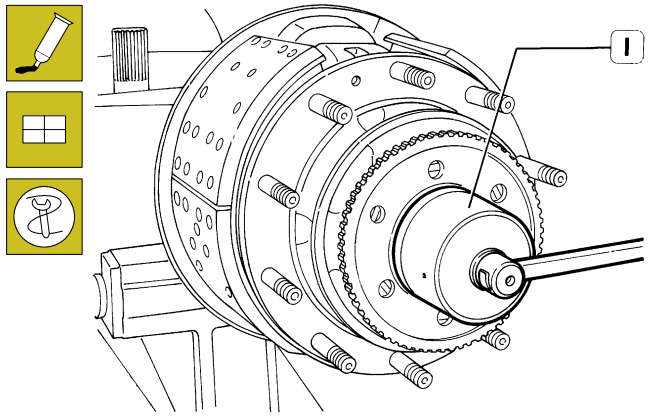
Figure 32



39650

Connect the crown wheel carrier (3) with its relevant taper roller bearing (2) onto the bearing shaft (4).

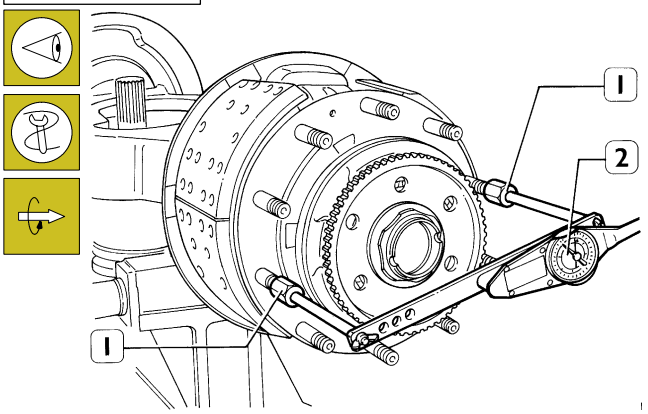
Figure 33



40070

Apply a thin coating of Molycote on the adjusting nut contact surface, screw, then tighten with wrench 99354207 (1) until it becomes difficult to turn the hub. Release the hub by axially hammering it in both directions.

Figure 34



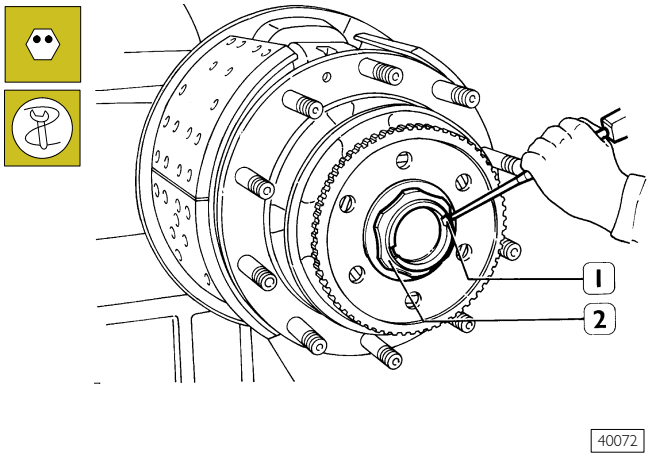
Set up tool (1) 99395026 and with a torque wrench (2) find the wheel hub rolling torque.

When finding the hub rolling torque the hub rotation must not exceed 40 r.p.m.

The hub rolling torque values vary according to the following conditions:

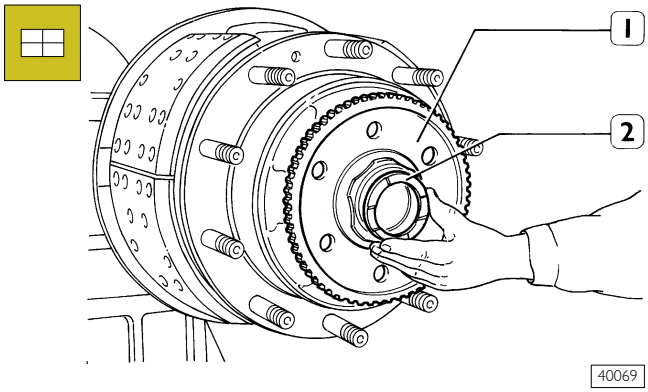
- ❑ new bearings with surface protection 3 + (12 ÷ 16) Nm
- ❑ run-in bearings and new lubricated seal rings 3 + (5 ÷ 7) Nm
- ❑ run-in bearings and seal rings 3 + (2.5 ÷ 4.5) Nm

Figure 35



Having obtained the prescribed rolling torque, use a suitable punch to dent the adjusting nut (2) in the two specific grooves on the bearing shaft (1).

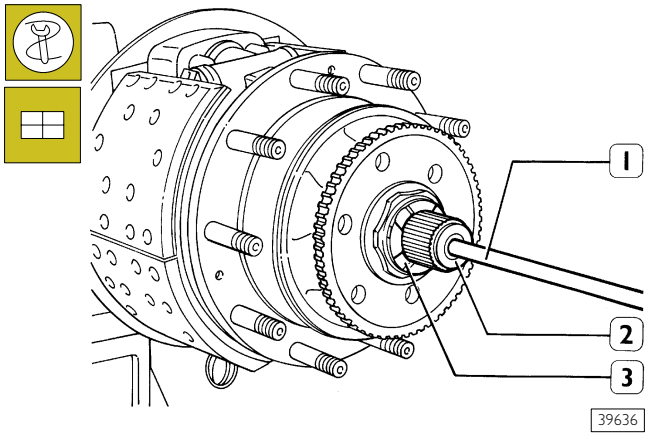
Figure 36



Fit the spacer ring (2) in the bearing shaft.

Fitting in place the epicyclic reduction unit

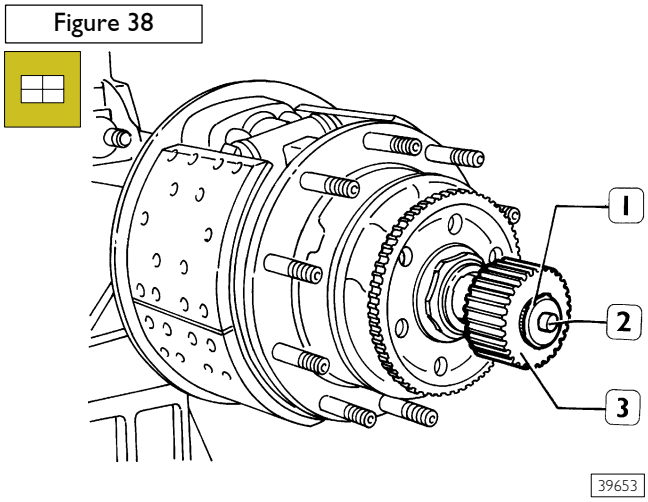
Figure 37



Use tool 99374451 (1) to insert the half shaft (2) into the bearing shaft (3)

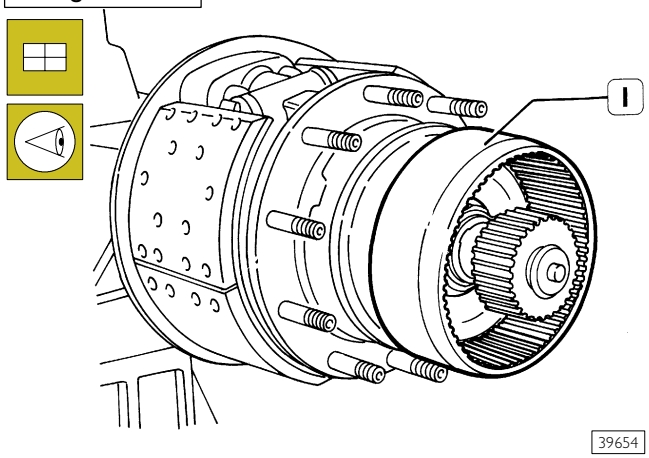
The double toothed short half shaft is to be fitted in the bearing shaft on the differential locking side.

Figure 38



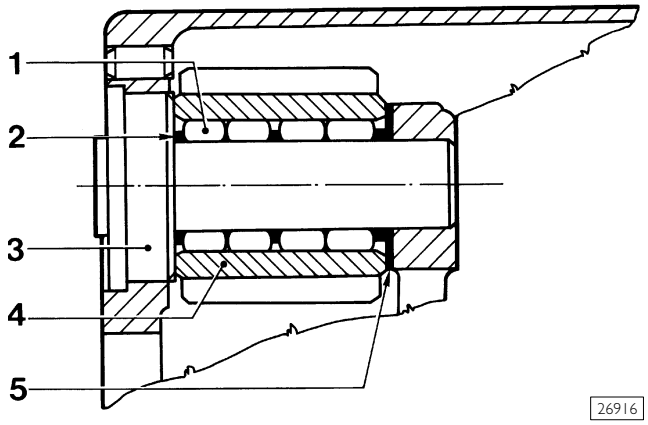
Place the planetary gear (3) on the splined section of the half shaft and the circlip (1) in its seat. Force the shoulder pin into its seat in the half shaft.

Figure 39



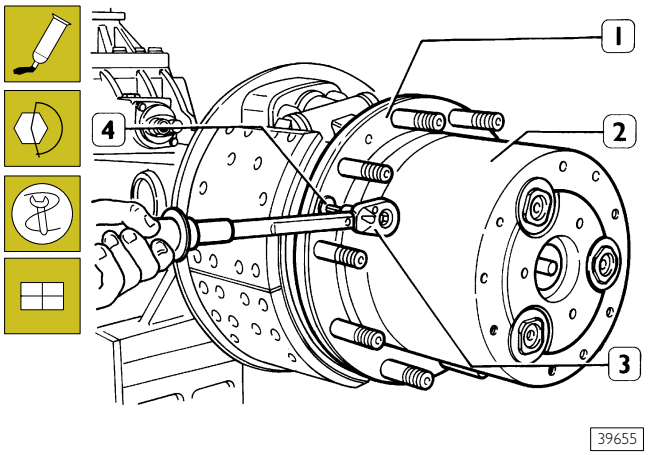
Position the crown wheel (1) with the chamfer directed outwards, then place it on the crown wheel carrier.

Figure 40



Grease the needles (1) arrange them with three spacer rings (2) in the planetary gear (4) as shown in the figure.
Insert the planetary gear (4) and spacer washer (5) in the planetary gear carrier support.
Insert the pin (3) from the cover side pushing it down to the bottom of its seat.
Repeat the same operation for the other two planetary gears.

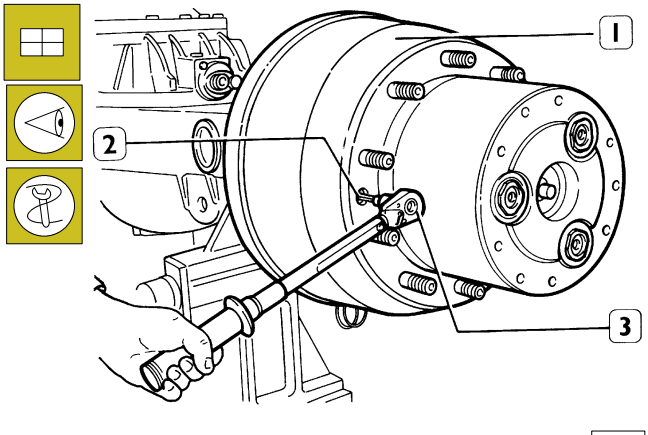
Figure 41



Spread a thin coating of Hylomar SQ 321 M or Reinzoplast sealant on the contact surfaces of the planetary gear support (2) and the wheel hub (1)

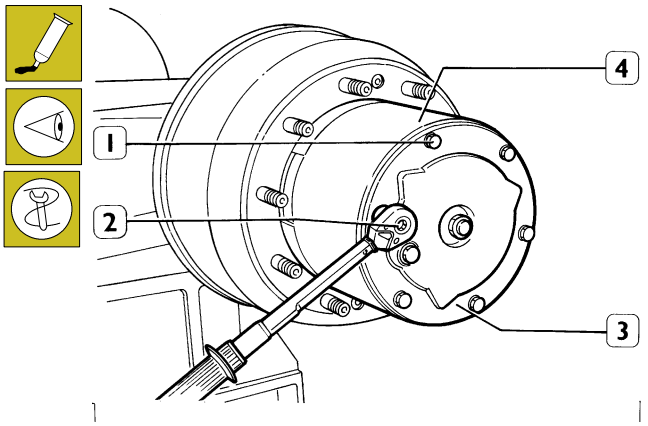
Push the planetary gear support (2) onto the hub, for easier tooth meshing, move the coupling flange alternately in the two directions. Take care that the holes to fasten the planetary gear support to the hub coincide.
Insert the three flathead screws(4) and tighten them with a dynamometric wrench (3) to the torque of 25 ± 3 Nm.

Figure 42



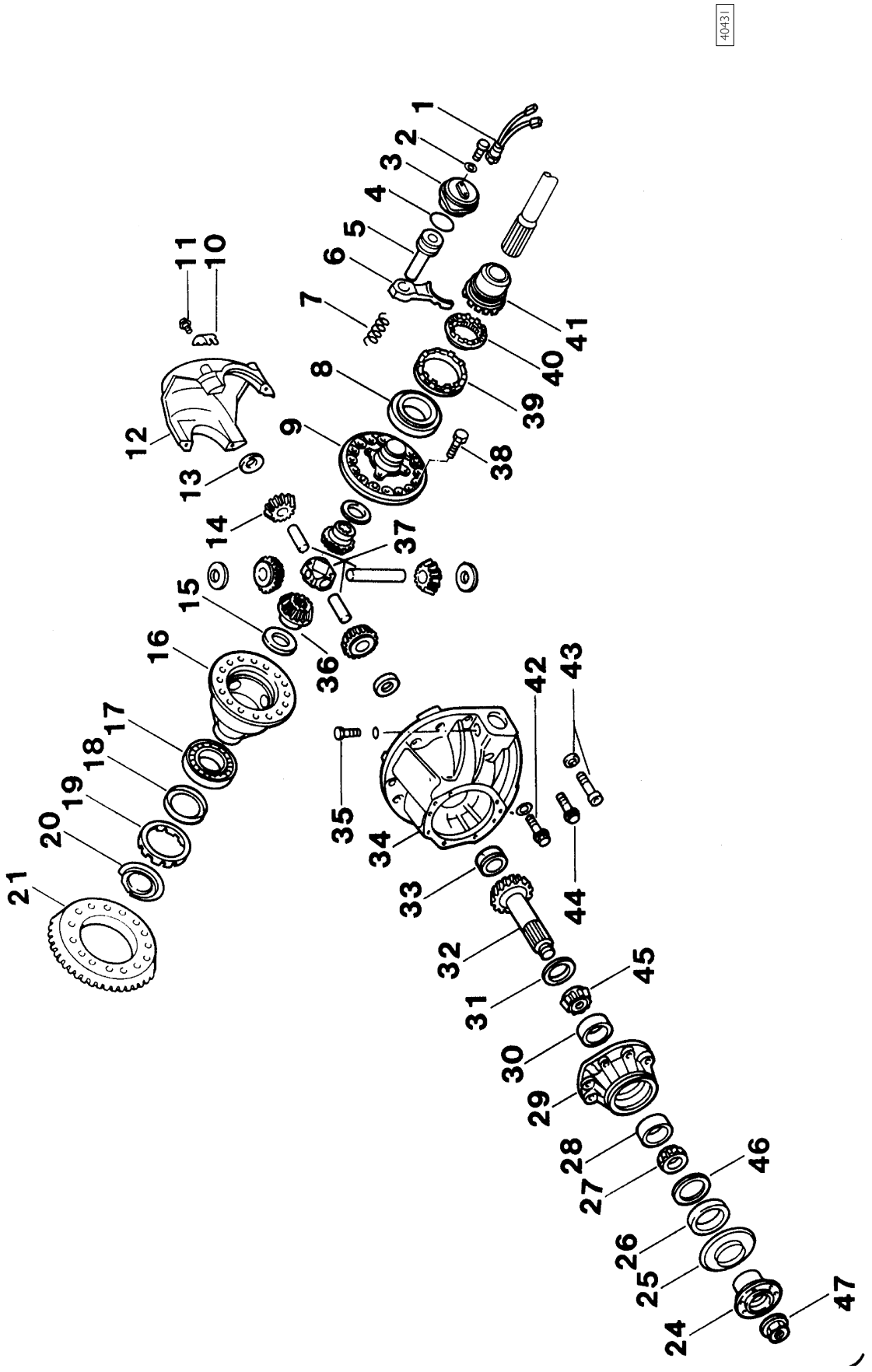
Fit the brake drum (1) onto the planetary gear support. Fasten the brake drum with the two flathead screws (2) tightening them with dynamometric wrench (3) to the torque of 25 ± 3 Nm.

Figure 43



Spread a thin coating of Hylomar SQ 321 M sealant on the contact surfaces of the cover (3) and the planetary gear support (4).
Position the cover so that the pin chamfers coincide with the notches in the cover.
Spread sealant paste on the threads of the screws (1) and with dynamometric wrench (2) tighten to a torque of 50 ± 5 Nm.

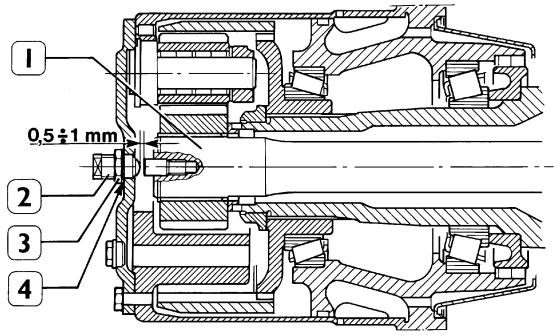
Figure 44



DIFFERENTIAL UNIT COMPONENTS

1. Electric transmitter - 2. Seal and union ring - 3. Cover - 4. Seal ring - 5. Piston - 6. Fork - 7. Spring - 8. Bearing - 9. Cover - 10. Plate - 11. Screw - 12. Cover - 13. Washer - 15. Shoulder washer - 16. Half-box - 17. Bearing - 18. Ring - 19. Ring nut - 20. Oil baffle - 21. Crown wheel - 22. Seal ring - 23. Differential unit - 24. Flange - 25. Dust guard - 26. Seal ring - 27. 28. Bearing - 29. Pinion support - 30. 45. Bearing - 31. Adjusting ring - 32. Pinion - 33. Bearing - 34. Box - 35. Screw - 36. Crown Wheel - 37. Pins and spider - 38. Screw - 39. Ring nut - 40. Sleeve - 41. Sliding sleeve - 42. Screw - 43. Screw - 44. Screw - 46. Ring - 47. Nut

Figure 45



26924

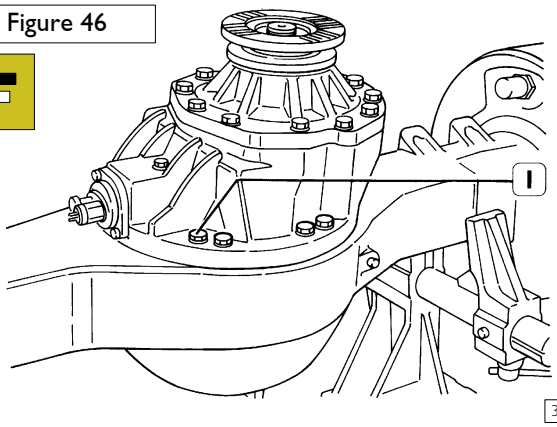
The half shaft (1) end play is to be between 0.5 and 1 mm. To obtain this, tighten the adjusting screw (2) to its stop, then come back by half a turn and lock it with the hexagonal nut (3).

The flat surface of the hexagonal nut should be directed towards the seal ring (4).

REMOVAL AND RE-FITTING IN PLACE THE DIFFERENTIAL

Removal

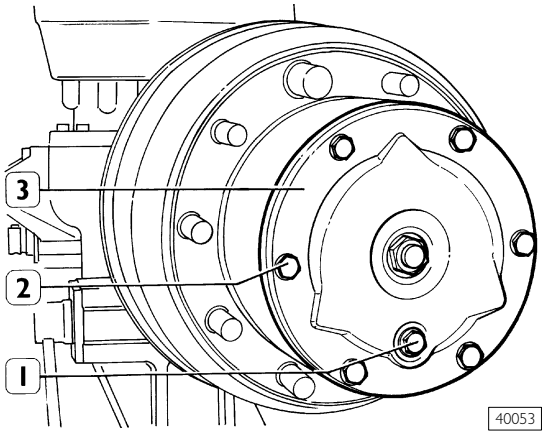
Figure 46



39658

Remove the screws (1) fastening the differential housing to the axle casing. Remove the cap screws and hexagonal socket

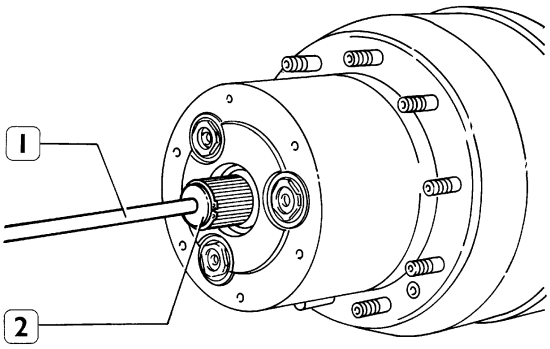
Figure 47



40053

Screw on the oil intake cap (1). Move one of the cover (3) hex screws (2) to a low position and unscrew it. Drain the oil from the epicyclic gears on the wheels.

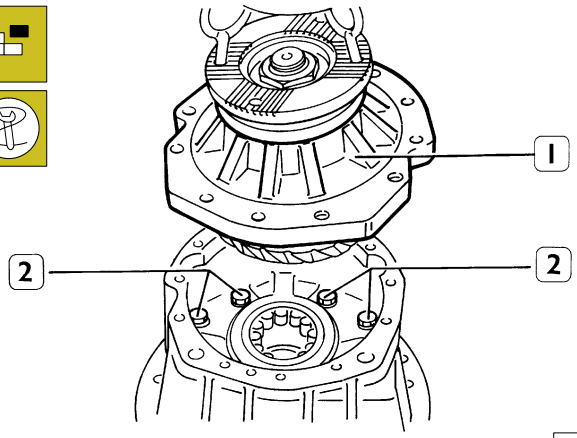
Figure 50



39659

Fit tool 9937445 (1) into the shoulder pin seat threads and withdraw the half-shaft (2) from the bearing shaft

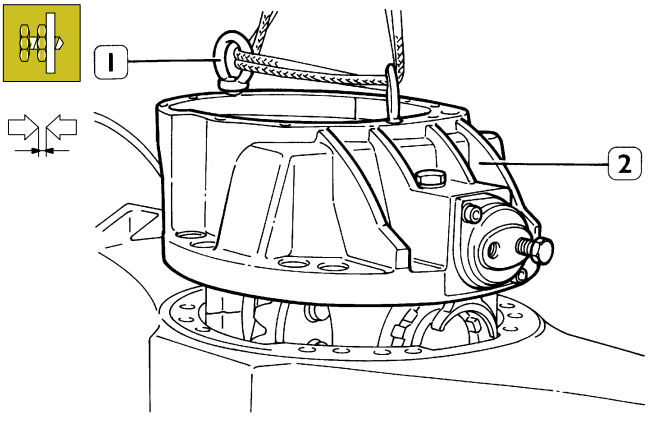
Figure 49



39660

Using the specific eye hooks and a rope, lift the pinion support (1) and remove the four differential housing screws (2).

Figure 48

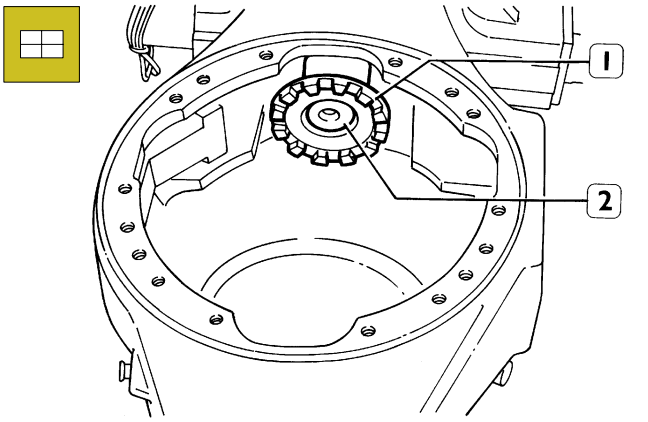


39661

Using the specific eye hooks (1) and a rope, lift the differential housing (2).

Re-fitting

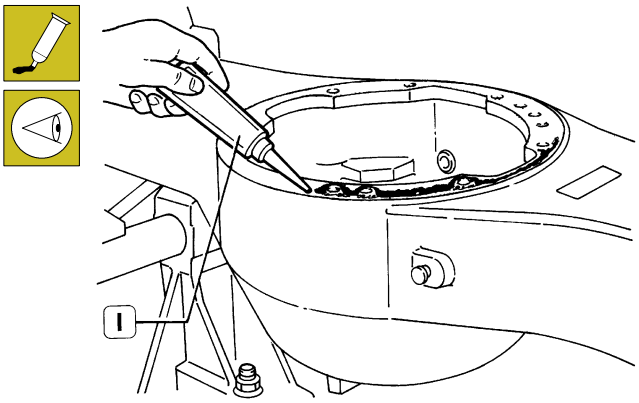
Figure 51



39662

Fit in place the sliding sleeve (1) on the double-tooth half-shaft (2)

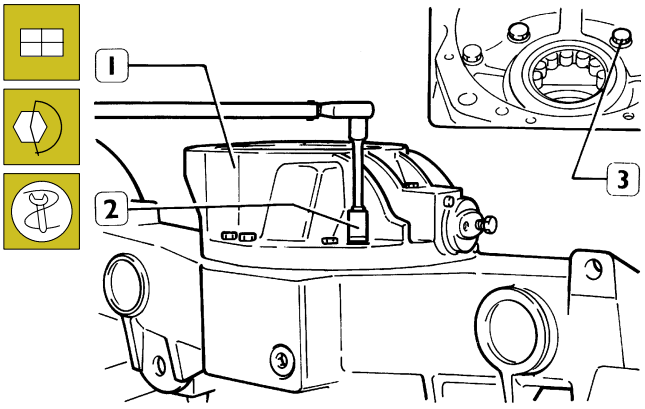
Figure 52



39663

Spread LOCTITE AVX on the contact surface (1). When fitting in place the differential housing it is important to make sure that the differential locking engagement fork is correctly positioned in the sliding sleeve seat.

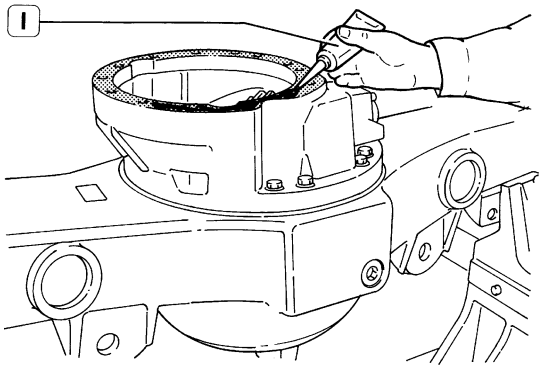
Figure 53



39664

Set the seal ring and fit in place the differential housing (1). Using a dynamometric wrench tighten the external (2) and internal (3) screws to the prescribed torque.

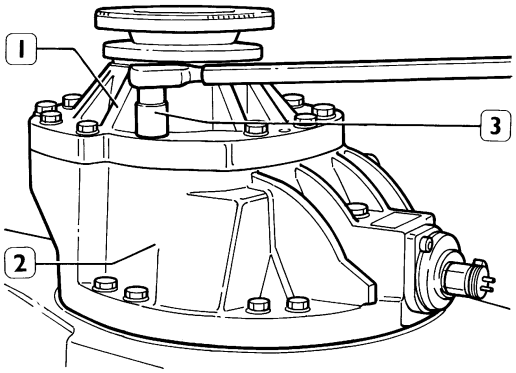
Figure 54



39665

Spread LOCTITE 573 on the contact surface (1)

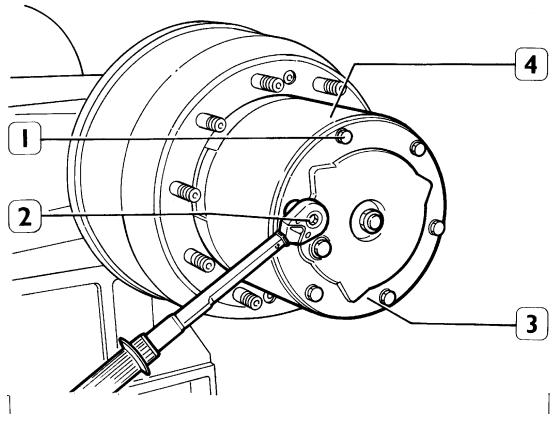
Figure 55



39666

Set the bevel pinion support (1) on the differential housing (2). Use dynamometric wrench (3) to tighten the screws to the prescribed torque.

Figure 56

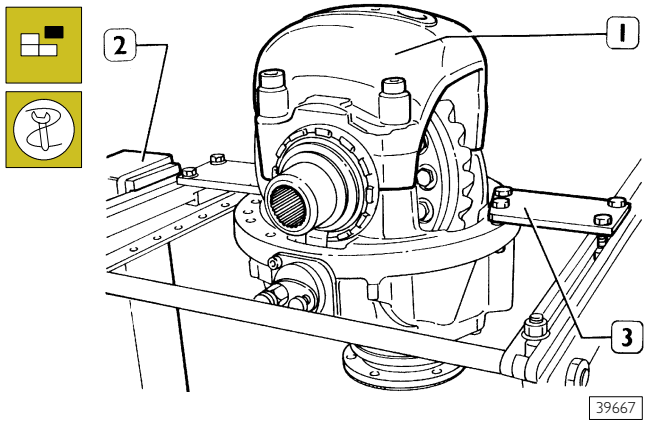


40073

Spread a thin coating of Hylomar SQ 321 M sealant paste on the contact surfaces of the cover (3) and the crown wheel support (4). Position the cover so that the pin chamfers coincide with the notches in the cover.
Spread sealant paste on the screw (1) threads and with a dynamometric wrench (2) tighten to the prescribed torque.

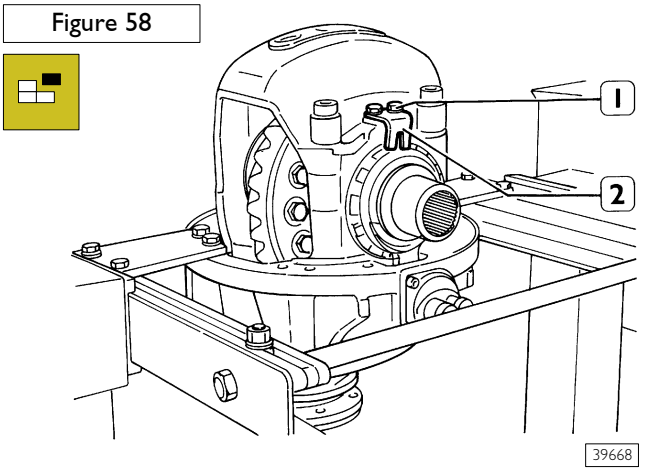
DIFFERENTIAL REPAIR OPERATIONS
Removing the differential housing

Figure 57



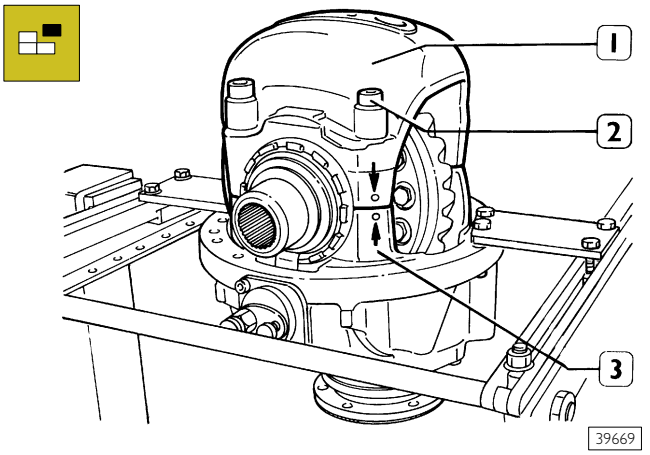
Set the complete differential housing, with the gear housing cover (1) upwards, on rotary stand 99322205 (2) fitted with support 99322228 and pair of brackets 99371022 (3).

Figure 58



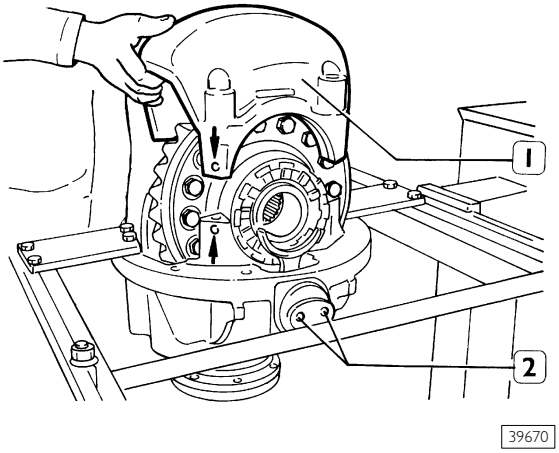
Remove the screws (1) then the safety plate (2). Carry out the same operation on the other side.

Figure 59



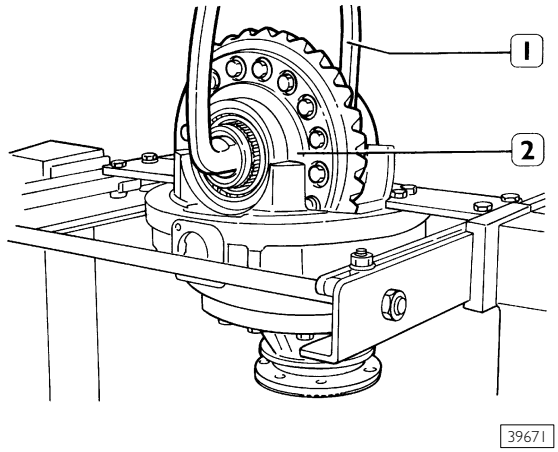
Mark the cover (1) position with reference to the differential housing (3) ⇒ ⇐.
Remove the cover fastening screws (2) (locked with LOCTITE).

Figure 60



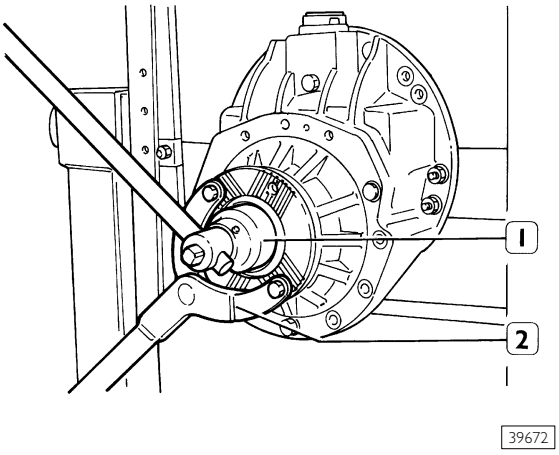
Lift the gear housing cover (1).

Figure 61



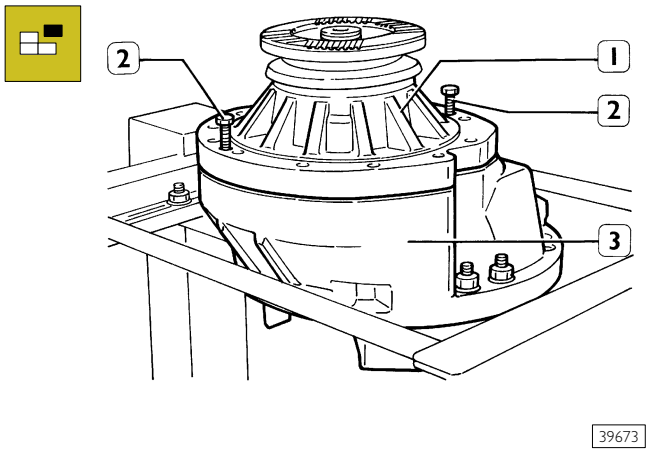
Use hook 99370509 (1) to lift the gear housing (2) with the relevant taper roller bearings and bearing outer rings.

Figure 62



Rotate the differential housing by 90°.
Remove the adjusting nut dent.
Apply the counter lever 993701317 (2) to the coupling flange, with socket wrench 99355081 (1) loosen the lock nut.

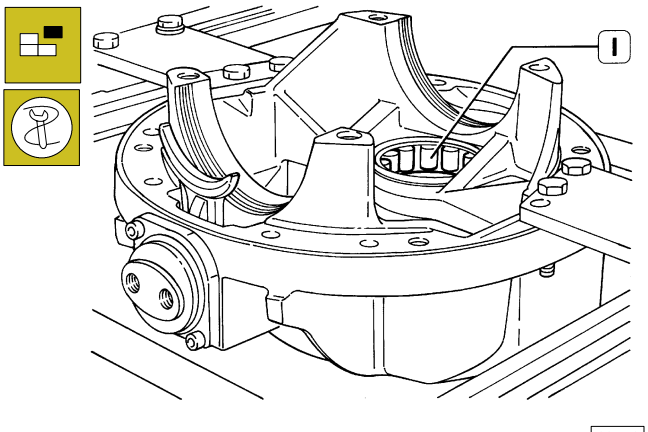
Figure 63



39673

Remove the screws and washers fastening the bevel pinion support (1) to the differential housing (3). Insert the counteracting screws (2) and take out the complete differential housing support.

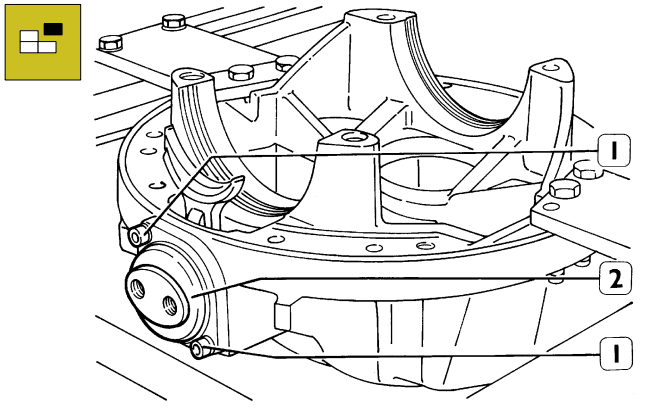
Figure 64



39674

Use a beater to expel the bevel pinion straight roller bearing (1) from its seat in the differential housing.

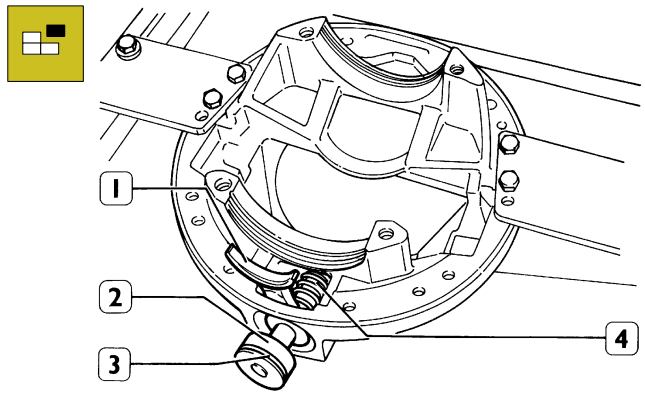
Figure 65



39675

Remove the two hexagonal socket head screws (1) and remove the differential locking device control cylinder (2).

Figure 66

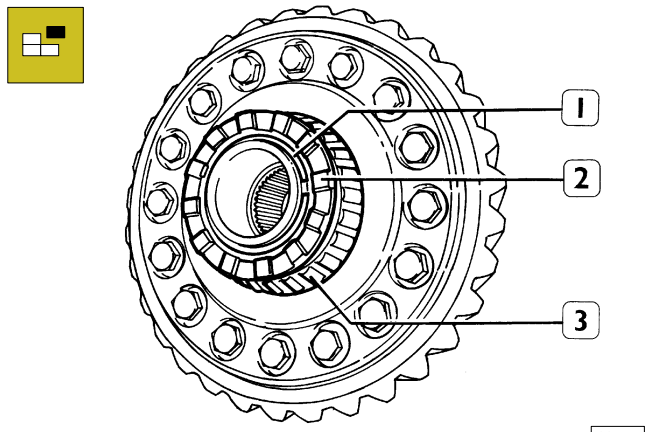


39676

Withdraw the control piston (2) with the seal ring (3), engagement fork (1) and compression spring (4).

Removing the gear housing

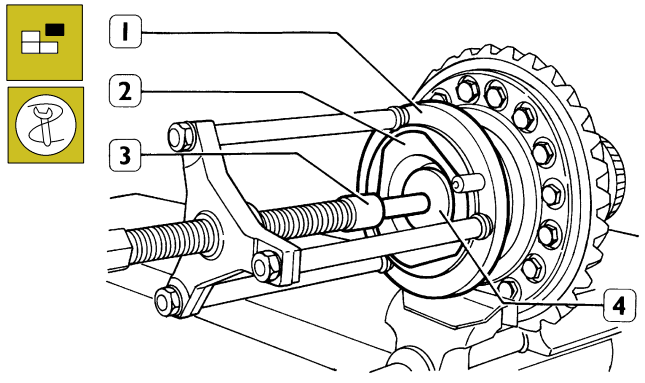
Figure 67



39677

Remove the split ring (1) and take away the differential locking device engagement sleeve (3) from the gear housing cover (2).

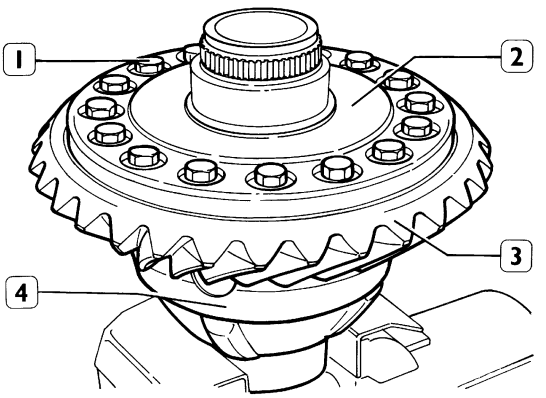
Figure 68



39678

Using puller 99347101 (1) equipped with a pair of gripping rings 99347182 (2), extension bar 99347361 (3) and counter block 99345055 (4), take out the taper roller bearing from the gear housing.
Repeat the same operation on the other side.

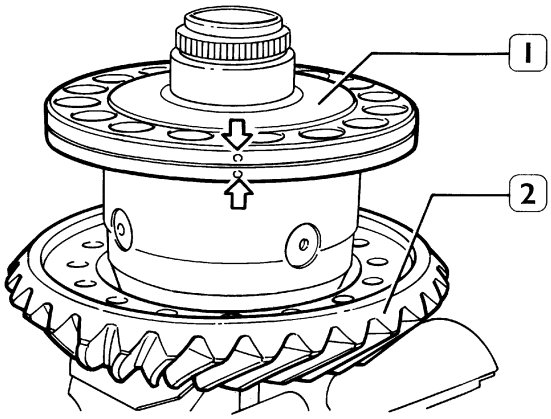
Figure 69



39679

Unscrew and remove the screws (1) that fasten the ring bevel gear (3) and cover (2) to the half-box (4).

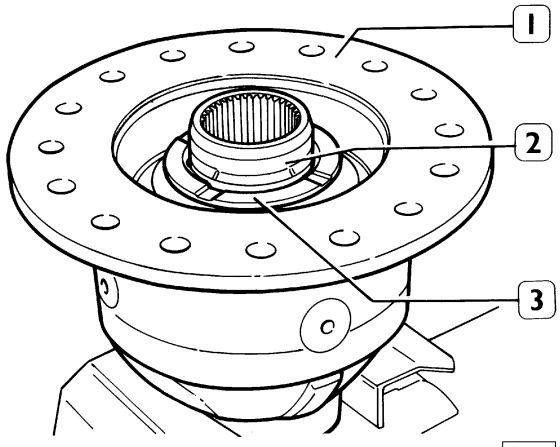
Figure 70



39680

Mark the cover and gear housing (⇒ ⇐).
Remove the gear housing cover (1) and release the ring bevel gear (2)

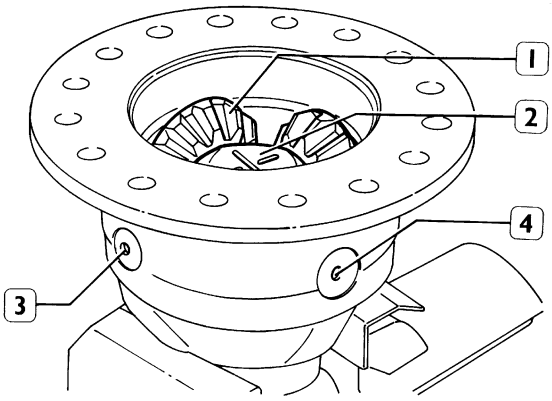
Figure 71



39681

Remove the crown wheel (2) with the relevant shoulder washer (3) from the gear housing (1).

Figure 72



39682

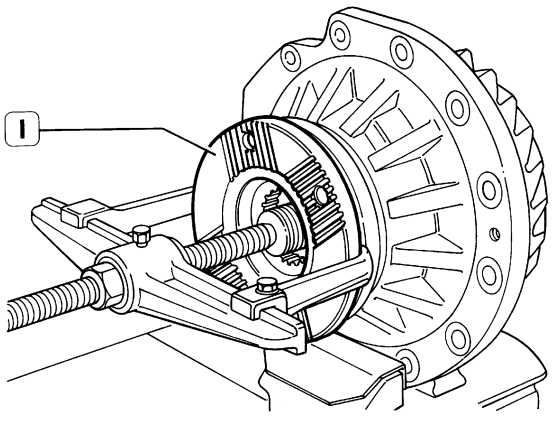
Use a beater to remove the long pin (4) then the two short pins (3).

The exact position of the pins is marked on the spider (2) by a long stripe for the long pin and two short stripes for the short pins.

Remove the spider (2) and 4 planetary gears (1) with the shoulder washers.
Remove the crown wheel and shoulder washer.

Removing the bevel pinion support

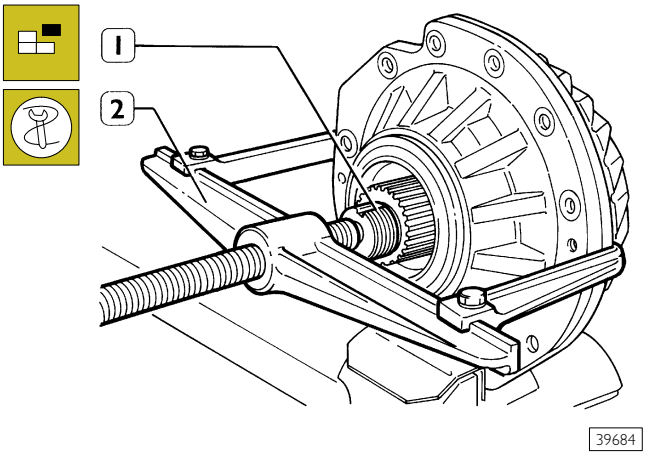
Figure 73



39683

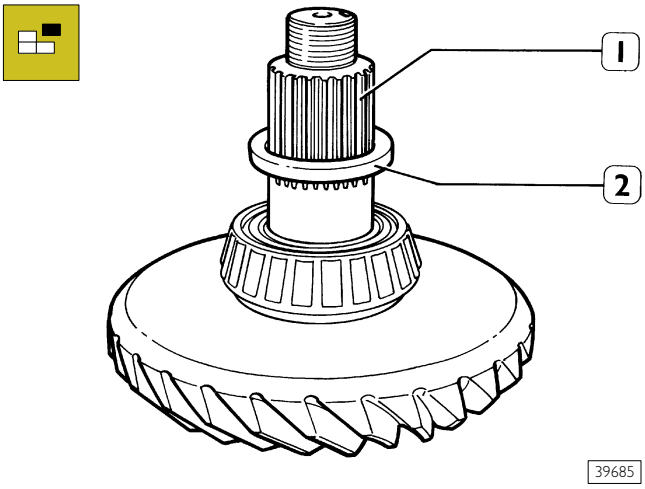
Remove the previously loosened lock nut and the coupling flange (1).
If the flange removal is difficult, use a universal puller.

Figure 74



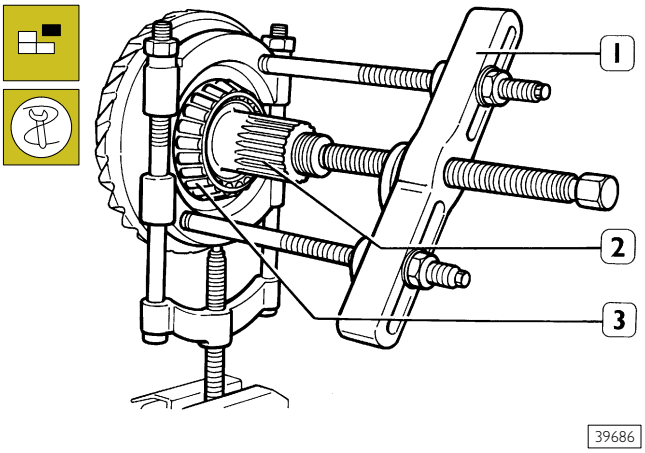
Take out the bevel pinion (1) with intermediate bearing and adjusting ring from the support. It is suggested to use a press for this operation, but if this is not possible, use a puller (2)

Figure 75



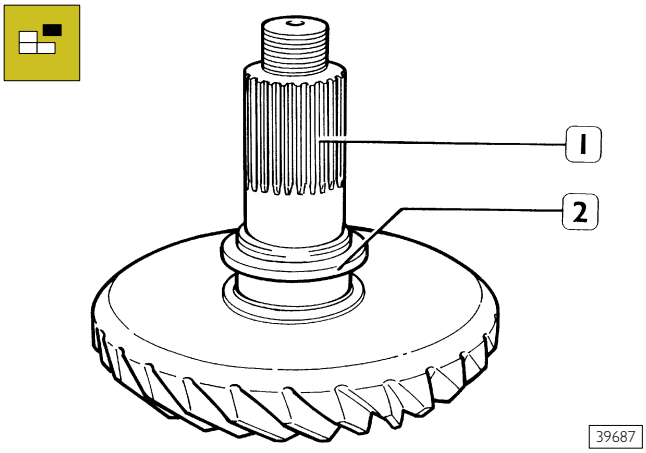
Remove the bearing adjusting nut (2) from the bevel pinion (1).

Figure 76



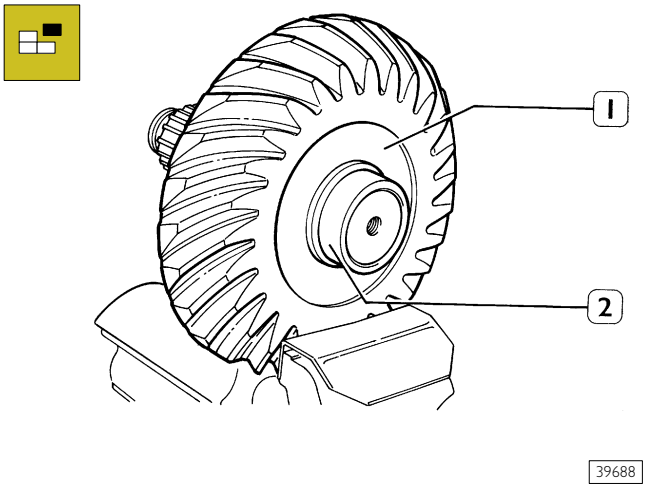
With a universal puller 99348001 (1) remove the intermediate taper roller bearing (3) from the bevel pinion (2).

Figure 77



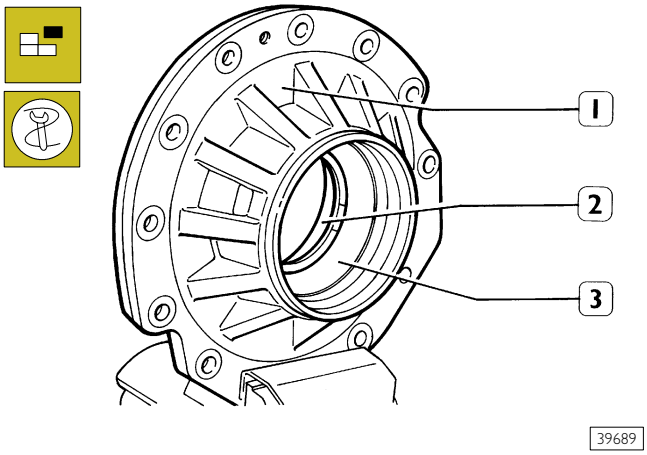
Withdraw the pinion location adjusting ring (2) from the bevel pinion (1)

Figure 78



Remove the rear straight roller bearing inner ring (2) from the bevel pinion (1). This is a destructive operation.

Figure 79



Use a beater to take out the front and intermediate bearings outer rings (3 and 2) from the support (1).

Differential components check

Carefully clean all the differential components.
Lubricate the bearings and rotate the roller cage freely. The rotation must be even and without signs of stiffness.

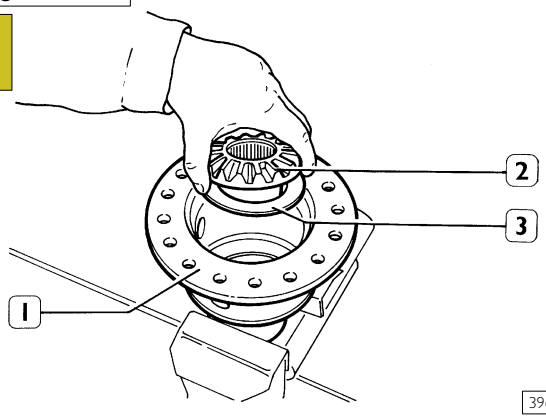
Carefully clean all the threads in order to obtain exact adjustments and accurate driving torques.

Check that the splined section for flange-pinion connection is not badly worn, if it is, replace the pinion.

When replacing the crown wheel or pinion it is necessary to replace both parts since they are supplied in pairs.

Fitting in place the gear housing

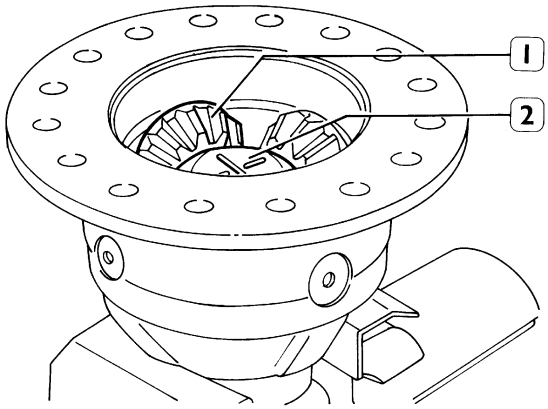
Figure 80



39690

Lock the gear housing (1) in a vice and set the crown wheel (2) with shoulder ring (3) in its housing.

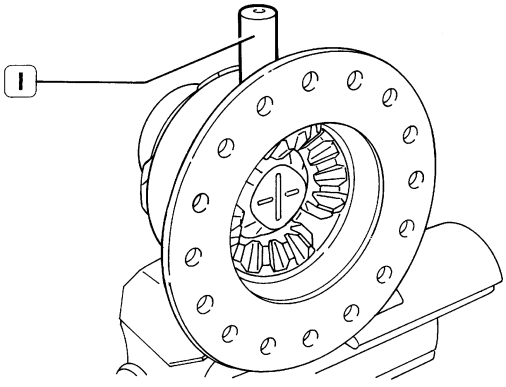
Figure 81



39691

Set the 4 planetary gears (1) with the shoulder washers and fit in the spider (2).

Figure 82

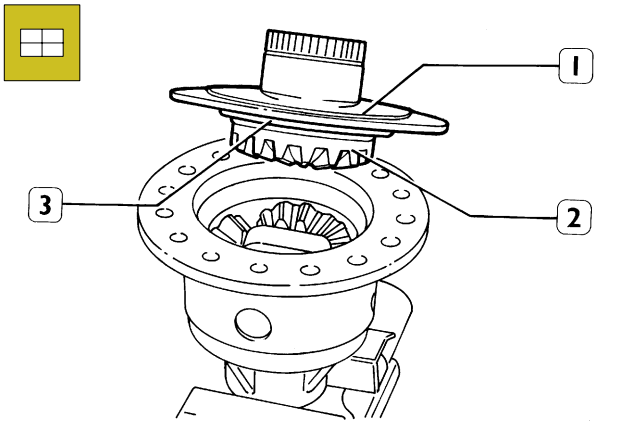


39692

Insert the long pin (1) and two short pins.

The long (through) pin is inserted first.
The exact position of the pins is marked on the spider (2) by a long stripe for the long pin and two short stripes for the short pins.

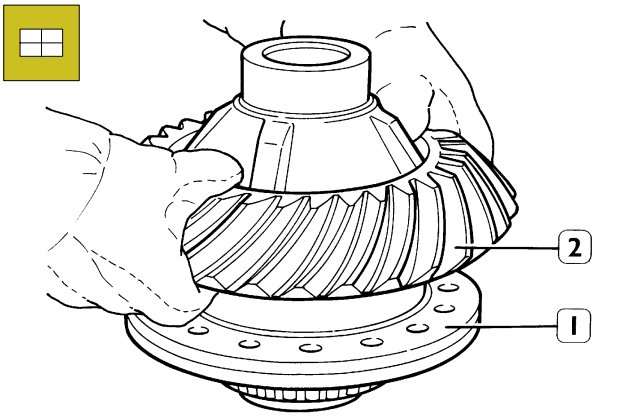
Figure 83



39693

Set the crown wheel (2) with its shoulder washer (3) on the planetary gears.
Fit in place the cover (1) on the housing matching the marking made before removal.

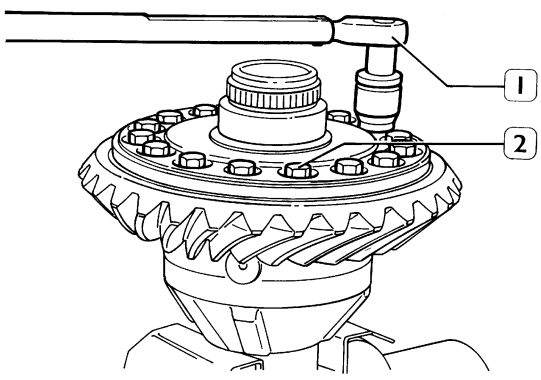
Figure 84



39694

Heat the bevel ring gear (2) to approx. 80°C, fit it in its housing on the gear housing (1) and lock it immediately with two fastening screws.

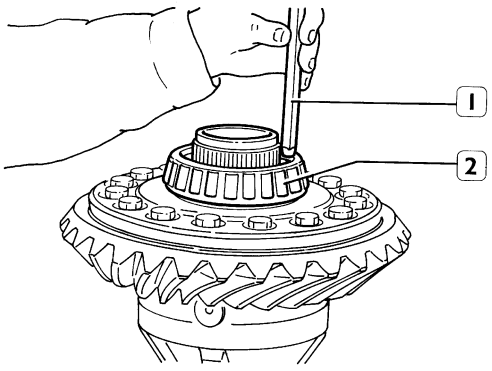
Figure 85



39695

Insert the rest of the fastening screws (2) and with a dynamometric wrench (1) tighten them to a torque of 300 ± 10 Nm (30 ± 1 kgm).

Figure 86

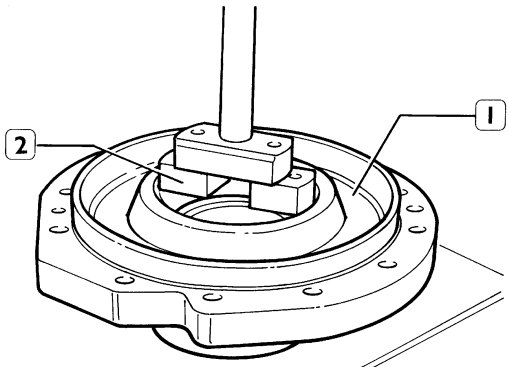


39696

Heat the bearing (2) to a temperature of 100°C for approx. 15 minutes then drive it in the gear housing cover using a suitable beater (1). Repeat this operation on the other side.

Fitting in place the bevel pinion support

Figure 87

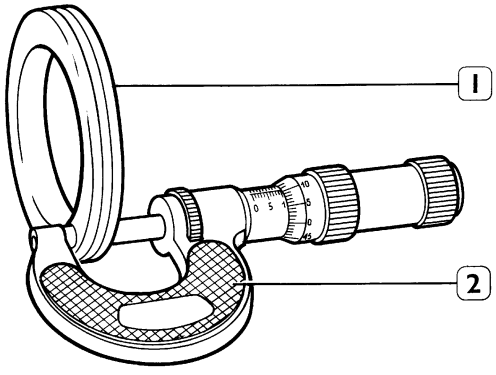


39697

Connect a new oil baffle to the pinion support (1).
Use beater 99374093 (2) to drive the intermediate bearing outer ring and the front bearing outer ring right down into their seats.

Procedure to determine the thickness of the bevel pinion rolling torque adjusting ring

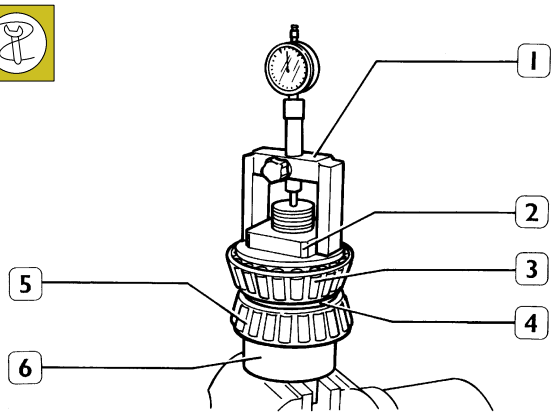
Figure 88



39572

Measure the thickness of the removed adjusting ring (1) and make a note of the value (value A).

Figure 89



39698

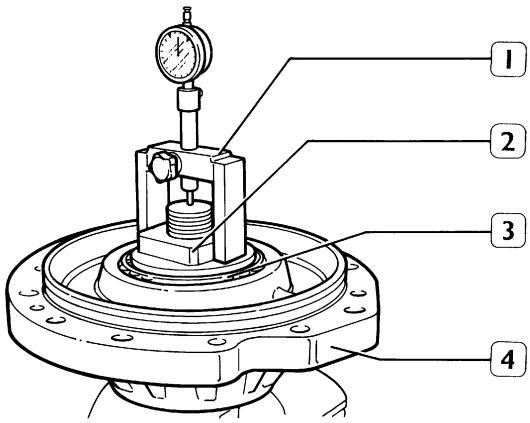
Fit tool 99395027 (6) in a vice and place on it:

- ❑ the pinion side bearing (5)
- ❑ adjusting ring (4), already measured, and bearing (3)

Screw the ring nut (2) and lock it tightly.
Position the dial gauge fitted to element (1) of tool 99395027 (6) on the bearing (3) and set the gauge to zero on the end of the tool (6).
Remove from the tool (6):

- ❑ element (1)
- ❑ ring nut (2)
- ❑ bearing (3)
- ❑ adjusting ring (4)

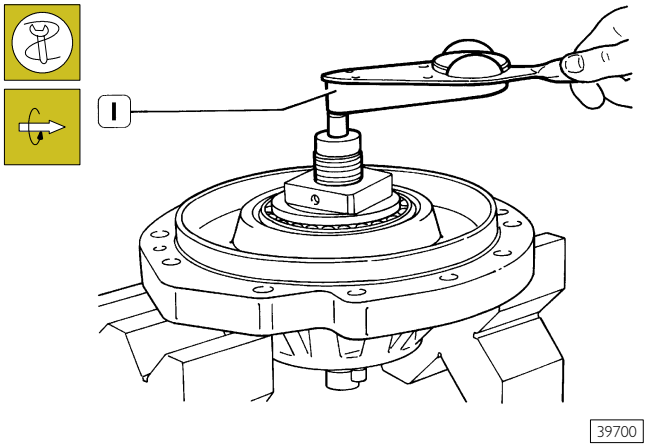
Figure 90



39699

Set the support (4, figure 90) on the bearing (5, figure 89); set bearing (3) on the support.
Manually tighten the ring nut (2) and check the rolling torque as indicated in figure 91.

Figure 91



Set the complete support on 2 parallel bars and with a dynamometric wrench (1) applied on tool 99395027 find the rolling torque which should be 1.5 to 3.5 Nm. If this is not so operate on the ring nut (2, figure 90). Place element (1, figure 89) with the dial gauage set to zero, on the bearing (3) and find the deviation, if any (value B)

Adjusting ring thickness "**S**" is obtained through the following formula:

S = A - (B) + C

where:

A = Thickness of adjusting ring fitted to set the dial gauage to zero;

B = Deviation value found;

C = 0.05 mm coefficient that takes into account the bearings dilation cause by assembling interference on the bevel pinion;

First example

A = 13.12 mm
B = + 0.13 mm
C = 0.05 mm

S = 13.12 - (+ 0.13) + 0.05 =
S = 13.12 - 0.13 + 0.05 = 13.04 mm.

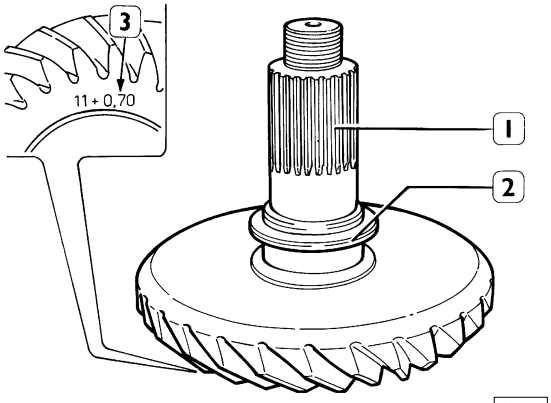
Second example

A = 13.12 mm
B = - 0.13 mm
C = 0.05 mm

S = 13.12 - (- 0.13) + 0.05 =
S = 13.12 + 0.13 + 0.05 = 13.35 mm.

Remove the elements from tool 9939507.

Figure 92



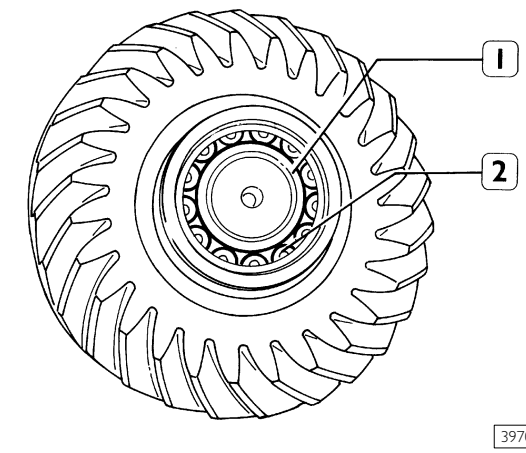
On the bevel pinion (1) fit in place the adjusting ring (2) to set the pinion with reference to the crown wheel and the chamfer directed downwards. The thickness of the adjusting ring depends on the reference value (3) engraved on the bevel pinion.

Figure 93

Value engraved on pinion	Adjusting ring thickness
0	4,6
0,1	4,5
0,2	4,4
0,3	4,3
0,4	4,2
0,5	4,1
0,6	4,0
0,7	3,9
0,8	3,8
0,9	3,7
1,0	3,6

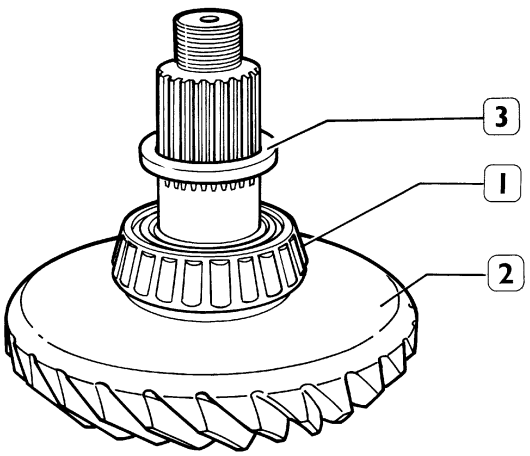
Table to determine the thickness of adjusting rings, bevel pinion position with reference to the crown wheel.

Figure 94



Heat the rear straight roller bearing (2) inner ring (1) to a temperature of 100°C and fit in place on the bevel pinion.

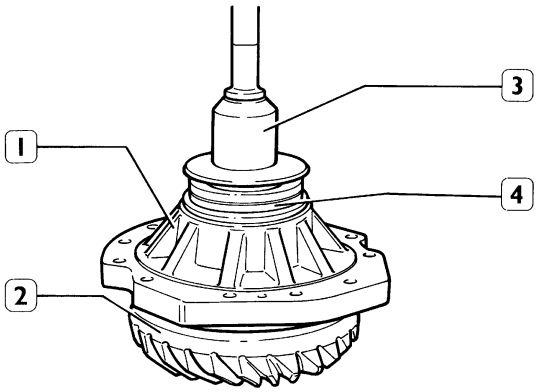
Figure 95



39703

Heat the intermediate bearing (1) to approx. 100°C and fit in place on the bevel pinion (2).
Fit in place the adjusting ring (3) with the proper thickness.

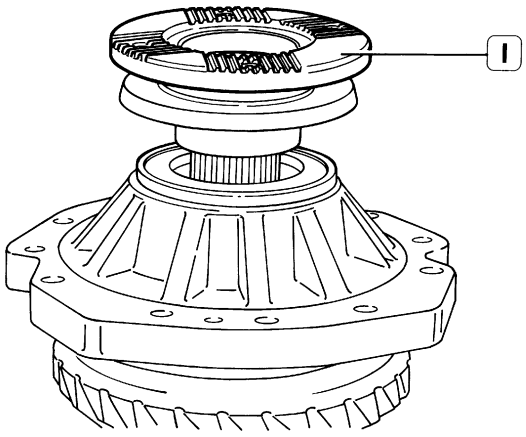
Figure 96



39704

Fit in place the support (1), already assembled, on the bevel pinion (2). Fit in place the front bearing. With a connection device (3) fit in place the oil seal ring (4)

Figure 97

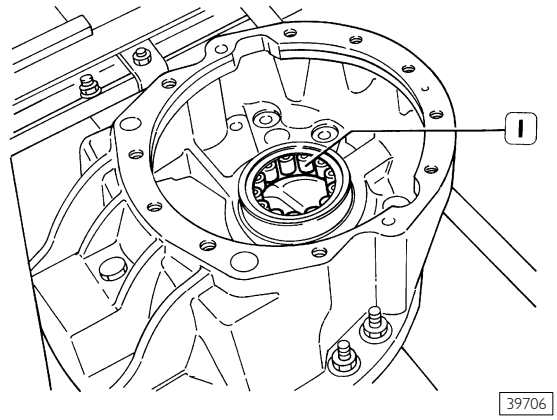


39705

Fit in place the coupling flange (1) using a suitable beater, then manually tighten the lock nut.

Fitting in place the differential housing

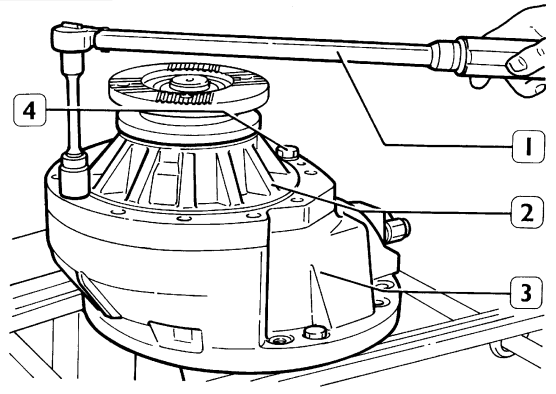
Figure 98



39706

Use a beater to drive the rear straight roller bearing into its seat in the differential housing.

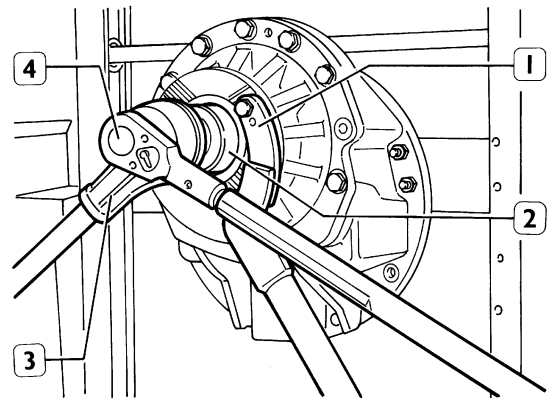
Figure 99



39707

Fit in place on the differential housing (3) the already assembled bevel pinion support (2), insert 2 screws (4) with spring washers in diametrically opposite positions. With a dynamometric wrench (1) tighten them to a torque of 160 ± 10 Nm (16 ± 1 kgm).

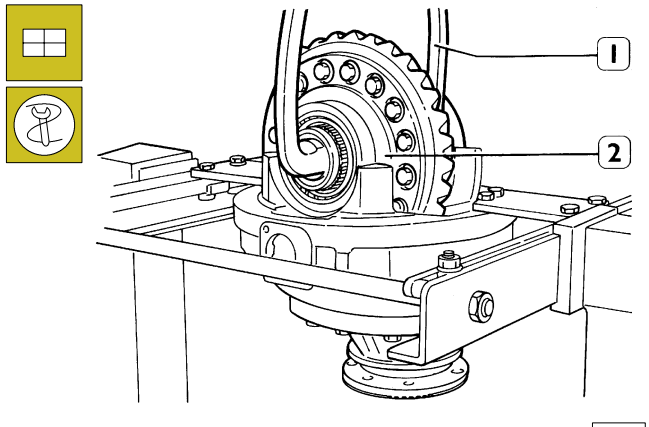
Figure 100



39708

Lock the coupling flange rotation with counter lever 99370317 (1) and using socket wrench 9935508, multiplier (3) and dynamometric wrench (4) tighten the lock nut to a torque of 700 ± 50 Nm (70 ±5 kgm).

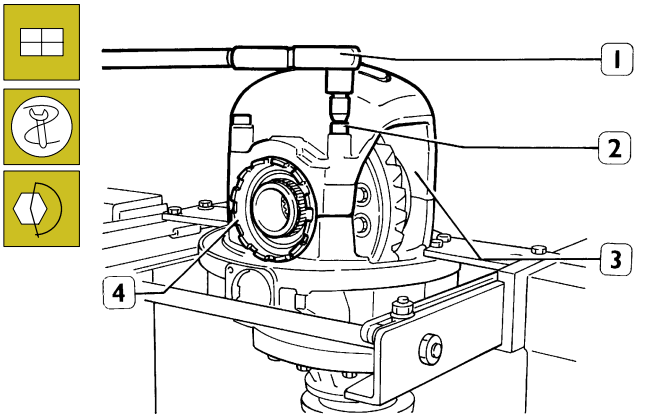
Figure 101



39671

With hook (1) 99370509 set the gear housing (2) with the rlevant roller bearings on the differential housing.

Figure 102



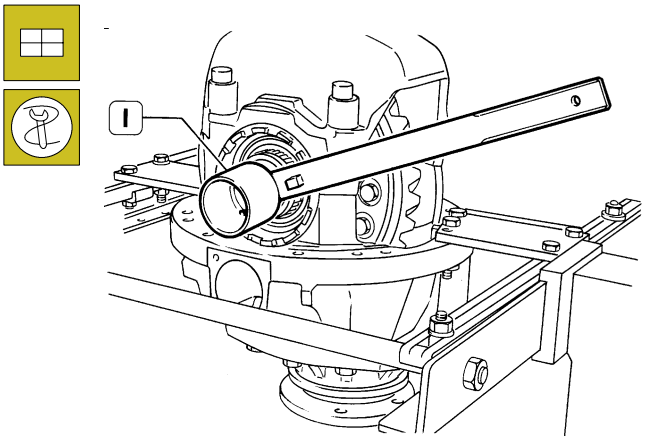
39709

Fit in place the cover (3) matching the marks made when removing, slightly lock the screws (2) and check that the adjusting ring nuts (4) can be screwed without difficulty.
Remove the screws (2), spread LOCTITE AVX on the threads and with a dynamometric wrench (1) tighten them to a torque of 280 ± 15 Nm.

Adjusting the rolling torque of the gear housing bearings

The rolling torque adjustment of gear housing bearings is obtained by measuring the total rolling torque.

Figure 103



39712

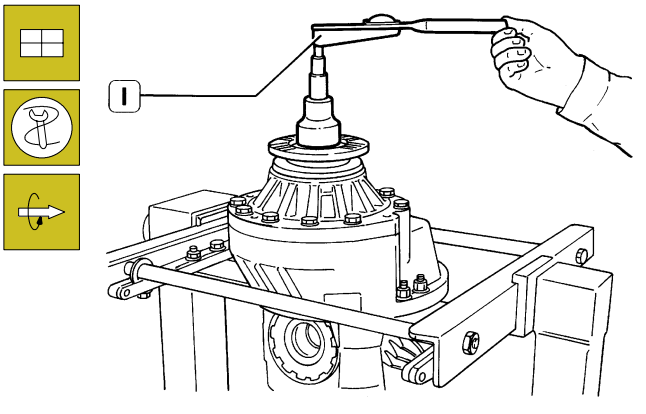
Using torque wrench 99389819 (1) and appropriate socket wrench find the prescribed rolling torque, operating on the bearing adjustment ring nuts, through wrench 99354001 (1).

Find in the table the total rolling torque value (this value varies according to the bevel pair ratio).

No. teeth	Ratio	Rolling torque Total Nm
21/40	1,905	a+11,5-2,51
19/33	1,737	a+11,6-2,61
23/36	1,565	a+11,9-3,21

a = 3 ÷ 4 Nm

Figure 104



39711

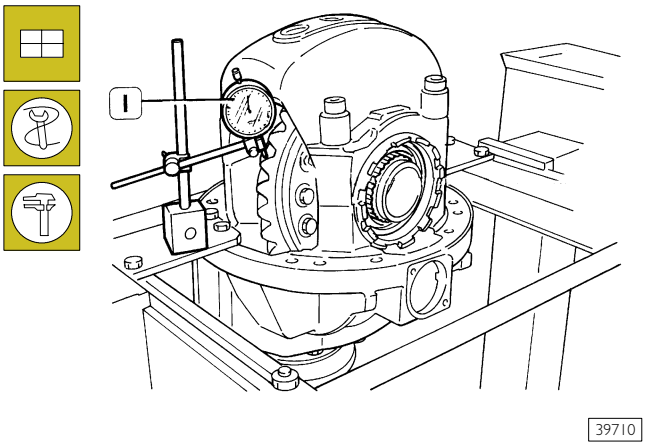
Adjusting the end play between bevel gear pair and pinion

Adjust the backlash between the teeth of the bevel pair operating as follows:

- ❑ Find the clearance value between the teeth; this varies according to the bevel pair ratio;

No. Teeth	Ratio	Clearance between teeth
21/40	1,905	0,20 ÷ 0,28
19/33	1,737	0,25 ÷ 0,33
23/36	1,565	0,20 ÷ 0,29

Figure 105

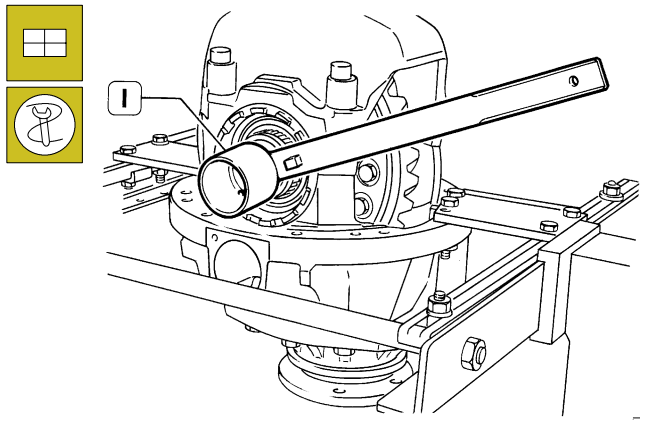


39710

- ❑ Set the dial gauge (1) with magnetic base as shown in the figure
- ❑ Lock the bevel pinion rotation through counter lever 99370317; reverse the crown wheel rotation and with the dial gauge find the backlash between the teeth of the two gears.

If it is not satisfactory, operate on the adjusting ring nuts using wrench 99354001 (1, figure 106)

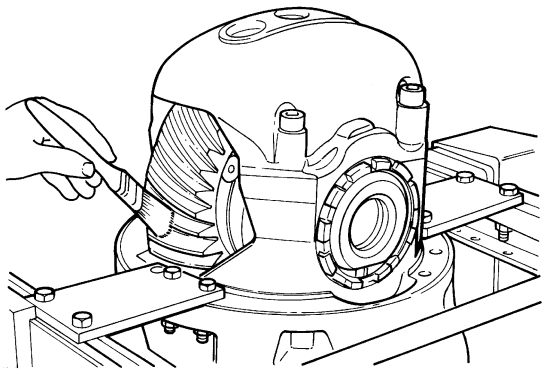
Figure 106



39711

To avoid altering the previously obtained rolling torque when adjusting the backlash between the teeth of the pinion and crown wheel, the adjusting ring nut can be tightened using wrench 99354001 (1) by the same amount as the ring nut on the other side has been loosened.
After the adjustment has been completed, check that the two ring nuts permit the mounting of the safety plates.

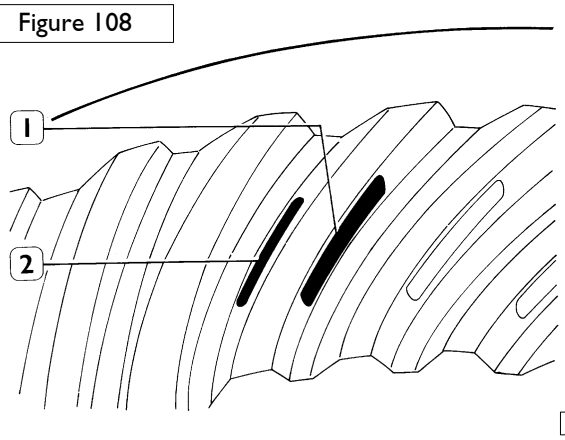
Figure 107



39704

Using a brush apply a thin coating of lead oxide to the crown wheel teeth.
Rotate the pinion and find the pinion teeth contact marks on the crown wheel teeth.
The figures that follow indicate possible contact points and how to correct any errors.

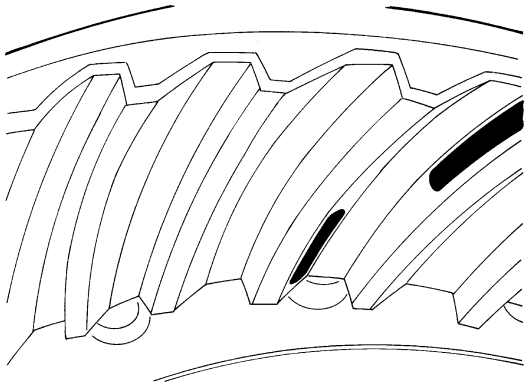
Figure 108



40160

The lead oxide should mark both the drawn surface (1) and the thrusting surface (2) approximately along the centreline of the tooth width. Without load, both meshing areas that contact are slightly displaced with reference to the crown wheel outer diameter.

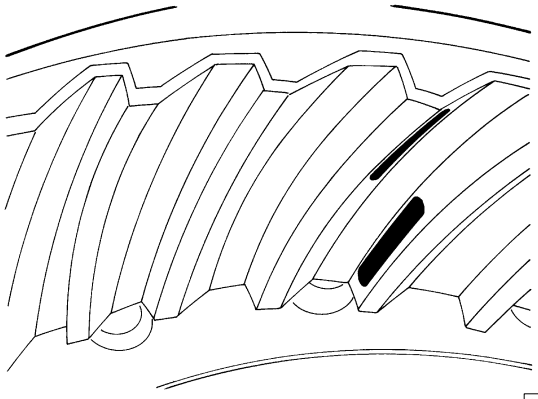
Figure 109



40161A

If the mark on the drawn surface (toward the outer diameter) and on the thrusting surface (toward the inner diameter) is displaced, this means that the pinion is too near the crown wheel.
- Cure: Increase the shim of the adjusting ring between the intermediate bearing and the bevel pinion

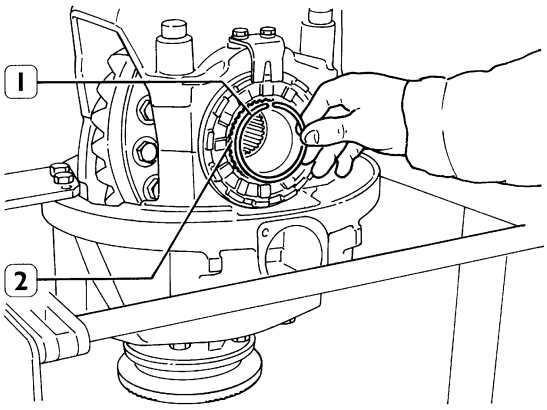
Figure 110



40161B

If the mark on the drawn surface is displaced towards the inner diameter and the mark on the thrusting surface is displaced towards the crown outer diameter, this means that the pinion is too far from the crown wheel axis.
Cure - reduce the shim of the adjusting ring between the intermediate bearing and the bevel pinion.

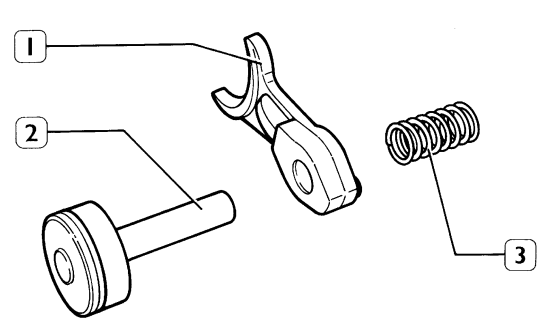
Figure 111



39713

Fit in place the engaging sleeve (1) on the gear housing teeth and using a screwdriver fit the split ring (2) into its groove.

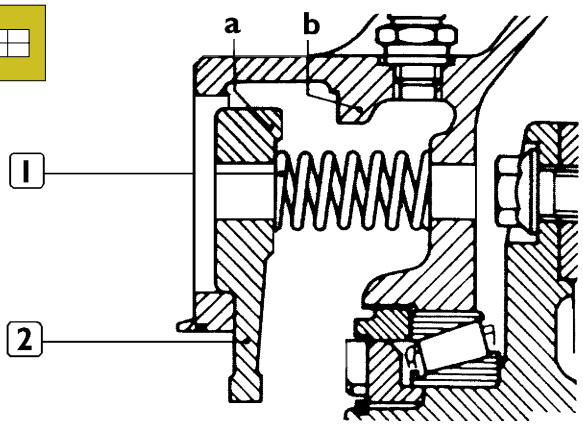
Figure 112



39714

Fit in place the differential locking device assembly composed of the control cylinder, piston (2), enagaging fork (1) and compression spring (3).

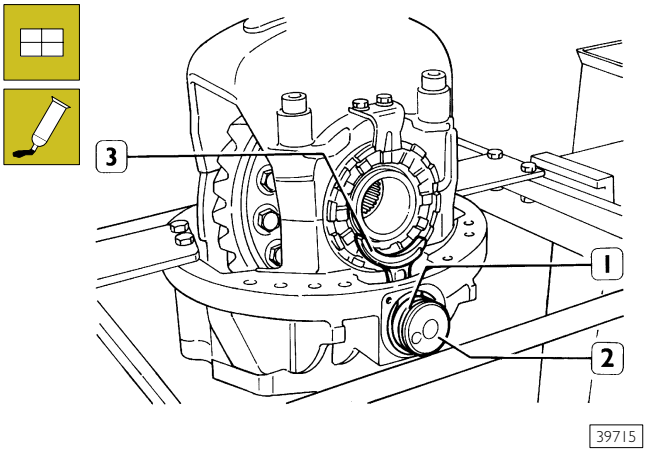
Figure 113



26609

Insert the compression spring (1) in the differential housing. Fit in place the engaging fork (2) so that the stop at the end of stroke (a) corresponds to the end of stroke (b) on the differential housing.

Figure 114



Fit in place a new seal ring (1) on the control piston (2) and grease it.
Insert the control piston (2) into the enagaging fork (3) in the compression spring, then in the specific hole in the differential housing.
Remove the bevel pinion support again.
Fitting in place the differential in the axle casing
1° Fit in place the sliding sleeve on the half-shaft
2° Fit in place the gear housing taking care that the control fork fits into the sliding sleeve spline
3° Tighten the screw and at the same time push the half shaft so that the sliding sleeve fits into the enagaging sleeve on the differential
4° Apply LOCTITE 573 to the thread and under the screw heads then tighten with a dynamometric wrench to the prescribed torque
5° Spread LOCTITE 573 on the contact surface, re-fit into place the pinion support and tighten the screws to the prescribed torque.

BRAKES

SECTION 13.1

SECTION 13.1

Brakes

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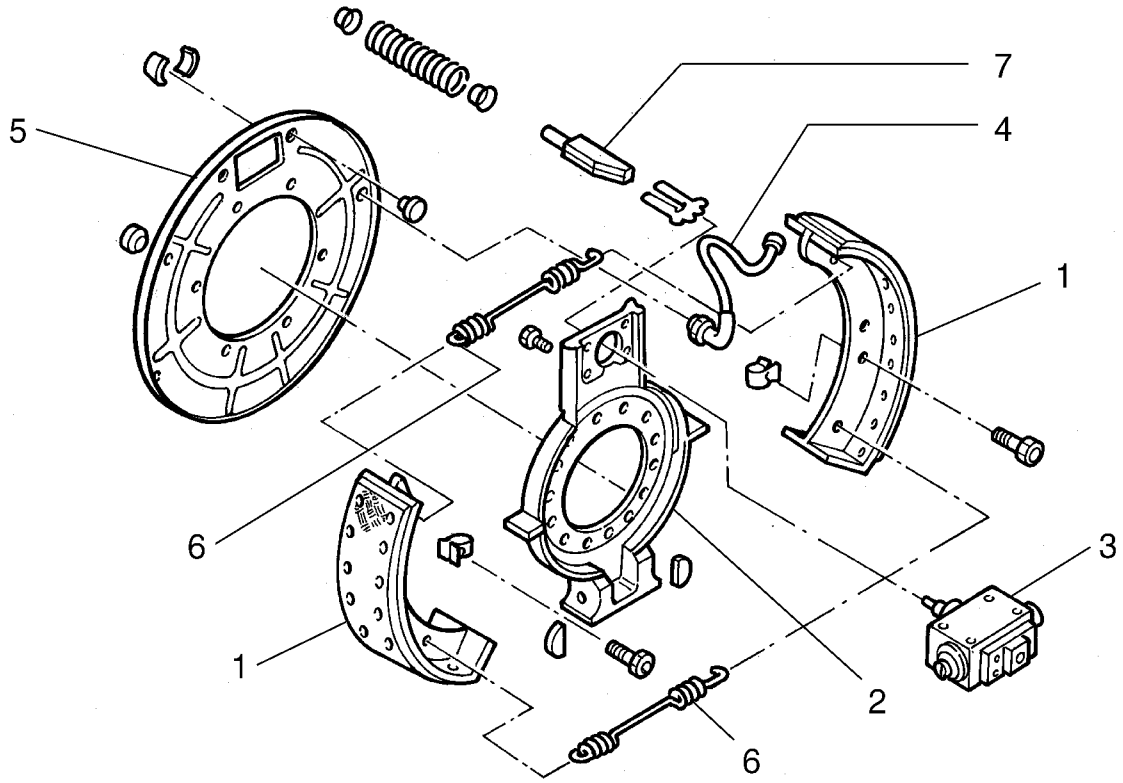
DESCRIPTION

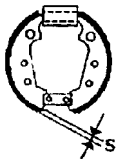
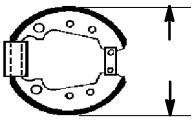
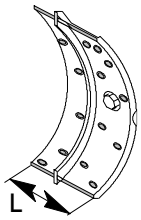
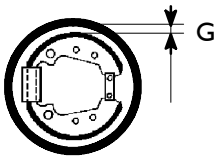
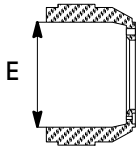
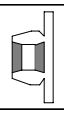
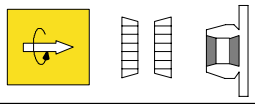
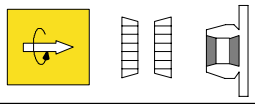
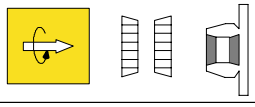
The vehicle is fitted with drum brakes.
Each brake unit features a housing that contains the adjusting pins, control pins and wedge elements. The wedges are acativated by the cylinder rods which, in their turn, are activated by the compressed air.
The stroke of the wedge unit rollers causes the control pins to expand, thus overcoming the resistance of the shoe return spring so that the shoes approach the drum and actuate the braking.
The adjusting and control pins are integrated into the brake housing by means of two pins inserted in a side milling.
When the brake is released, since the air pressure in the diaphragm section of the brake cylinders becomes insufficient, the wedge unit returns to its original position.

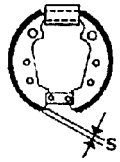
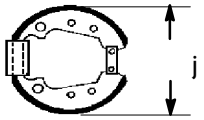
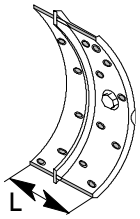
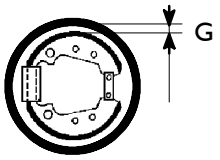
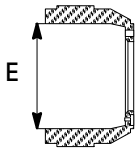
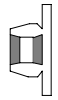
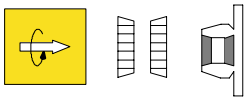
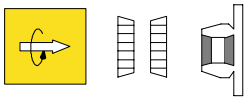
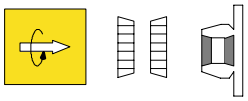
Figure 1



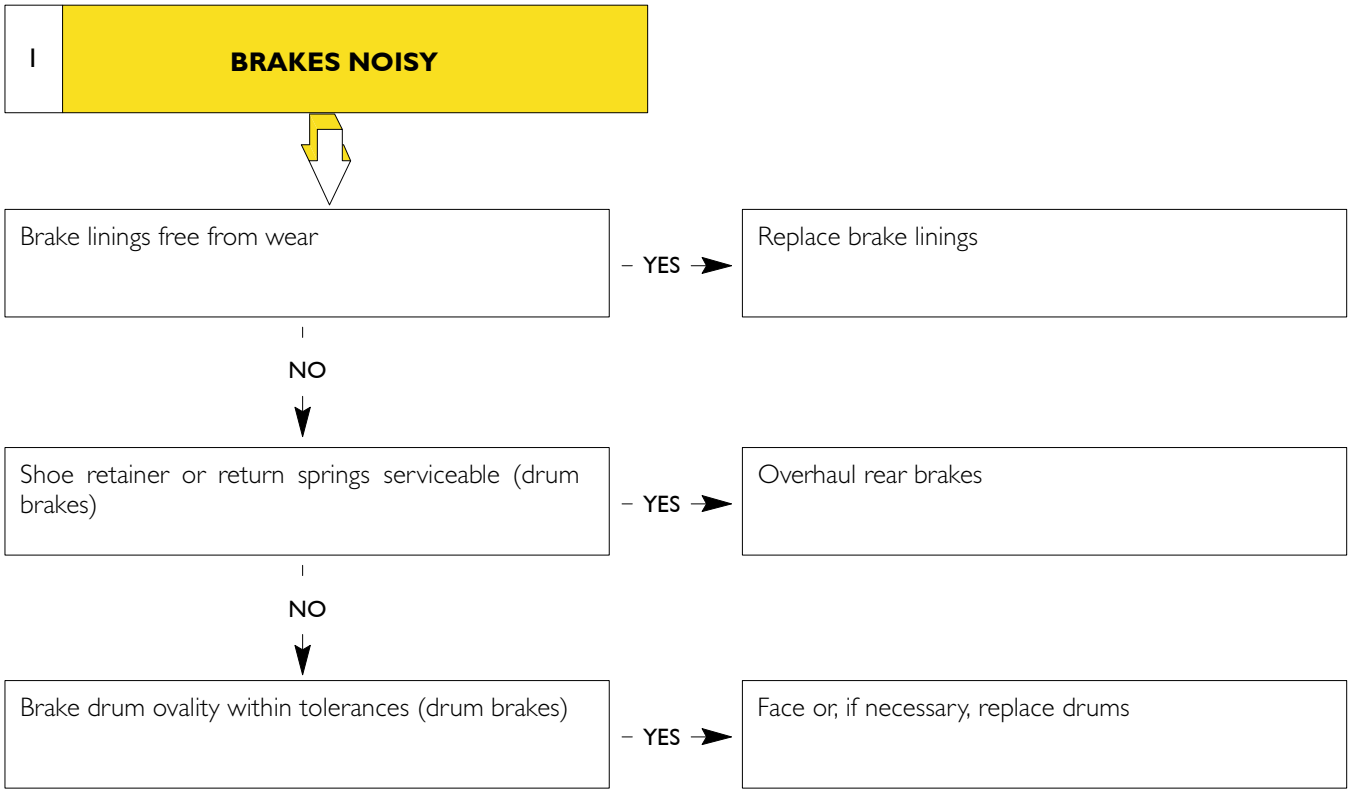
1. Friction linings – 2. Brake shoe carrier – 3. Thrust pin casing – 4. Pneumatic control – 5. Dust cover – 6. Return springs – 7. Wedge units

SPECIFICATIONS AND DATA

	FRONT AXLES BRAKES	DRUM BRAKES
	Drum diameter: - nominal Ø mm - 1st oversize Ø mm - 2nd oversize Ø mm	 410 ÷ 410,4 412 414
	Brake lining thickness: - Nominal S mm - 1st oversizing S mm - 2nd oversizing S mm - Minimum admitted S_{1}* mm	 21,1 22,1 23,1 4,7
* In correspondence to the last rivet of the shoe with wear-out sensor, on the side opposite the cylinder		
	Brake lining diameter: - nominal Ø mm - 1st oversize Ø mm - 2nd oversize Ø mm	 407,5 ÷ 409 409,5 ÷ 411 411,5 ÷ 413
	Brake lining width: L mm	180
	Clearance between brake linings and drum G mm	0,5 ÷ 1,45
	Max. error of concentricity of drum diameter after skimming E mm	0,04
	**WHEEL HUBS**	
	Wheel hub bearings	2, taper roller bearings
	Wheel hub bearing rolling torque new bearings with surface protection Nm	3 Nm + (7,5 ÷ 9 Nm)
	Wheel hub bearing rolling torque run-in bearings and new lubricated seal rings Nm	3 Nm + (4 ÷ 5 Nm)
	Wheel hub bearing rolling torque run-in bearings and seal rings Nm	3 Nm + (3 ÷ 4 Nm)
	Half shaft end play mm	0,5 ÷ 1

	REAR AXLES BRAKES	DRUM BRAKES
	Drum diameter: - nominal Ø mm - 1st oversize Ø mm - 2nd oversize Ø mm	 410 ÷ 410,4 412 414
	Brake lining thickness: - Nominal S mm - 1st oversizing S mm - 2nd oversizing S mm - Minimum admitted S_{1*} mm	 21,1 22,1 23,1 4,7
* In correspondence to the last rivet of the shoe with wear-out sensor, on the side opposite the cylinder		
	Brake lining diameter: - nominal Ø mm - 1st oversize Ø mm - 2nd oversize Ø mm	 407,5 ÷ 409 409,5 ÷ 411 411,5 ÷ 413
	Brake lining width: L mm	 200
	Clearance between brake linings and drum G mm	 0,5 ÷ 1,45
	Max. error of concentricity of drum diameter after skimming E mm	 0,04
	**WHEEL HUBS**	
	Wheel hub bearings	2 taper roller bearings
	Wheel hub bearing rolling torque new bearings with surface protection Nm	3 Nm + (12 ÷ 16 Nm)
	Wheel hub bearing rolling torque run-in bearings and new lubricated seal rings Nm	3 Nm + (5 ÷ 7 Nm)
	Wheel hub bearing rolling torque run-in bearings and seal rings Nm	3 Nm + (2,5 ÷ 4,5 Nm)
	Half shaft end play mm	0,5 ÷ 1

DIAGNOSTIC



For further information on brake system and components diagnostic procedure see Section 16 "Pneumatic system - brakes".

TIGHTENING TORQUES

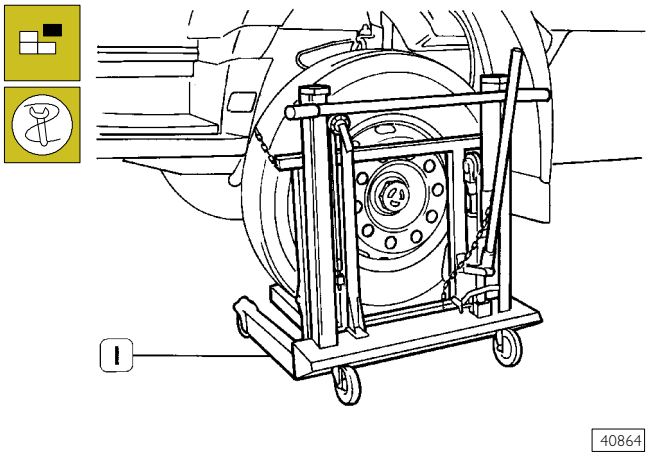
DESCRIPTION	TORQUE Nm (Kgm)
Front drum brakes	
Wheel fastening nut	25 ± 3 (2,5 ± 0,3)
Drum to reducer fastening screws	650 (65)
Rear drum brakes	
Wheel fastening nut	25 ± 3 (2,5 ± 0,3)
Drum to reducer fastening screws	650 (65)

TOOLS

TOOL NO.	DESCRIPTION
99301001	Drum lathe and relevant accessories
99301006	Brake shoe turning equipment
99305087	Riveting press
99305117	Checking equipment for air circuits
99321024	Hydraulic trolley for removing and refitting wheels
99345030	Bridge for dismantling/refitting combined brake actuators
99345037	Element for dismantling/refitting combined brake actuators (use with 99345030)
99345094	Base for removal and re-fitting in place spring brake cylinders (to be used with 99345030 - 99345095)
99345095	Elements to use with 99345094
99356001	Wrench for brake shoes adjustment
99356606	Wrench for removal and re-fitting in place combined brake cylinders ring nut
99357111	Pliers for assembling shoe return springs
99372213	Brake drum turning tool (use with 99301002)

FRONT BRAKES
Removal

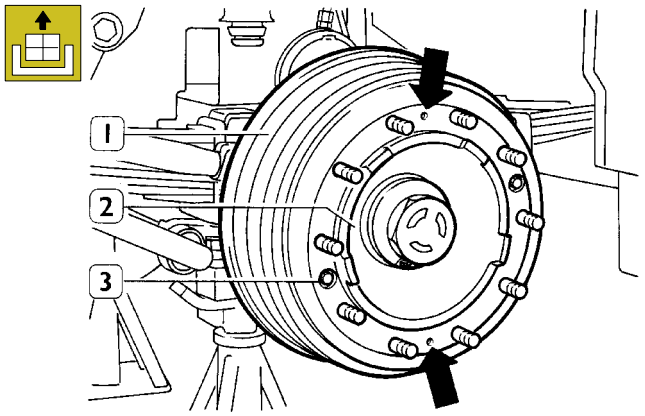
Figure 2



40864

Place the vehicle on flat ground; remove the wheel nut covers and loosen the nuts.
Lift the front of the vehicle and rest it on suitable stands.
Place hydraulic truck 99321024 (1) under the wheels.
Remove the nuts and the wheels.

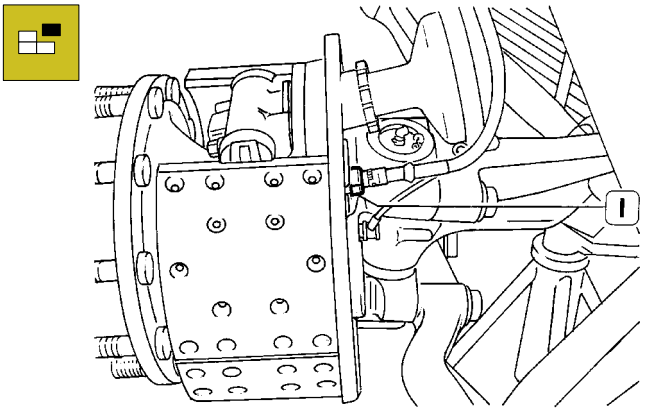
Figure 3



40865

Remove the brake drum (1) to wheel hub (2) fastening screws (3); lock two appropriate screws in the drum holes (⇒) and remove this from the wheel hub.

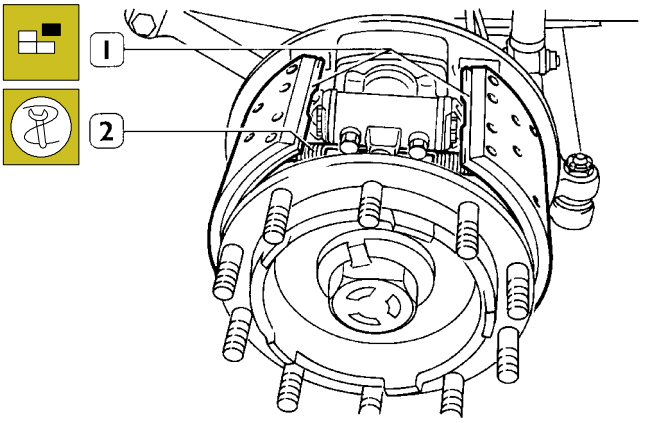
Figure 4



40866

Disconnect the brake lining wear indicator cable electrical connection (1).

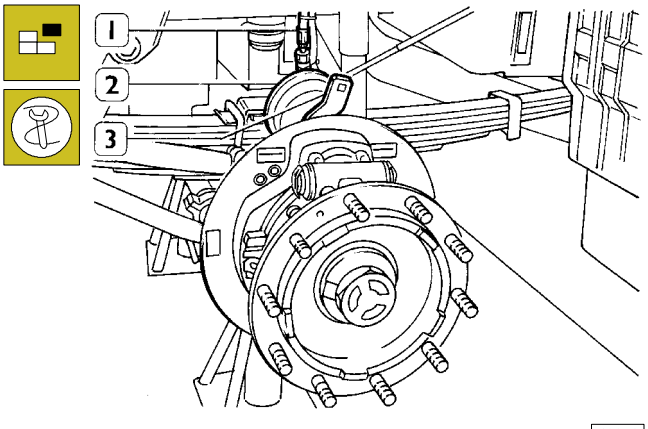
Figure 5



40867

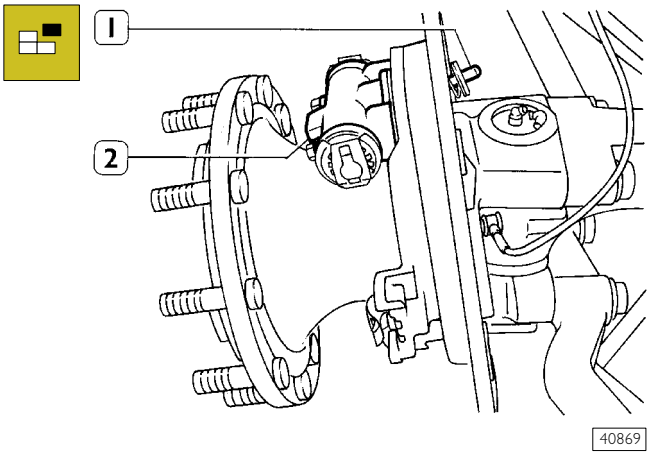
Unhook the shoe (1) return springs (2) using pliers 99357111. Remove the shoes (1) releasing the brake linings wear indicator cable from the brake-carrier plate clamps and withdraw the cable.

Figure 6



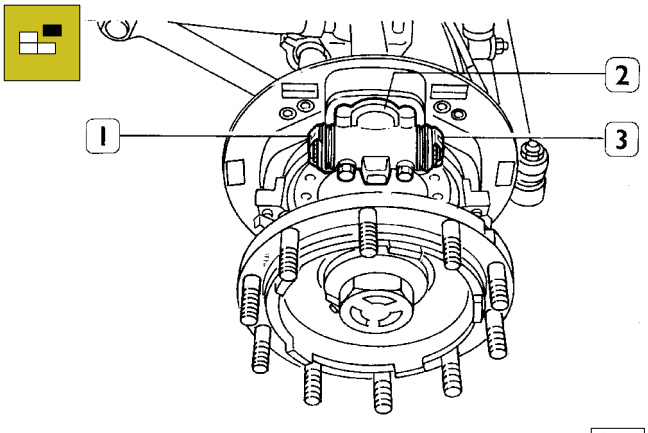
Disconnect the brake cylinder (2) feeding pipes (1). Using wrench 99356006 (3) loosen the ring nuts and remove the brake cylinder (2).

Figure 7



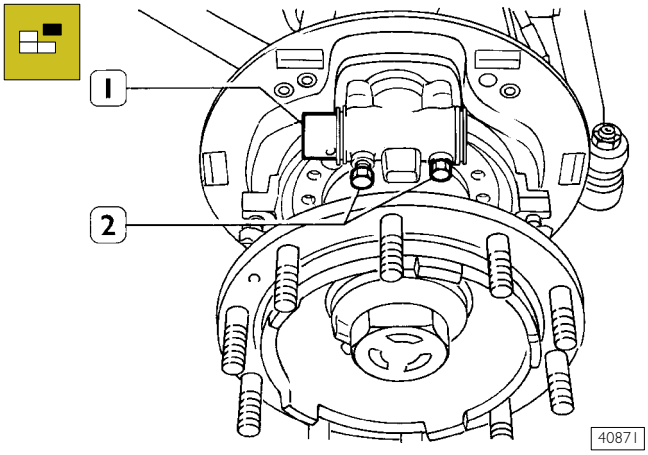
Take away the wedge units (1) controlling the brake housing (2).

Figure 8



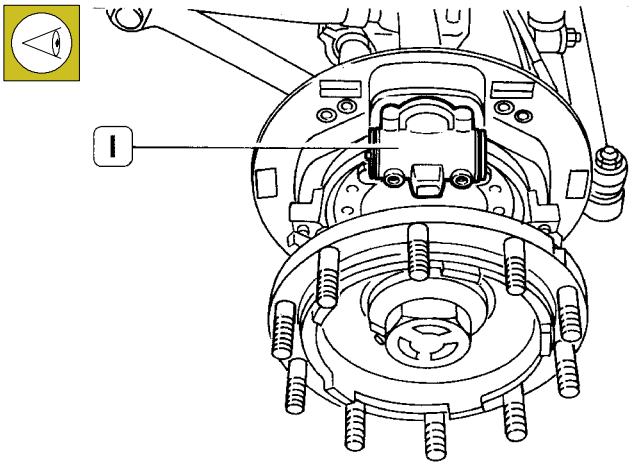
Take away the wedge units (1) controlling the brake housing (2).

Figure 9



Remove the guide screws (2) and remove the thrust pins (1) with the adjustment bushes and relevant springs.
Remove the opposite brake unit.

Figure 10



Check the wear on the pin seats of the brake housing (1), if they are scored or very worn replace the faulty brake housings.

Check the wear on the drums to decide whether they can be re- used.

Measure the drum diameters with a gauge without bending the arms.

Measure the diameter in several points to establish the ovality and wear, also taking into consideration the depth of scores on the braking surface.

Allowed tolerance for ovality and/or eccentricity is 0.25 mm

If the braking surface scoring or wear cannot be repaired by turning, or if there are evident signs of overheating, replace the drum (see Specifications and data table).

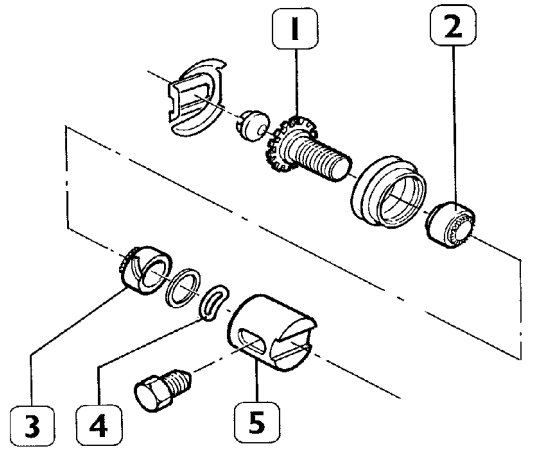
Check the conditions of the brake shoes, if they are cracked replace them.
If the brake lining surfaces show signs of grease, find the cause and remove it.

The minimum thickness admitted for the brake linings is 4.7 mm, measured at the last rivet of the shoe with the wear sensor on the side opposite the cylinder.
If a value that is under, or only just over the specified thickness, replace.

Check the integrity and/or efficiency of the brake lining wear indicator cable.

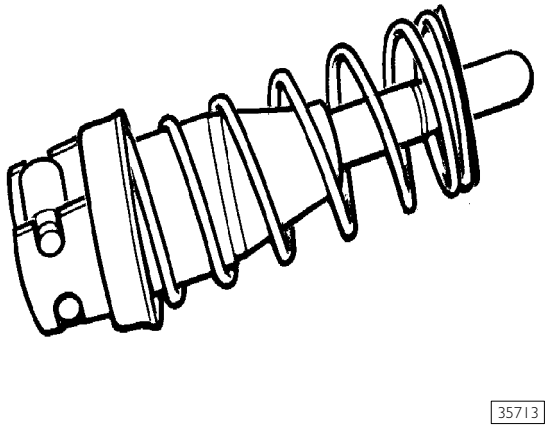
Check the integrity and/or efficiency of the shoe return springs.

Figure 11



Dis-assemble the automatic adjustment unit.
Carefully clean all the components of the braking unit. Check the wear on the adjusting bush teeth (2 and 3), ascertain that the bushes (2) slide freely screwing them on the relevant adjusting pins (1).
Check the condition of the springs (4) and thrust pins (5).

Figure 12



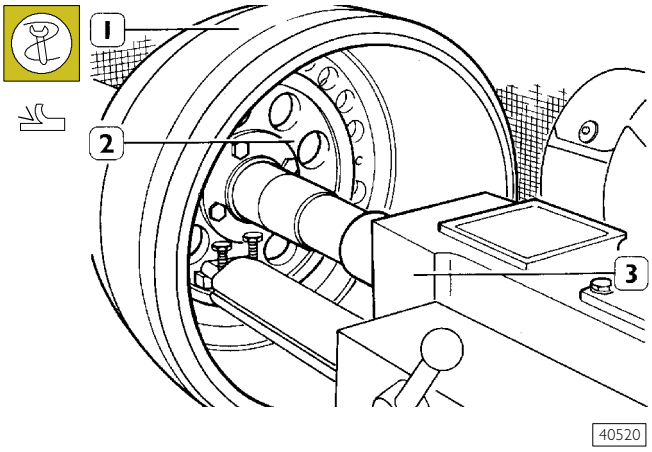
Check that the wedge units slide easily and that there are no abrasions.

If wear is found on the wedge components the complete unit must be replaced.

Drum turning

Measure the drum diameters using a gauge without bending the arms, find the diameter in several points to establish the ovality and wear.

Figure 13



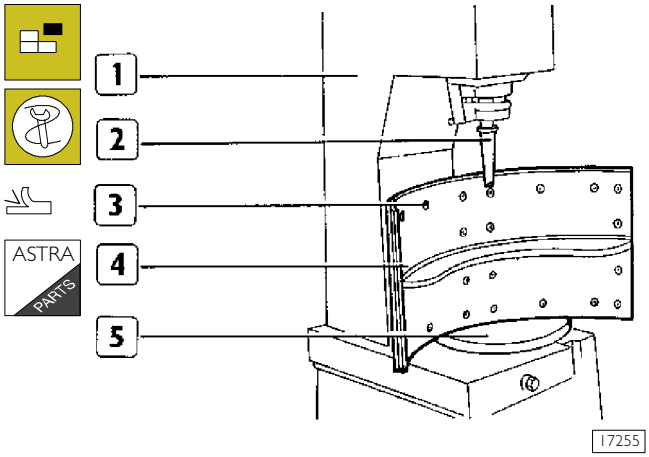
Fit tool 99372213 (2) into the brake drum.
Fit this combined unit onto the lathe shaft 99301001 (3).
Fit a set of spacers on the shaft to remove unit end play, tighten the lock nut and place the lathe support.
Fit the antivibration band on the brake drum.
Turn the drums by stages, removing the amount of material necessary to correct the imperfections found.
After turning remove the drum brake and carefully clean it.

The maximum diametral oversizing admitted for the drum is indicated on the drum itself.
This limit must not for any reason be exceeded as it would jeopardize the braking effect and the drum resistance characteristics.

Couple the brake linings suitable for each drum according to the oversizing.
Each vehicle axle must be fitted with linings of the same type.

Replacing brake linings

Figure 14

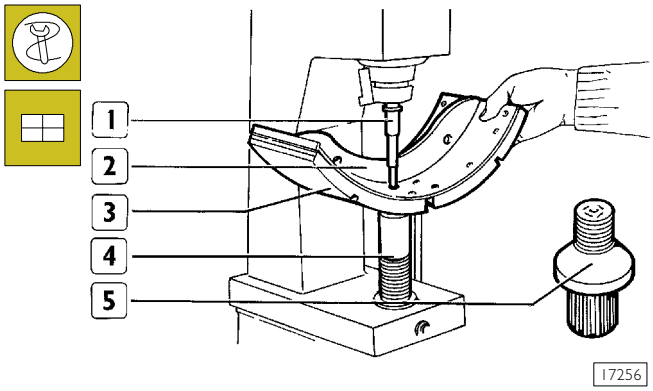


Remove the worn brake linings from the shoes with compressed air press 99305087 (1).

Remove the brake lining wear indicator cable from the lower shoes.

Set the complete shoes (4) on an adjustable stand (5).
With a chisel (2) in the press tooling head (1) shear the rivet heads (3).
Eject the rivets from the shoes.
Carefully wash and blow the shoes to clean them.

Figure 15

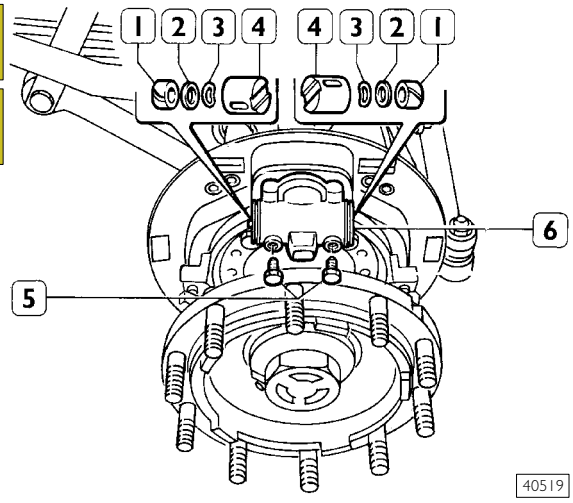


Set the contact pin (5) on the press moving support (4).
Rivet the brake linings (3) onto the shoes (2) with the beater (1) fitted in the press tooling head.

To rivet the brake linings correctly start in the centre, gradually extending to the braking sectors.

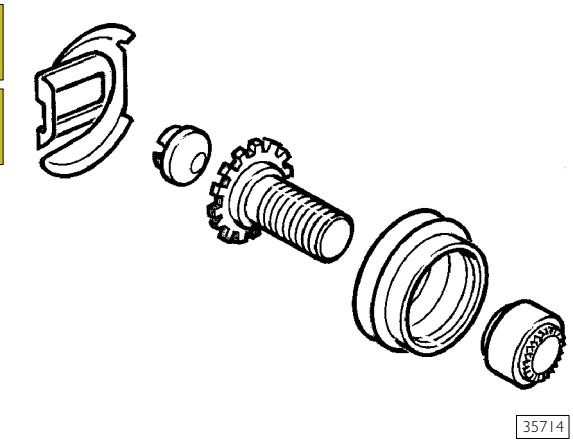
Fitting in place

Figure 16



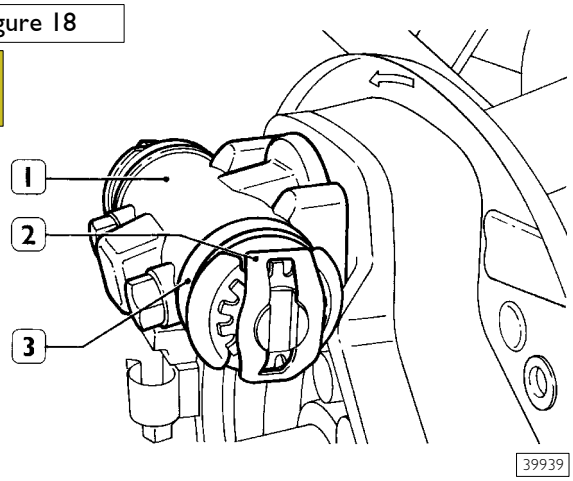
Grease components (1,2 and 3) and fit them, in sequence, in the thrust pin (4).
Grease the interior of the brake housing (6) and fit in place the thrust pins (4) restraining them through the guide pins (5).

Figure 17



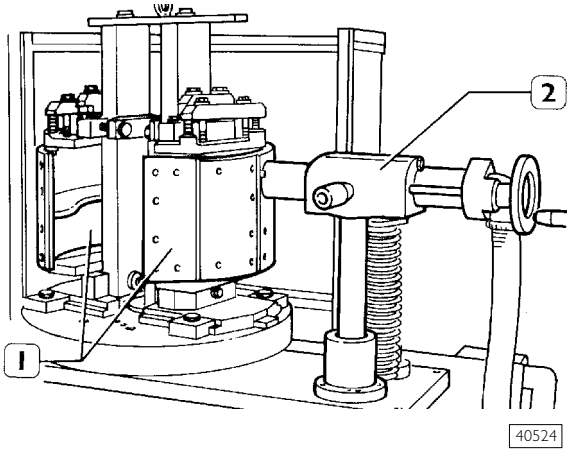
Fit together the adjusting unit thoroughly greasing the sliding surfaces.

Figure 18



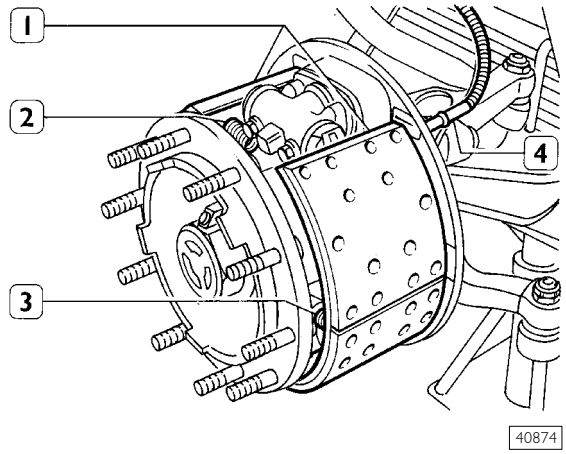
Fit the adjusting units (2) into the brake housing (1) placing the clasp as shown in the figure.
Fit in place the protection housing (3) in the brake housing groove (1).

Figure 19



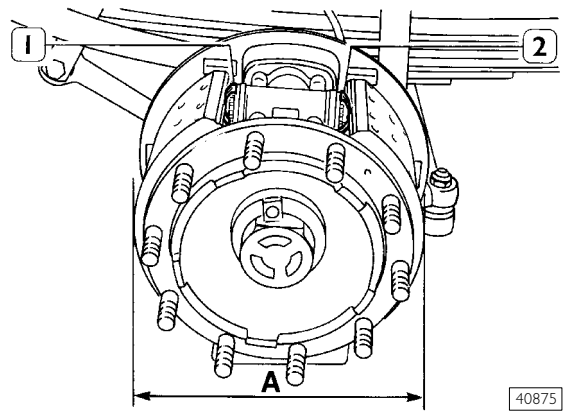
Using tool 99301006 (2) turn the brake linings (1).

Figure 20



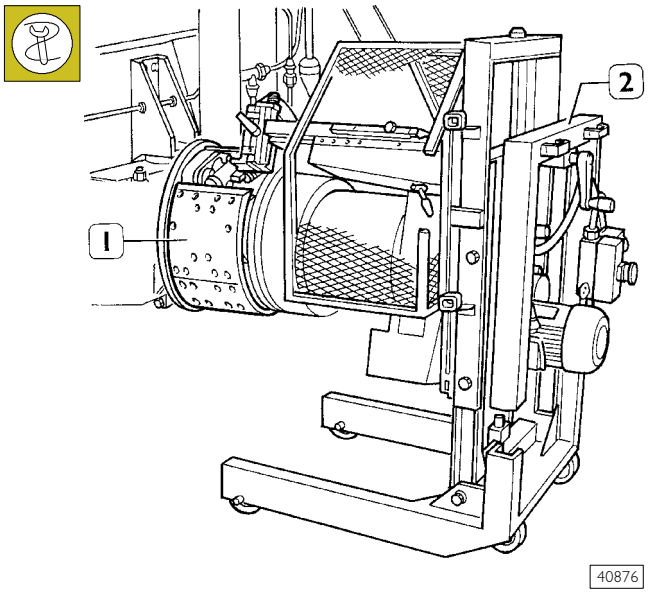
Fit the brake lining wear indicator cable in the clamp and in the brake carrier plate hole.
Fit in place the shoes (1) and hookup the return springs (2 and 3). Electrically connect (4) the wear indicator.

Figure 21



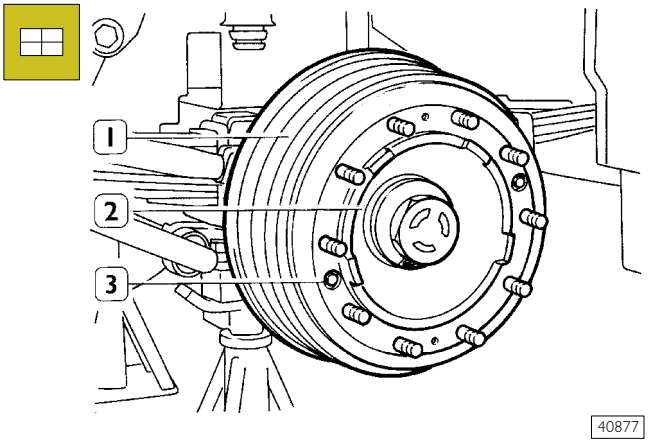
Loosen the adjusting units (1 and 2) equally to obtain that diameter A is 2 mm less than the diameter of the drum brake to be fitted.

Figure 22



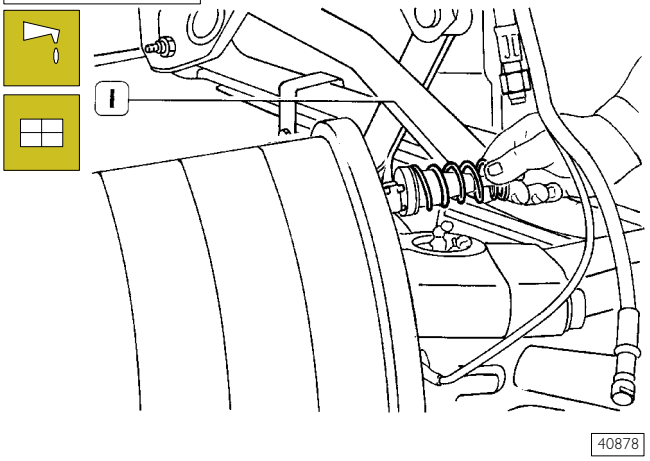
Having tool 99305079 (2) available instead of 99301006 (2, figure 19) turn the brake linings (1)

Figure 23



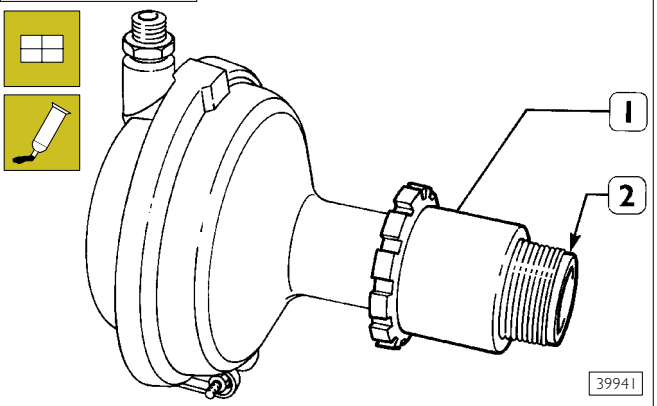
Fit in place the brake drum (1) and fasten it to the wheel hub (2) with the screws (3).

Figure 24



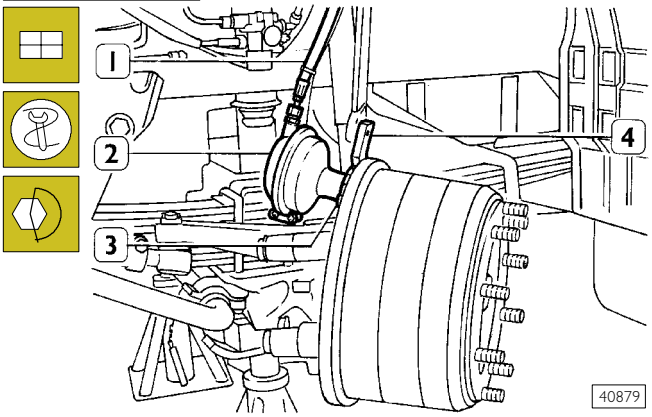
Generously grease the wedge control units (1) and fit them in their seats on the brake housing so that the wedge unit rollers rest in the thrust pin raceways.

Figure 25



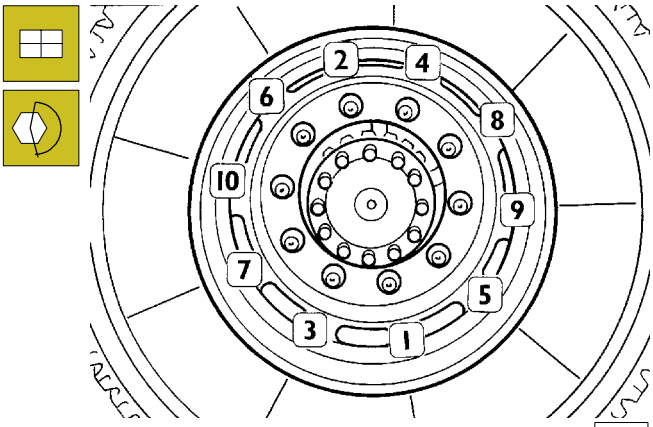
Tighten the ring nut (1) by hand onto the shaft (2) to the end of its stroke. Spread non hardening sealant paste LOCTITE 573 on the three pin threads of the shaft (2).

Figure 26



Screw the cylinder (2) right down into its seat. Check that the feed coupling holes are in the same position as before removal, if they are not, loosen the cylinder (2) and connect the feed pipes (1).
Feed the cylinder through the service brake and with wrench 99356006 (4) tighten the ring nut (3) to the prescribed torque.

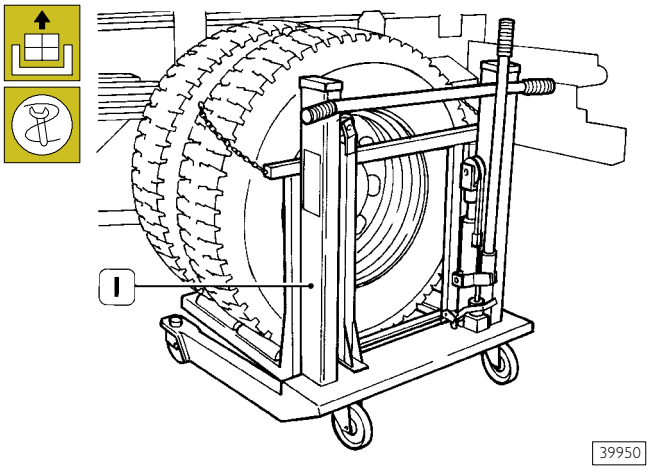
Figure 27



Fit in place the wheels and tighten the nuts to the prescribed torque in the sequence shown in the figure.
Fit in place the other braking unit.
Start up the engine for sufficient time to recharge the system.
Brake several times to settle the braking unit and to recover the slack between the brake linings and the drum with the vehicle running.

REAR BRAKES
Removal

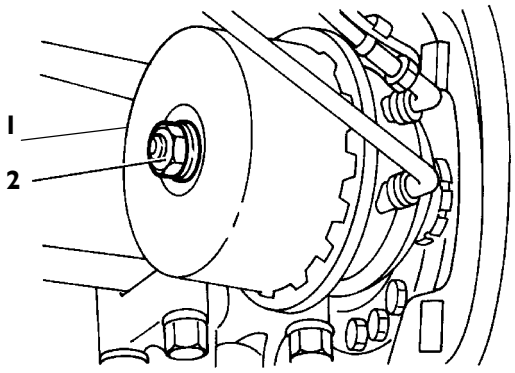
Figure 28



39950

Place the vehicle on flat ground. Bring the parking brake hand lever into running position, loosen the rear wheel nuts. Using a hydraulic jack lift the rear of the vehicle and rest it on suitable stands. Using hydraulic truck 99321024 (1) remove the wheels.

Figure 29



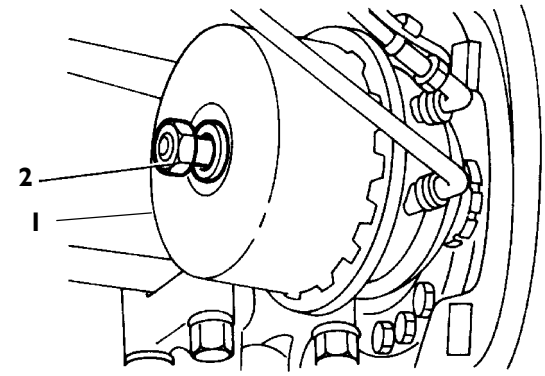
39951

Completely unscrew the manual braking release screw (2) of the combined cylinder (1).

Overhaul the braking unit following the instructions given for the front brakes, unless stated otherwise.

Fitting in place

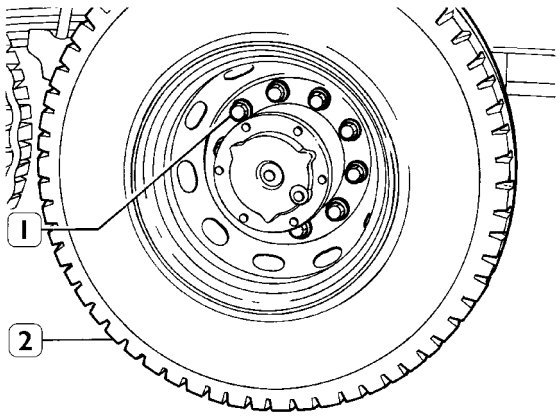
Figure 30



39954

After the brake unit has been overhauled and re-fitted in place, fit in place the cylinder (1) following the instructions given for the front brake cylinder.
Feed the cylinder (1) through the service brake and tighten the ring nut to the prescribed torque using wrench 99356006. Restore parking brake control cylinder (1) operation,fully tightening the screw (2).

Figure 31



39955

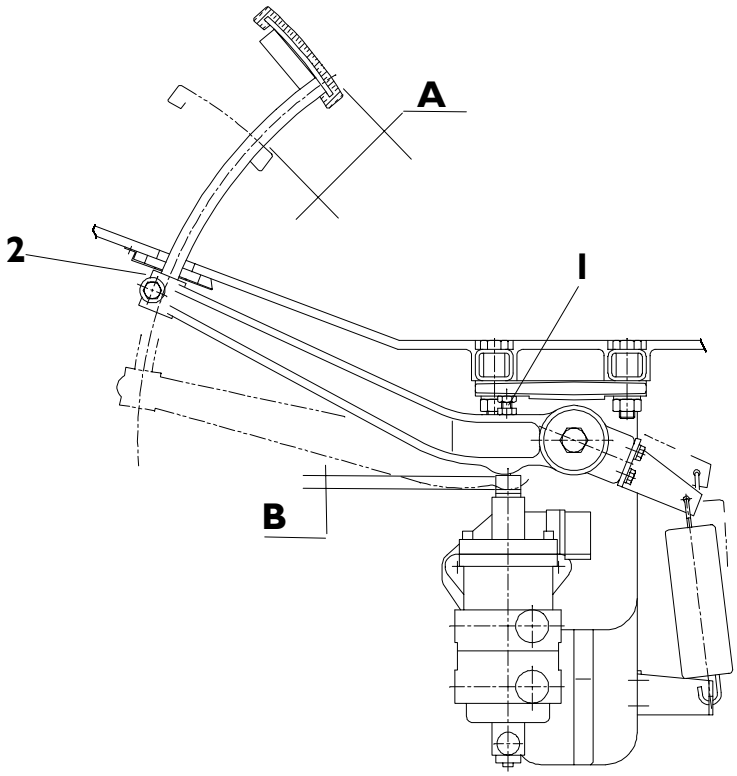
Fit in place the wheels (2) lock the nuts (1) to the prescribed torque.
Fit in place the other braking unit.
Start up the engine for sufficient time to recharge the system.
Brake several times to settle the braking units and to recover the slack between the brake linings and the drum with the vehicle running.

SETTING THE BRAKE PEDAL

Floor pedal unit

Adjust the stop screw (1) to avoid the pedal (in rest position) and the cab floor being in touch in point (2).
Brake pedal stroke (dimension A) = 77 mm
Brake distributor stroke (dimension B) = 11 mm

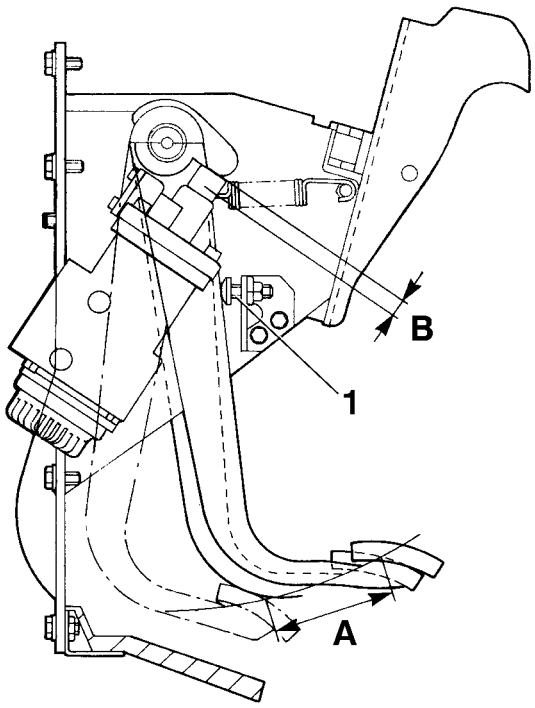
Figure 32



Hanging pedal unit

Set the screw (1) to dimension C = 23.5 mm; the prescribed brake distributor stroke (dimension B) must correspond to this value.
Adjust the stop push rod (2) to have the brake distributor not depressed with brake pedal in rest position.
Brake pedal stroke (dimension A) = 97 mm
Brake distributor stroke (dimension B) = 11 mm

Figure 33



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WHEELS AND TYRES

SECTION 13.2

SECTION 13.2

Wheels and tyres

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DESCRIPTION

The wheel rim represents the rigid structure of the wheel and is identified by the following dimensions :

- ❑ diameter of the rim, measured at the base of the circumferential groove (that is, on the surface on which the air chamber rests)
- ❑ width of the circumferential groove in the wheel rim (that is, the distance between the surfaces on which the cover rests)

The tyre has the following functions :

- ❑ to absorb the greater part of the jolts caused by roughness of the road surface by utilising the elasticity of air
- ❑ to generate on the ground the motive force supplied by the engine necessary for the vehicle to move
- ❑ to ensure the maximum grip and stability of contact between the tyre and the road, with satisfactory life
- ❑ to withstand the forces generated by sudden braking, hard acceleration and by the thrust of centrifugal force on bends
- ❑ to ensure the stability of the vehicle even at high speeds; to ensure the steerability of the vehicle
- ❑ to ensure vehicle directional control.

SPECIFICATIONS AND DATA

Standard

Tyres	Rims
3R22,5 MICHELIN 156/150 G tubeless / PIRELLI 156/150 K (154/150L) tubeless	9,00 – 22,5"

Optional

Tyres	Rims
1200R20 MICHELIN 156/150G / PIRELLI 157/153F20PR	8,0V – 20"
315/80R22,5 MICHELIN 156/150 K tubeless / PIRELLI 156/150 K tubeless	9,00 – 22,5"
12.00 R 24"	8,0 – 24"
14.00 R 20"	10,0 – 20"

Tyre inflation pressure data

Tyres		13R22,5 156/150 G tubeless	12.00R20 156/150 G	315/80R22,5 156/150 G	12.00 R 24	14.00 R 20
Inflation pressure [bar]		8,00	8,50	8,50	7,50	6,50
Limit mass admitted [kg]	(s)	8000	8000	8000	8000	8000
	(g)	13000	13000	13000	13000	13000

(s) = single tyres
(g) = twin tyres

This table enables, with the vehicle in running position, to identify the correct operating pressure according to the type of adopted tyres and the loads acting on the axles.

TIGHTENING TORQUES

DESCRIPTION	TORQUE	
	Nm	kgm
Wheel fixing screws	650	6,6

TOOLS

TOOL	DESCRIPTION
99305037	Electronic unit for balancing the front wheels on the vehicle

CHECKS AND REQUIREMENTS

Wheels shall be checked periodically, e.g. when changing a tyre.

The driver shall perform the following operations accurately:

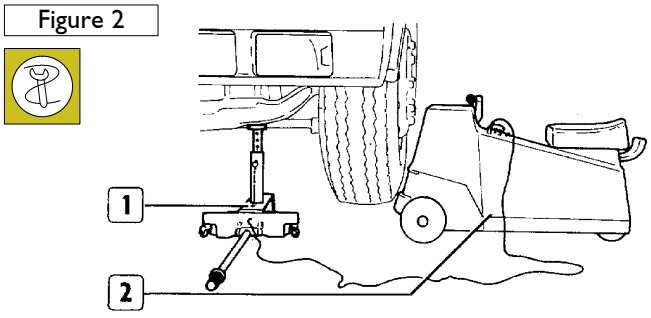
- ❑ Clean the coupling surfaces when removing a wheel from the vehicle.
- ❑ Inspect the rim, along its whole circumference, and the disk using special care to hub centering and fixing area.
- ❑ Check absence of defects, wear, corrosion or cracks which can impair wheel reliable performances.
- ❑ Check whether all surfaces are correctly and suitably protected, especially tyre and vehicle faying surfaces. Repaint, if required, after removing surface oxidation, if any and after suitable priming avoiding excessive paint application in the coupling areas.

Only minor repairs (e.g. removal of scratches or dents), apart the above mentioned surface protection resetting, can be performed on steel wheels. In case of serious damages the wheel shall be repaired by skilled workers only, since tyre removal and refitting when are not performed correctly can be dangerous for the driver.

Never repair rims or disks by welding or adding material to restore wheel geometry since these areas which are already affected by wear due to running stress, will break in a short time.

WHEEL STATIC BALANCING

Figure 2

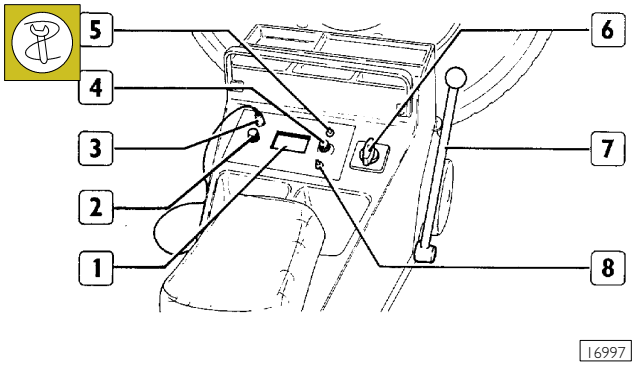


The front wheels can be balanced on the vehicle using the electronic unit 99305037; this has the great advantage of balancing the wheel together with the other rotating masses.

The operation must be carried out as follows :

- ❑ Raise the front of the vehicle and make sure that the wheels rotate freely
- ❑ Position the imbalance detector (1) under the axle close to the wheel being examined, arranging the height so that the spin-up wheel of unit 99305037 (2) is in contact with the tyre; position a support stand under the opposite side of the axle and lower the hydraulic jack

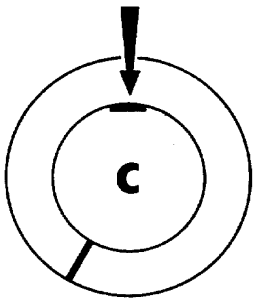
Figure 2



- ❑ Connect the cable (3) of the imbalance detector to unit 99305037
- ❑ Make a reference mark on the tyre by drawing a radial mark with chalk or using a strip of gummed paper
- ❑ Turn switch (2) to the static balancing position and sensitivity switch (4) to notch no. 5 on the graduated scale
- ❑ Turn on switch (5) for instrument light (1) and strobe lamp switch (8).
- ❑ Turn the spin-up switch (6) of unit 99305037 to the first speed position so as to make the wheel rotate.

Turn up the spin switch (6) to the second speed and place the balancing machine against the tyre.
While the wheel is being spun, it will be found that the stroboscopic effect on the wheel will make the reference mark appear stationary; the pointer of the instrument (1), moving from the value zero, reaches a maximum value on the scale and then returns to zero.
When the pointer has begun to fall back, withdraw the balancing machine, turn off the spin-up switch (6) completely and brake the motor by means of the brake lever (7). The wheel continues to revolve due to inertia and the reference mark made on the tyre moves; the point to which the reference mark has moved should therefore be noted.
Read off from the instrument (1) the value shown by the pointer, multiply it by 10, giving the value of the balance weight to be fitted to the rim.

Figure 3



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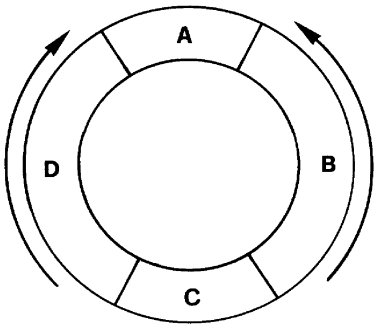
Fit the balance weight calculated in this way as shown in the figure. If during the test, the pointer of the instrument (1, fig. 2) remains in the green area of the box, the wheel is balanced.

If the weight required to balance the wheel is more than 600 - 800 grammes, divide the weight in half and position the two parts so formed with one half on the inside and one half on the outside of the rim, making sure that they are in the same position.

CORRECTING RESIDUAL STATIC IMBALANCE

Figure 4



23885

To correct the residual imbalance, repeat the operations already carried out above; depending to the new reading on the instrument (1, fig. 2), refer to the diagram in figure 4 and proceed as follows to adjust :

- If the weight is in the zone marked with the letter A, this means that it is too light, and in that case weight must be added as indicated by the instrument (1, fig. 2).
- If the weight is in the bottom zone marked with the letter C, this means that it is too heavy and in that case the weight must be reduced as shown by the measuring instrument.
- If the weight is found to be in the zones marked with the letters B or D, do not remove or add any weight but instead move it 5 cm upwards in the direction of the arrows, see figure 4.

TYRE PRESSURE

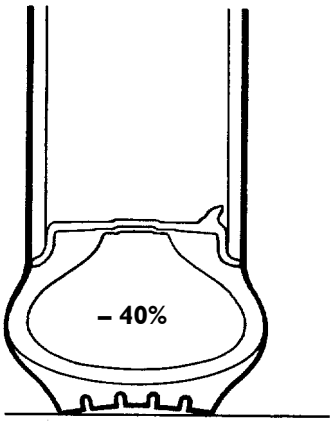
The tyre pressures must be checked with the tyres cold.
Take great care that the pressure is correct since, if it is higher than required, a harsh ride and excessive wear of the centre of the tread will result, while if it is lower, the load is not distributed over the whole tread but is concentrated at either side, causing premature wear of these areas and also damaging the internal structure of the tyre.
Unequal pressures between tyres affects the driving stability of the vehicle and impairs operating safety.
Abnormal wear of the tyres may appear in various areas of the tyre treads.

How tyre behaviour depends on pressure

Schematic views to demonstrate how tyre behaviour and performance depends on pressure.

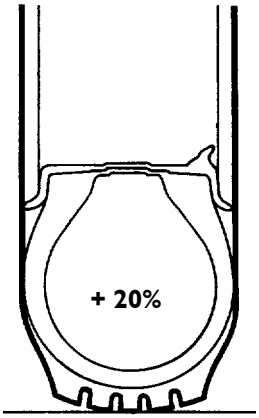
(The value shown inside each tyre indicates the level of pressure of the tyre, while the efficiency relates to the life of the tyre.)

Figure 5



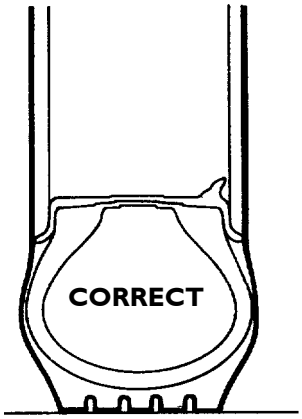
EFFICIENCY 40%

Figure 6



EFFICIENCY 90%

Figure 7



EFFICIENCY 100%

FRONT SUSPENSIONS

SECTION 14.1

SECTION 14.1

Front suspensions

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DESCRIPTION

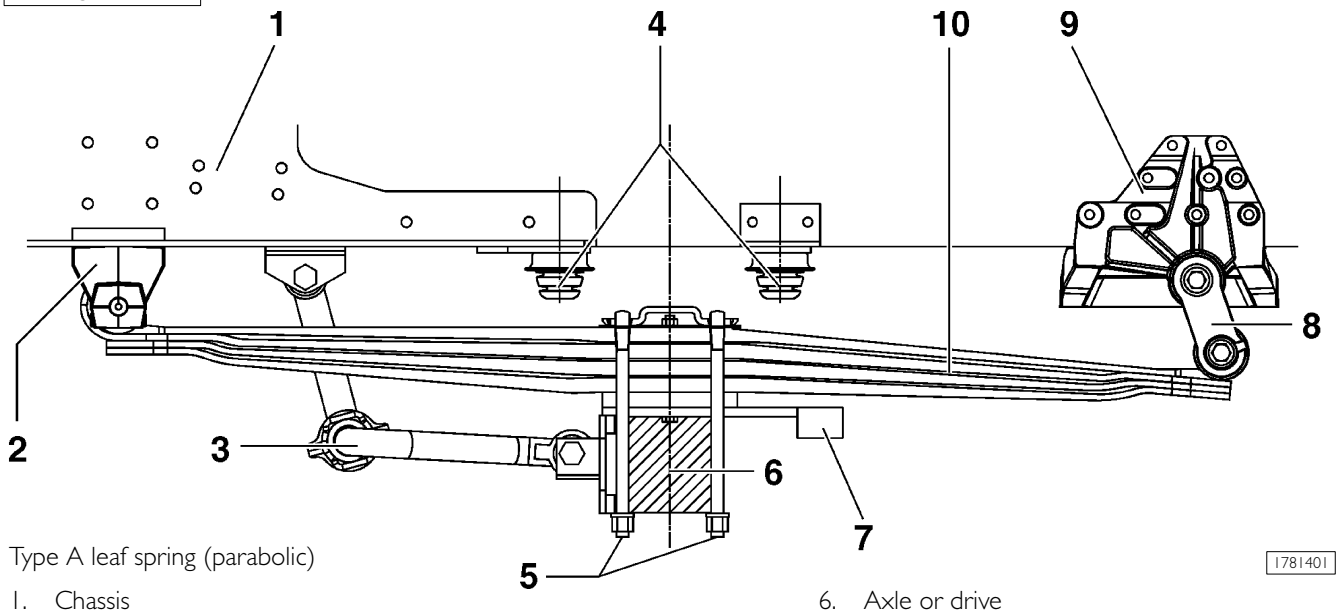
1st axle suspension

The suspension system is comprised of a pair of longitudinally arranged single action leaf springs, supplemented by a pair of dual action hydraulic telescope shock absorbers and two excursion limit elastic buffers for each spring.
The suspension is also fitted with a roll bar to control vehicle inclination when cornering.

There are two possible types of leaf spring:

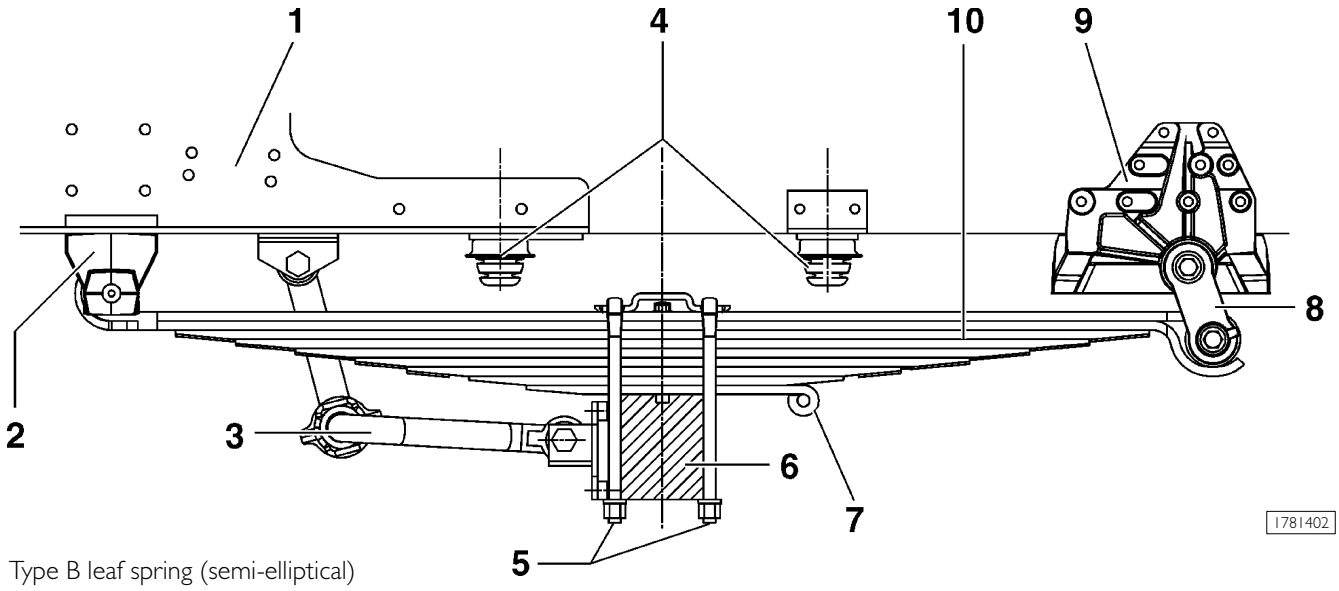
- ❑ Type A, parabolic spring, standard.
- ❑ Type B, semi-elliptical spring, on request.

Figure 1



Type A leaf spring (parabolic)

1. Chassis
2. Spring front mounting
3. Roll bar
4. Buffer
5. Anchor stirrup
6. Axle or drive
7. Shock absorber mounting
8. Shackle
9 Spring rear mounting
10. Spring



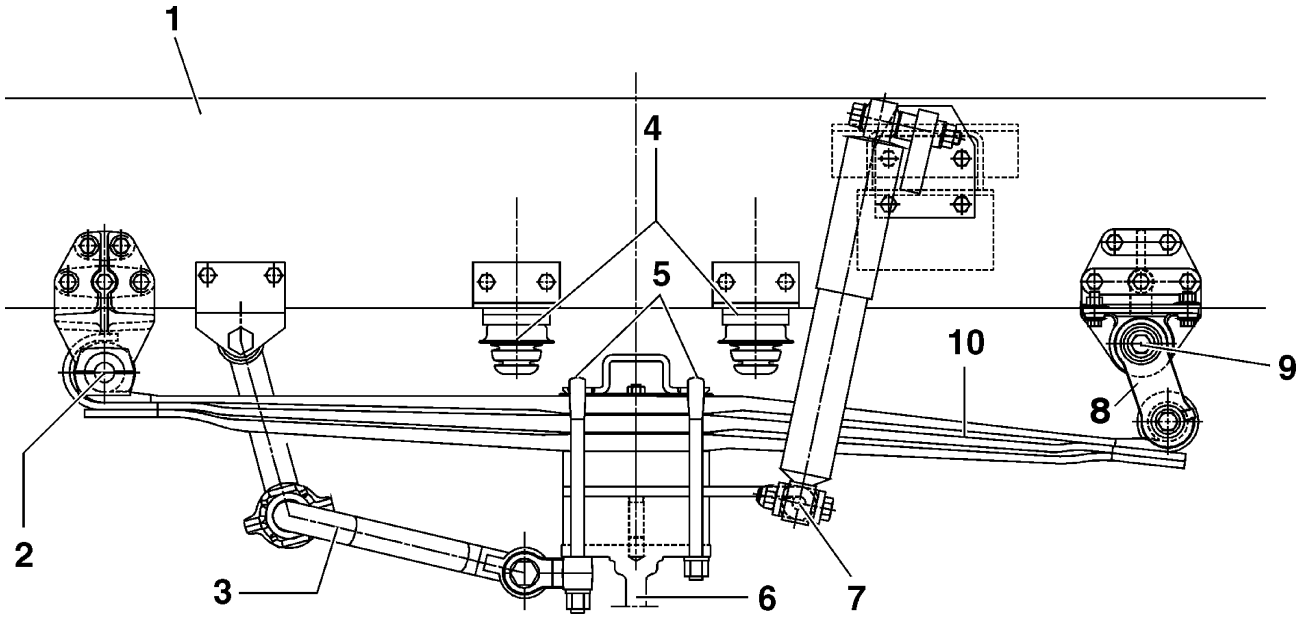
Type B leaf spring (semi-elliptical)

1. Chassis
2. Spring front mounting
3. Roll bar
4. Buffer
5. Anchor stirrup
6. Axle or drive
7. Shock absorber mounting
8. Shackle
9 Spring rear mounting
10. Spring

2nd axle suspension

The suspension system is comprised of a pair of longitudinally arranged single action leaf springs.
It is supplemented by a pair of dual action hydraulic telescope shock absorbers and two excursion limit elastic buffers for each spring.
The leaf springs are parabolic

Figure 2



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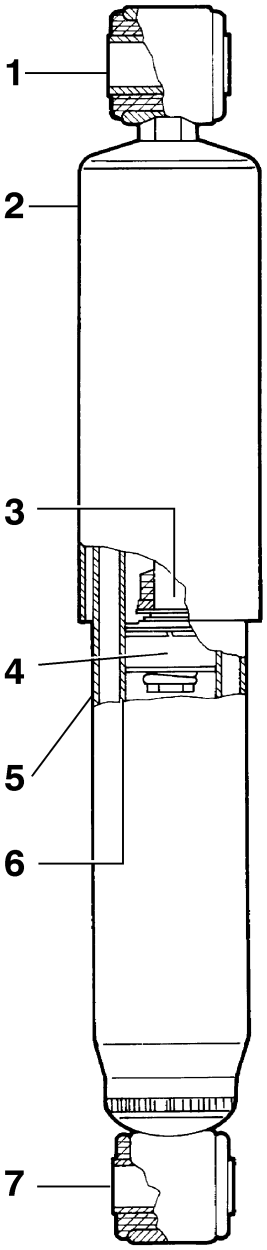
1. Chassis
2. Spring front mounting
3. Roll bar
4. Buffer
5. Anchor stirrup
6. Axle or drive
7. Shock absorber mounting
8. Shackle
9 Spring rear mounting
10. Spring

Hydraulic shock absorbers

Figure 3



The hydraulic shock absorbers are of the telescopic double acting type.

These shock absorbers are also defined "direct acting" since their braking action is directly performed on the suspension elements without levers.

They are fitted with thermostatically controlled valves, thus ensuring that there are no noticeable differences in their performance, even following sharp changes in temperature.

Shock absorbers are divided into three different parts:

1. the cylinder part located above the piston (always filled with oil);
2. the cylinder part located under the piston (always filled with oil);
3. the oil reserve, i.e. the compartment between the cylinders (5 and 6) (never completely filled with oil).

During the bouncing stage, i.e. when the shock absorber extends, the oil pushed by the piston (4) passes through the compartment, from the upper part of the piston to the lower part of the cylinder.

During the compression stage, i.e. when the shock absorber lengthens and piston goes downwards, the oil located under the piston passes directly to the upper part of the cylinder.

For oil passing from one part of the piston to the other, a forcing pressure intervenes acting on the piston and opposing piston movement thus causing suspension braking.

Noise

This defect, which is often laid to shock absorbers, can have different origins. It is therefore recommended to inspect suspensions carefully, including shock absorber connections to chassis or leaf spring.

Check whether no shock absorber part is in "metallic" touch with the leaf spring or the chassis.

Shock absorber dust protection distortion, due to wheel rotation, or short oil due to accidental leaks, can cause noise; in this case the shock absorber must be replaced.

Changes in braking effect

A change in the braking effect can take place accidentally.

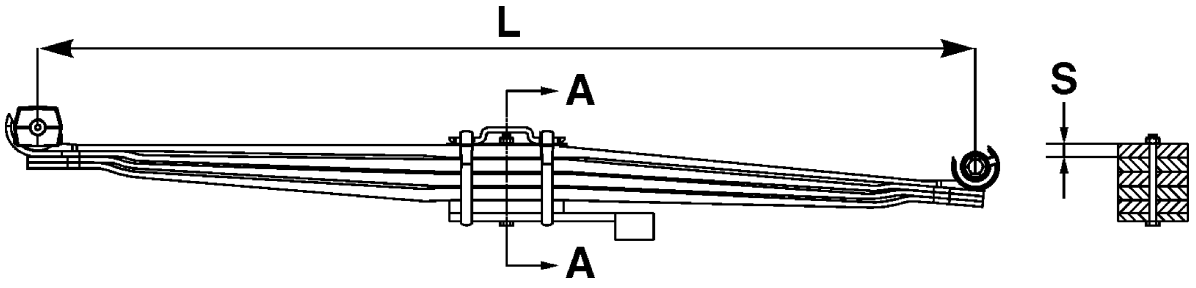
The decrease of the braking effect can be due to breakage of internal parts, short oil or jams.

Replace the shock absorber in any case.

CHARACTERISTICS AND SPECIFICATIONS
Leaf springs

Vehicle	Type A spring (parabolic)					
	Mounting		Spring characteristics			
	bearing	bush	leafs	thickness [mm]	length [mm]	Flexibility [mm/kN]
2-axle	standard	on request	4	24	1800	3.001
3-axle	standard	on request	4	24	1800	3.001
4-axle 1st axle 2nd axle	standard	on request	3	26	1600	2.155
	standard	on request	3	26	1600	2.155

Vehicle	Type B spring (semielliptical)					
	Mounting		Spring characteristics			
	bearing	bush	leafs	thickness [mm]	length [mm]	Flexibility [mm/kN]
2-axle	standard	-	10	15	1800	2.679
3-axle	standard	-	10	15	1800	2.679
4-axle 1st axle 2nd axle	-	-	-	-	-	-
	-	-	-	-	-	-



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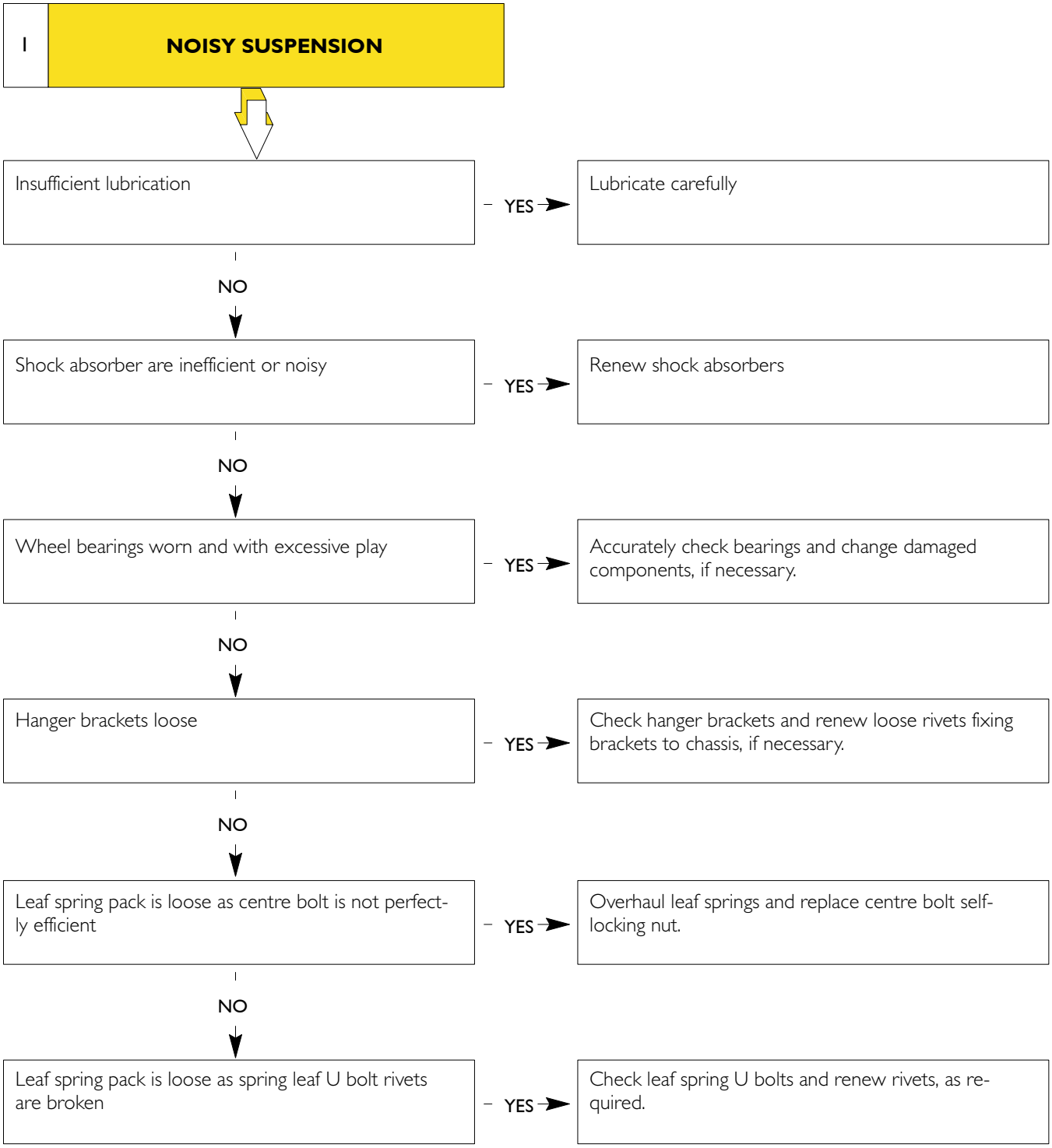
SHOCK ABSORBERS

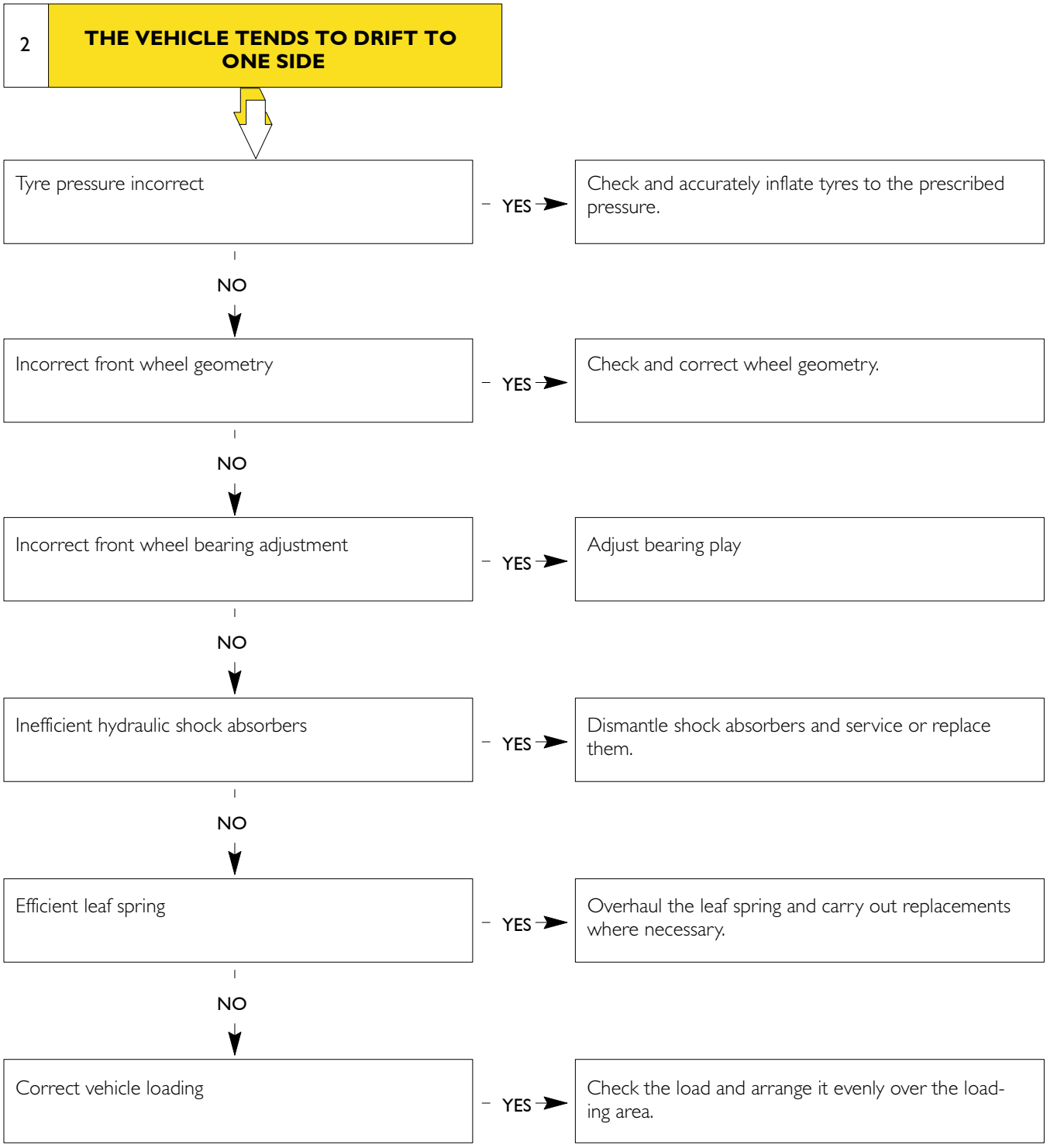
Vehicle	
open	650 ± 3
closed	427 ± 3
stroke	223

DIAGNOSTICS

Main possible defects:

1 - Noisy suspension;
2 - The vehicle tends to drift to one side:
3 - Excessive suspension flexibility:
4 - Squeaking, knocking and noisiness in general.




2
THE VEHICLE TENDS TO DRIFT TO ONE SIDE
Tyre pressure incorrect
YES
Check and accurately inflate tyres to the prescribed pressure.
NO
Incorrect front wheel geometry
YES
Check and correct wheel geometry.
NO
Incorrect front wheel bearing adjustment
YES
Adjust bearing play
NO
Inefficient hydraulic shock absorbers
YES
Dismantle shock absorbers and service or replace them.
NO
Efficient leaf spring
YES
Overhaul the leaf spring and carry out replacements where necessary.
NO
Correct vehicle loading
YES
Check the load and arrange it evenly over the loading area.

3 EXCESSIVE SUSPENSION FLEXIBILITY

Spring centre pin broken – YES → Replace the part.

NO

Spring leaves inefficient – YES → Overhaul the spring and replace those parts which cannot be used or, if necessary, the complete spring.

4 SQUEAKING, KNOCKING AND NOISINESS IN GENERAL

Incorrect fastening of leaf spring mountings – YES → Check mountings an if necessary replace the rivets fastening the spring to the frame that are loose.

NO

Leaf spring pack is loose as central fastening pin is broken – YES → Overhaul leaf spring and replace central pin and self-locking nut.

NO

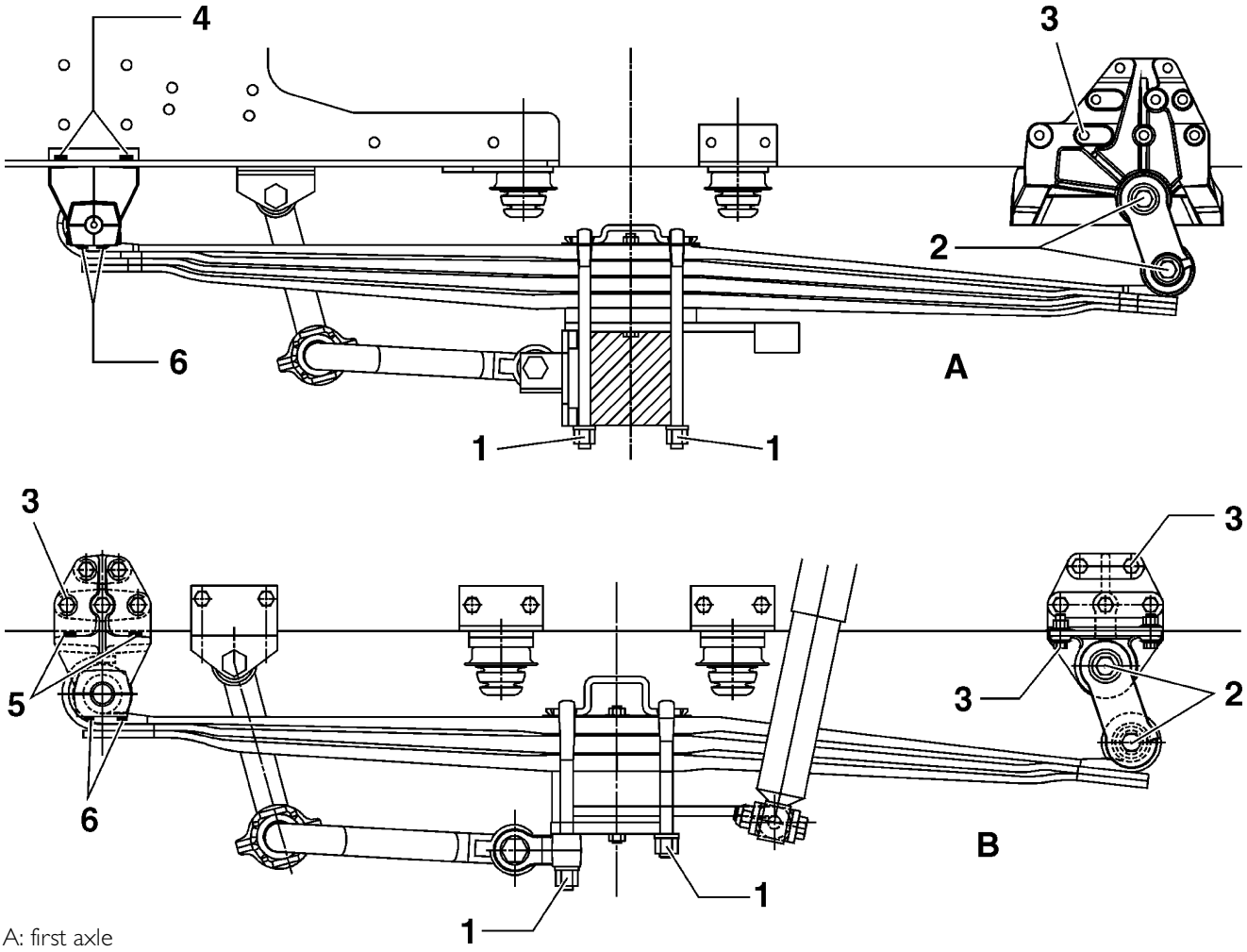
Leaf spring pack is loose as fixing rivets for spring U bolts are not efficient – YES → Check leaf spring locking U bolts and change fixing rivets.

NO

Wheel bearings worn with excessive play – YES → Carefully check the bearings and, if necessary, replace any damaged parts.
Adjust the wheel bearing play.

TIGHTENING TORQUES

Figure 4



A: first axle
B: second axle

1781405

PART		TORQUE	
		Nm	(Kgm)
1.	Leaf spring retaining stirrup nuts	485	49
2.	Shackle pin fastening bolts	625	64
3.	Shackle screws on chassis	190	19
4.	First axle front mounting screws	210	21
5.	Second axle front mounting screws	150	15
6.	Leaf spring pin cap fastening screws	130	13

TOOLS

TOOL NO.	DESCRIPTION
99306064	Trolley for leaf spring support during removal-replacement
99321024	Trolley for wheel removal

LEAF SPRING REMOVAL-REPLACEMENT (AXLE)

Removal

To remove one of the front leaf springs, proceed as follows:

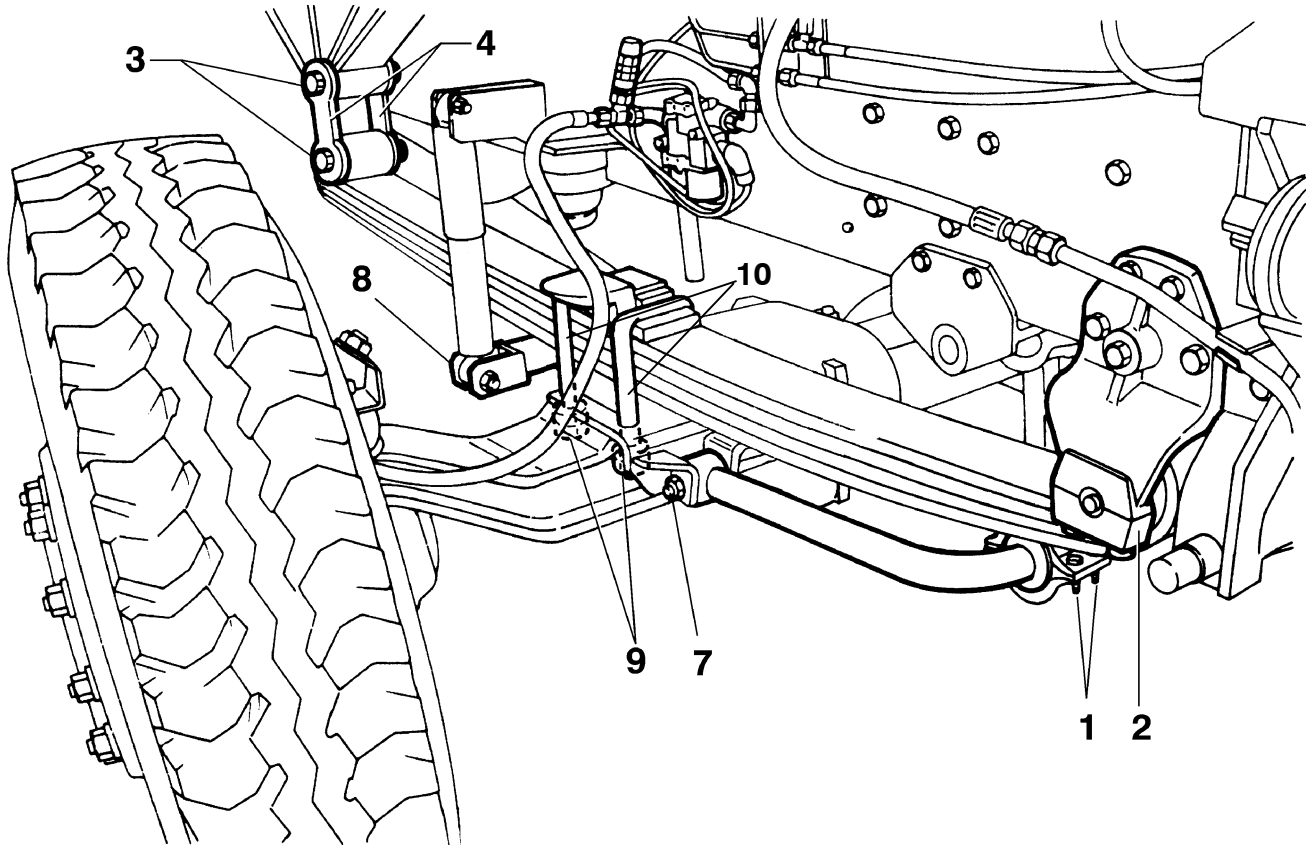
- ❑ Park the vehicle in a flat area and lock the rear wheels;
- ❑ Loosen the wheel nuts of the corresponding front wheel;
- ❑ Lift the front of the vehicle with a hydraulic jack and rest it on the two support stands;
- ❑ Remove the front wheel;
- ❑ Remove the stabiliser bar bolts (7) from both sides of the axle end and rotate it downwards;
- ❑ Unscrew the shock absorber nut (8);
- ❑ Unscrew the front leaf spring mounting (2) lower cap screws (1);
- ❑ Remove the upper and lower leaf spring shackle plate bolts (3);
- ❑ Remove the spring anchor plates (4);
- ❑ Unscrew the nuts (9) and remove the leaf spring fastening stirrup (10);
- ❑ Lower the axle with the hydraulic jack in order to remove the centring pin and extract the leaf spring.

Replacement

Repeat the removal operations in reverse order.

Once the springs are replaced, carry out wheel the convergence check described in Section 15.

Figure 5



1781406

LEAF SPRING REMOVAL-REPLACEMENT (DRIVE AXLE)

Removal

To remove one of the front leaf springs, proceed as follows:

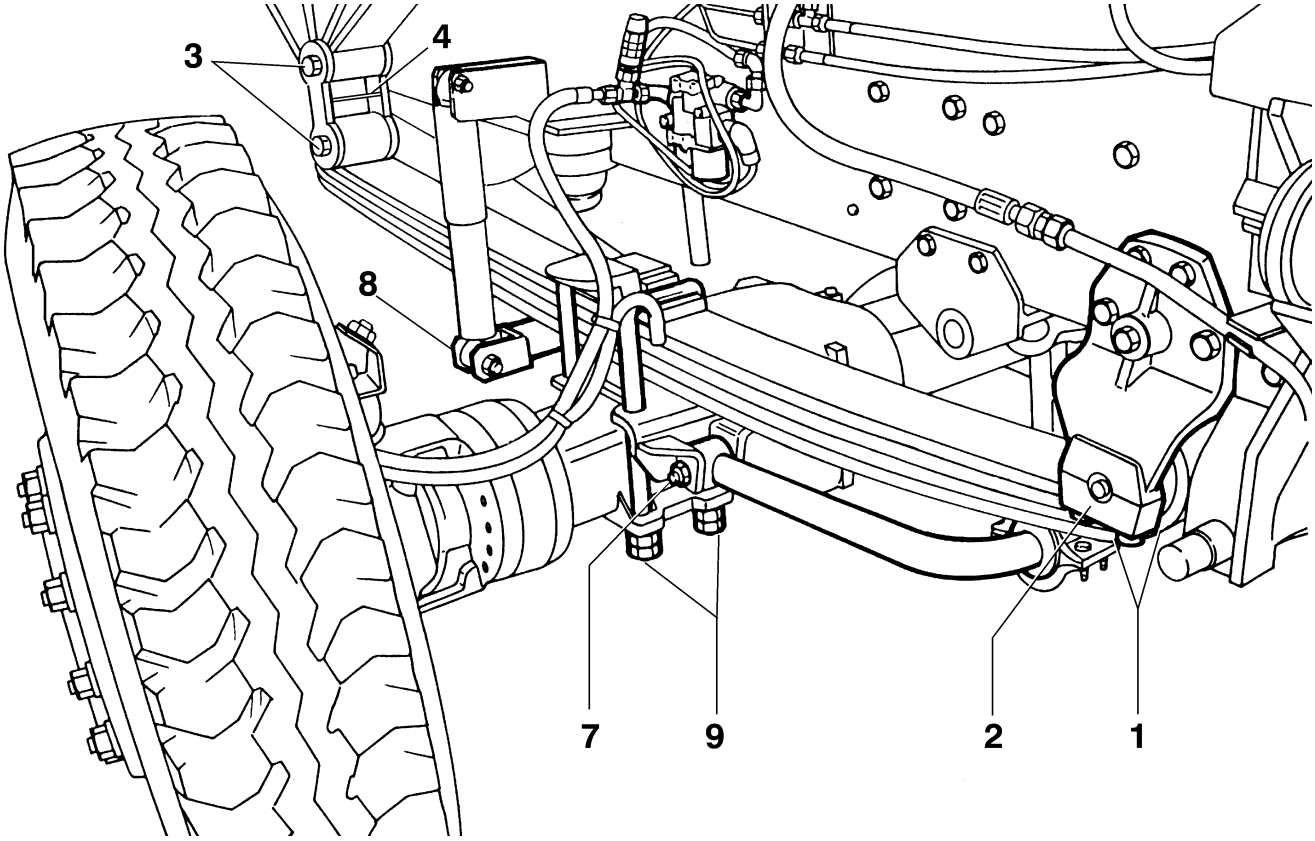
- ❑ Park the vehicle in a flat area and lock the rear wheels
- ❑ Loosen the wheel nuts of the corresponding front wheel
- ❑ Lift the front of the vehicle with a hydraulic jack and rest it on the two support stands
- ❑ Remove the front wheel
- ❑ Remove the stabiliser bar bolts (7) from both sides of the axle side and rotate it downwards
- ❑ Unscrew the shock absorber nut (8)
- ❑ Unscrew the front leaf spring mounting (2) lower cap screws (1)
- ❑ Remove the upper and lower leaf spring shackle plate bolts (3)
- ❑ Remove the spring anchor plates (4)
- ❑ Remove the spring anchor plates (4)
- ❑ Unscrew the nuts (9) and remove the leaf spring fastening stirrup (10)
- ❑ Lower the axle with the hydraulic jack in order to remove the centring pin and extract the leaf spring.

Replacement

Repeat the removal operations in reverse order

Once the springs are replaced, carry out wheel the convergence check described in Section 15.

Figure 6



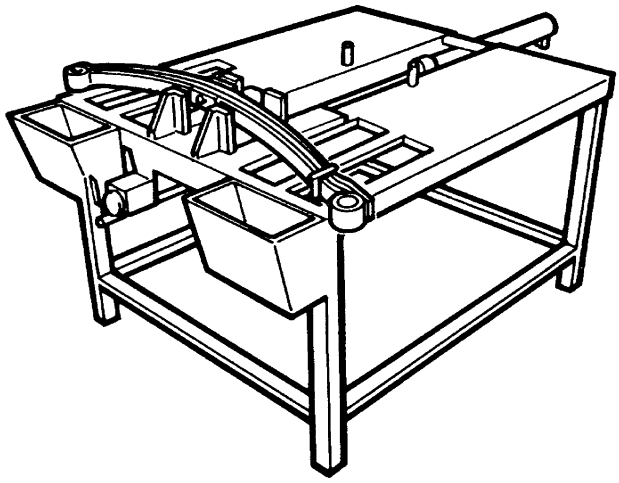
REPAIR OPERATIONS

Leaves are not to be replaced if the faulty spring is made up of less than three leaves.

The remaining leaves of the faulty spring that need not be replaced must not have visible scores or any shape deformation that could compromise the conformity to the working drawing.

Removing the rear leaf spring

Figure 7



38745

Set the leaf spring in the vice on the bench (15) clamping it near the central pin.
Remove the relevant nut and withdraw the central coupling pin.
Unscrew the nuts that lock the side brackets then remove the brackets.
The individual leaves that make up the leaf spring will now be free.

Checks

Use diesel or a suitable solvent to clean all the components.

Fitting in place the leaf spring

Ensure that the leaf contact surfaces are perfectly clean and smooth.
Place together the leaves that form the pack, setting the relevant spacers between them and aligning the central holes for the insertion of the coupling pin.
Lock the leaves between the vice clamps and insert the central pin into the side coupling clips, and locking with the relevant nut.
The clips must be locked so that they keep the leaves aligned, but without obstructing the movement.
After assembly, use a punch to fit the central pin and clip pins so that they are securely locked.

At every overhaul operation the spring centre pin and the side clip pins and nuts are always to be replaced.

ASTRA PARTS

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REAR SUSPENSIONS

SECTION 14.2

SECTION 14.2

Rear suspensions

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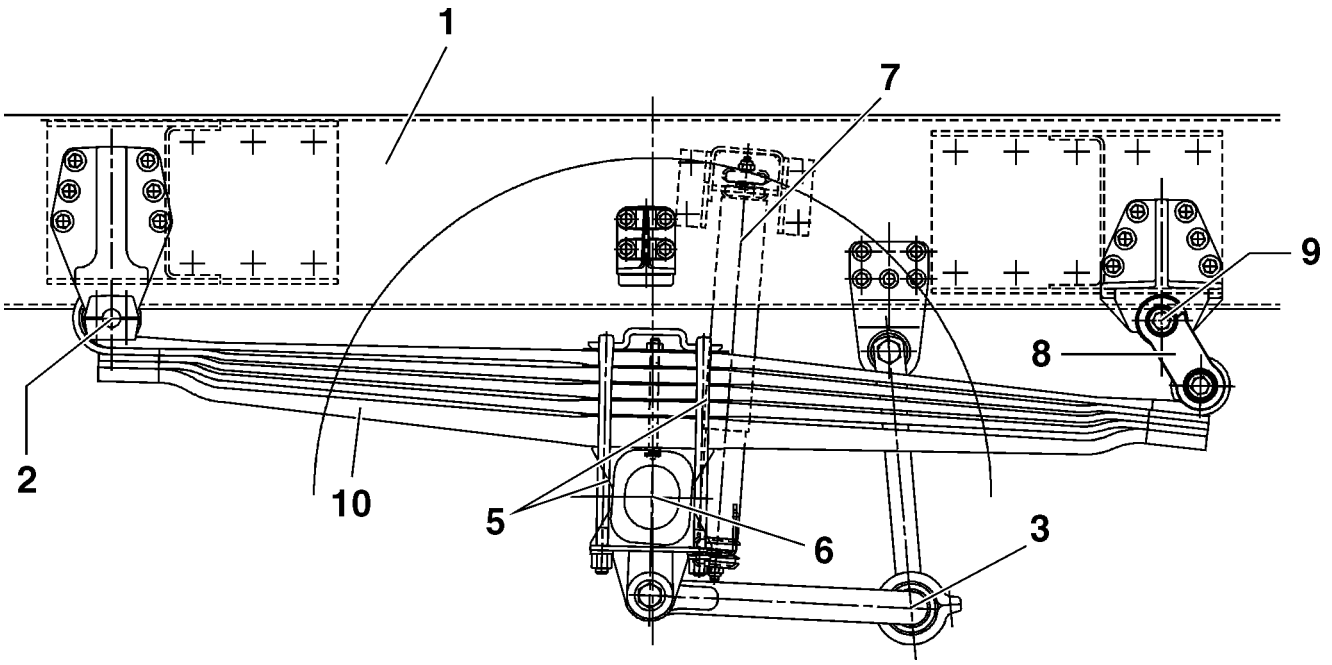
DESCRIPTION
2-axle vehicle suspension

The suspension system is comprised of a pair of longitudinally arranged single action leaf springs.

It is supplemented by a pair of dual action hydraulic telescope shock absorbers.

The suspension is also fitted with a roll bar to control vehicle inclination when cornering.

Figure 1



1 - Chassis. - 2. Spring front mounting. - 3. Roll bar. - 4. Not used. - 5. Anchor stirrups. - 6. Drive shaft or axle. - 7. Shock absorber. - 8. Shackle. - 9. Spring rear mounting. - 10 Spring.

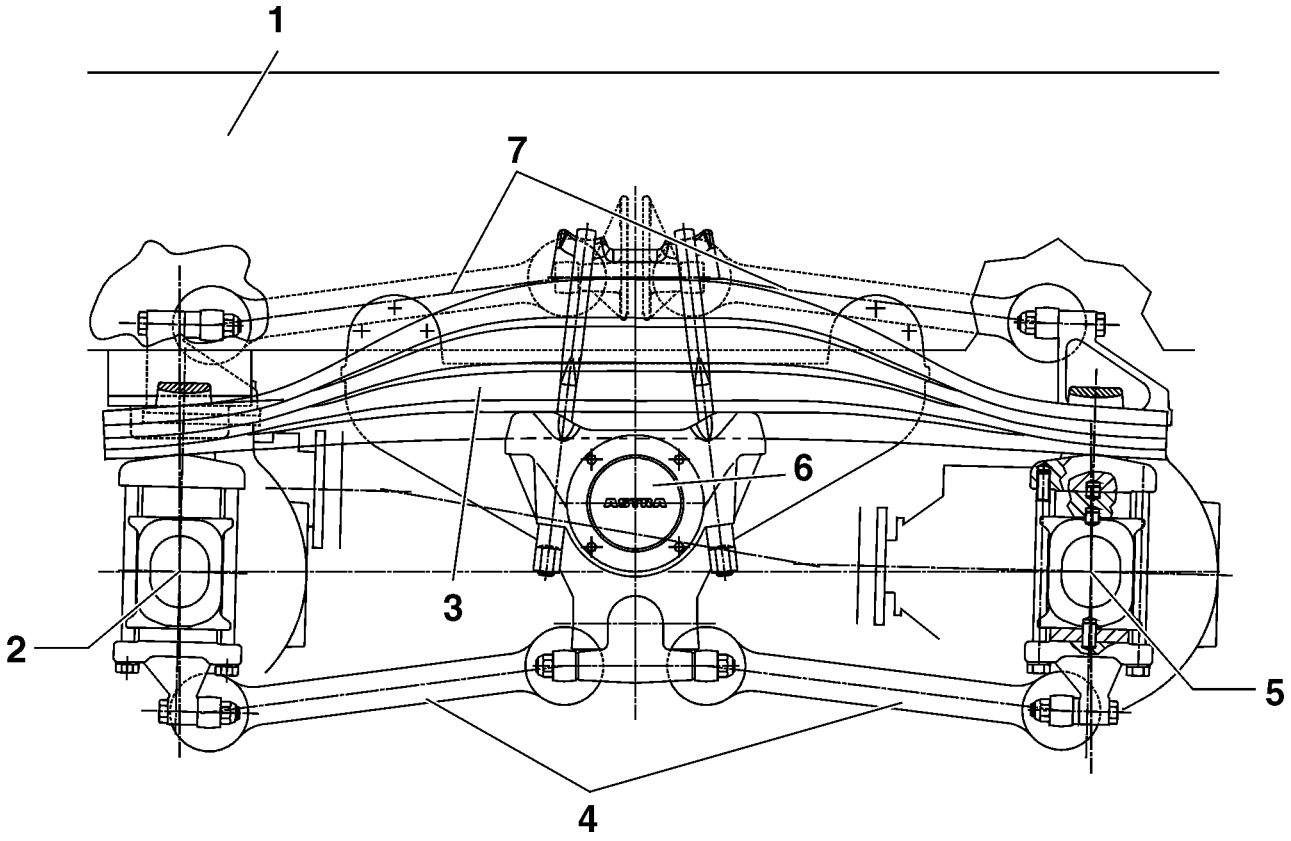
3 and 4-axle vehicle suspension

The suspension system is comprised of a pair of longitudinally arranged single action leaf springs, which serve both axles of the tandem.
The spring oscillates around a central pin, and the extremities of the springs slide on the axles themselves.
The suspension also has reaction bars between the axles and a central support for axial thrust control in braking and acceleration.

There are two possible types of leaf spring:

- ❑ Type A, parabolic spring, standard.
- ❑ Type B, semi-elliptical spring, on request.

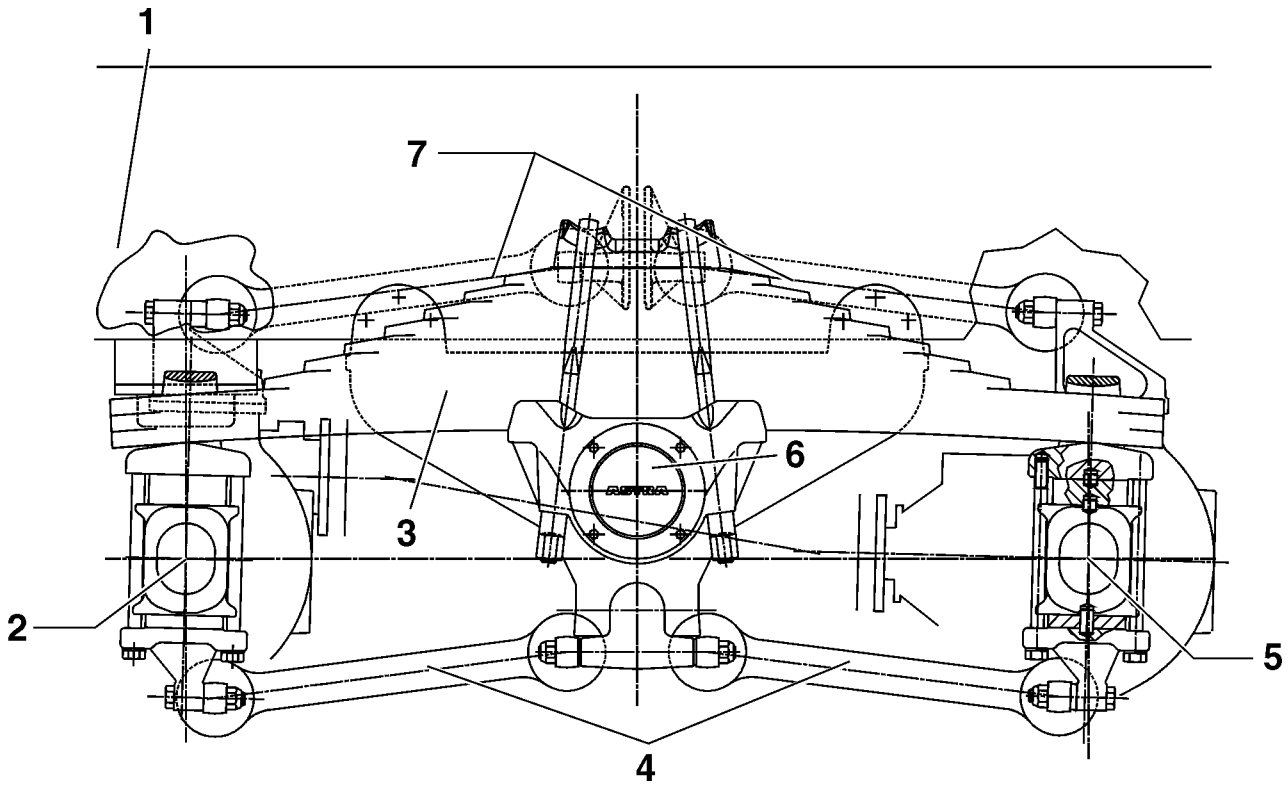
Figure 2



1781411

Type A leaf springs (parabolic)
1 - Chassis. - 2. Front tandem axle. - 3. Spring. - 4. Lower reaction bars. - 5. Rear tandem axle. - 6. Centre carriage. - 7. Upper reaction bars.

Figure 3



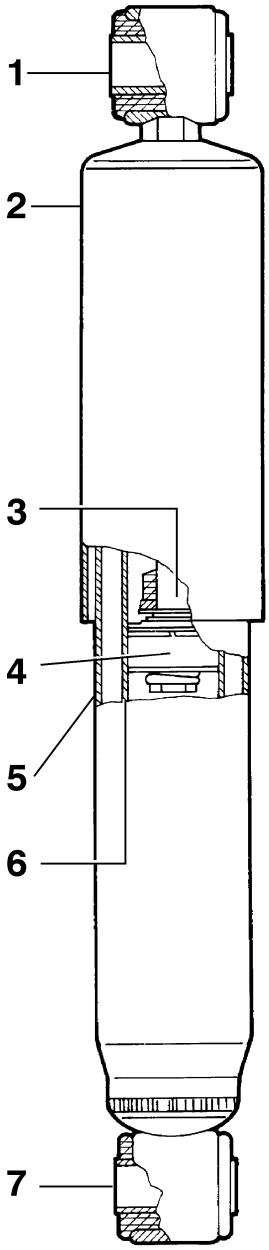
1781411

Type B leaf springs (semielliptical)

1 - Chassis. - 2. Front tandem axle. - 3. Spring. - 4. Lower reaction bars. - 5. Rear tandem axle. - 6. Centre carriage. - 7. Upper reaction bars

Hydraulic shock absorbers

Figure 4



The hydraulic shock absorbers are of the telescopic double acting type.

These shock absorbers are also defined "direct acting" since their braking action is directly performed on the suspension elements without levers.

They are fitted with thermostatically controlled valves, thus ensuring that there are no noticeable differences in their performance, even following sharp changes in temperature.

Shock absorbers are divided into three different parts:

1. the cylinder part located above the piston (always filled with oil);
2. the cylinder part located under the piston (always filled with oil);
3. the oil reserve, i.e. the compartment between the cylinders (5 and 6) (never completely filled with oil).

During the bouncing stage, i.e. when the shock absorber extends, the oil pushed by the piston (4) passes through the compartment, from the upper part of the piston to the lower part of the cylinder.

During the compression stage, i.e. when the shock absorber lengthens and piston goes downwards, the oil located under the piston passes directly to the upper part of the cylinder.

For oil passing from one part of the piston to the other, a forcing pressure intervenes acting on the piston and opposing piston movement thus causing suspension braking.

Noise

This defect, which is often laid to shock absorbers, can have different origins. It is therefore recommended to inspect suspensions carefully, including shock absorber connections to chassis or leaf spring.

Check whether no shock absorber part is in "metallic" touch with the leaf spring or the chassis.

Shock absorber dust protection distortion, due to wheel rotation, or short oil due to accidental leaks, can cause noise; in this case the shock absorber must be replaced.

Changes in braking effect

A change in the braking effect can take place accidentally.

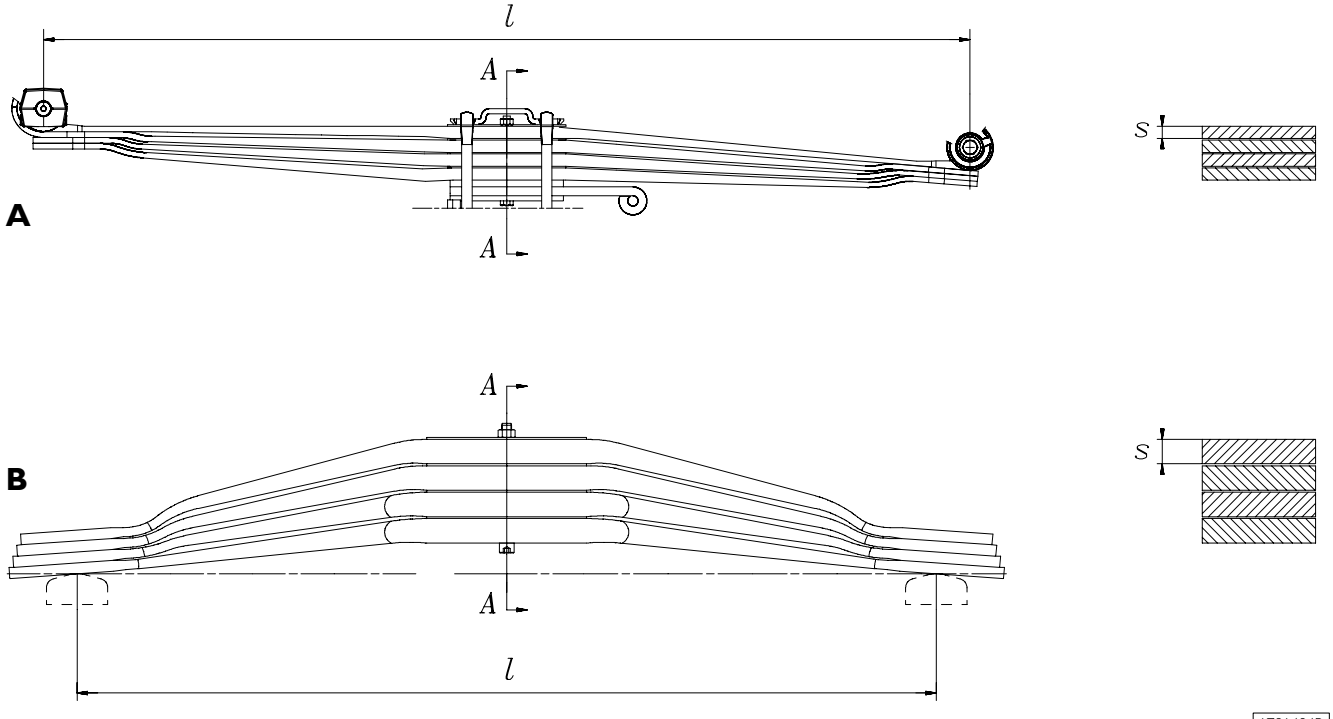
The decrease of the braking effect can be due to breakage of internal parts, short oil or jams.

Replace the shock absorber in any case.

SPECIFICATIONS AND DATA
Leaf springs

Vehicle	Type A spring (parabolic)					
	Mounting		Spring characteristics			
	bearing	bush	leafs	thickness [mm]	length [mm]	Flexibility [mm/kN]
2-axle	standard	on request	4	24	1800	0.865
			1	50		
3-axle	-	-	4	40	1400	0.228
4-axle	-	-	4	40	1400	0.228

Vehicle	Type B spring (semielliptical)					
	Mounting		Spring characteristics			
	bearing	bush	leafs	thickness [mm]	length [mm]	Flexibility [mm/kN]
2-axle	-	-	-	-	-	-
3-axle	-	-	10	25	1400	0.229
4-axle	-	-	1400	25	1400	0.229



1781404B

A: 2-axle
B: 3 and 4-axle

SHOCK ABSORBERS

Vehicle	
open	650 ± 3
closed	427 ± 3
stroke	223

DIAGNOSTICS

Main possible defects:

1 - Noisy suspension;
2 - The vehicle tends to drift to one side:
3 - Excessive suspension flexibility:
4 - Squeaking, knocking and noisiness in general.

1 NOISY SUSPENSION

Insufficient lubrication – YES → Lubricate carefully

NO

Shock absorber are inefficient or noisy – YES → Renew shock absorbers

NO

Wheel bearings worn and with excessive play – YES → Accurately check bearings and change damaged components, if necessary.

NO

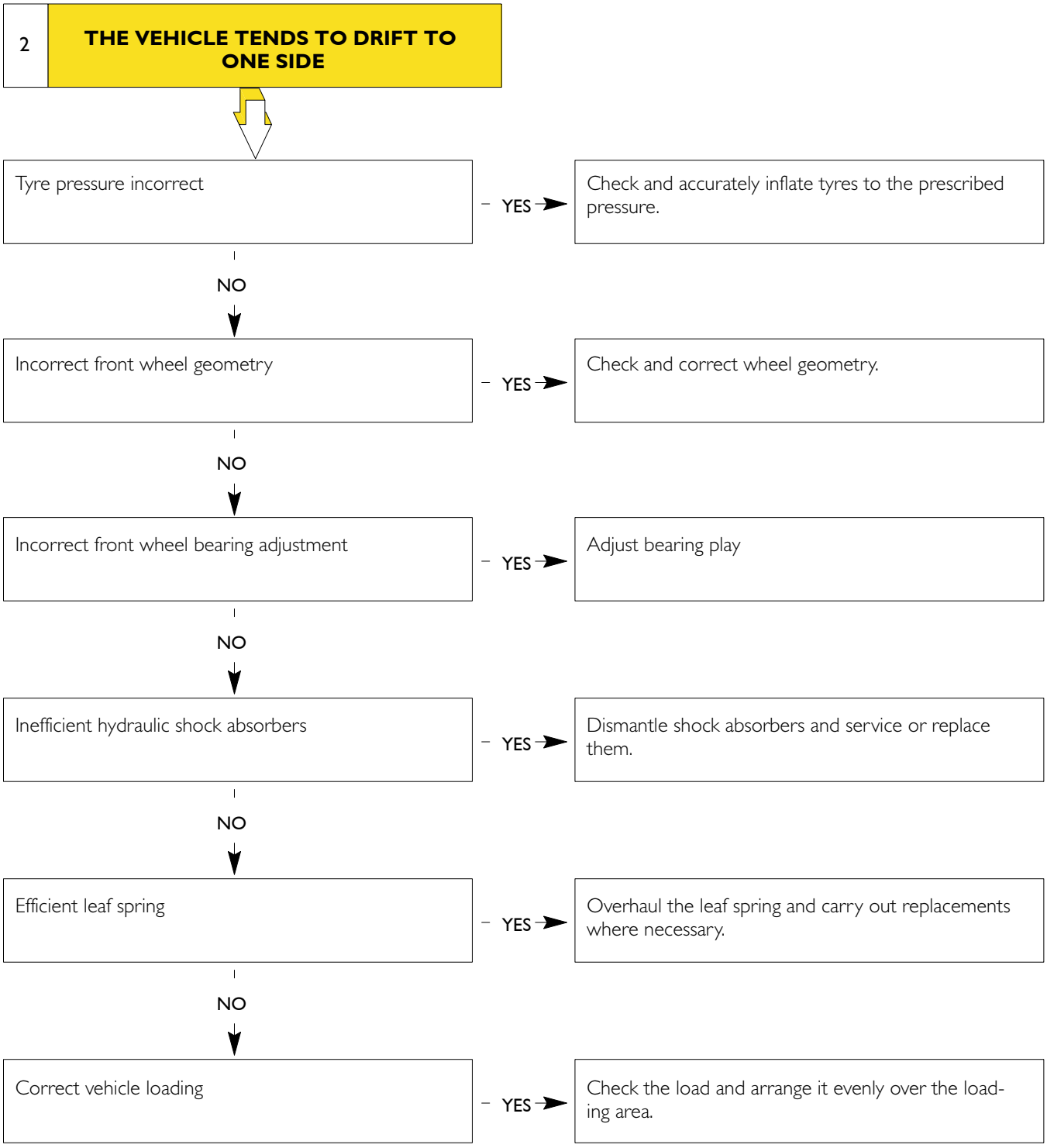
Hanger brackets loose – YES → Check hanger brackets and renew loose rivets fixing brackets to chassis, if necessary.

NO

Leaf spring pack is loose as centre bolt is not perfectly efficient – YES → Overhaul leaf springs and replace centre bolt self-locking nut.

NO

Leaf spring pack is loose as spring leaf U bolt rivets are broken – YES → Check leaf spring U bolts and renew rivets, as required.


2
THE VEHICLE TENDS TO DRIFT TO ONE SIDE
Tyre pressure incorrect
YES
Check and accurately inflate tyres to the prescribed pressure.
NO
Incorrect front wheel geometry
YES
Check and correct wheel geometry.
NO
Incorrect front wheel bearing adjustment
YES
Adjust bearing play
NO
Inefficient hydraulic shock absorbers
YES
Dismantle shock absorbers and service or replace them.
NO
Efficient leaf spring
YES
Overhaul the leaf spring and carry out replacements where necessary.
NO
Correct vehicle loading
YES
Check the load and arrange it evenly over the loading area.

3 EXCESSIVE SUSPENSION FLEXIBILITY

Spring centre pin broken – YES → Replace the part.

NO

Spring leaves inefficient – YES → Overhaul the spring and replace those parts which cannot be used or, if necessary, the complete spring.

4 SQUEAKING, KNOCKING AND NOISINESS IN GENERAL

Incorrect fastening of leaf spring mountings – YES → Check mountings an if necessary replace the rivets fastening the spring to the frame that are loose.

NO

Leaf spring pack is loose as central fastening pin is broken – YES → Overhaul leaf spring and replace central pin and self-locking nut.

NO

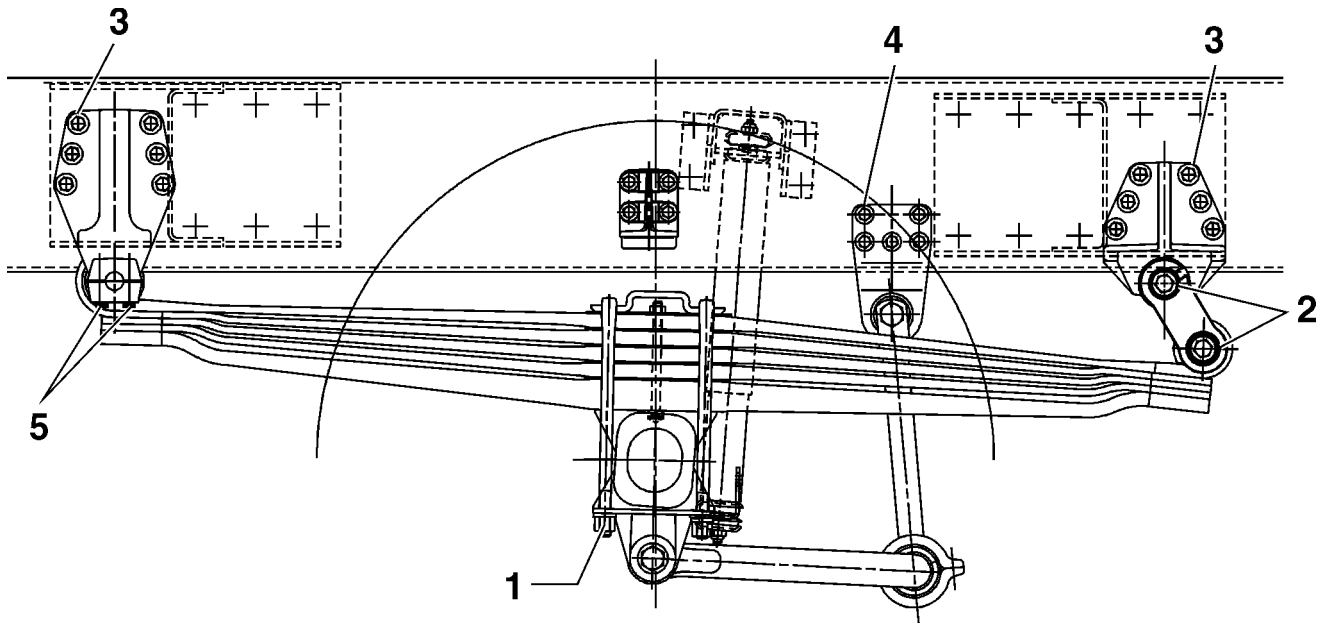
Leaf spring pack is loose as fixing rivets for spring U bolts are not efficient – YES → Check leaf spring locking U bolts and change fixing rivets.

NO

Wheel bearings worn with excessive play – YES → Carefully check the bearings and, if necessary, replace any damaged parts.
Adjust the wheel bearing play.

TIGHTENING TORQUES
2-axle vehicles

Figure 5



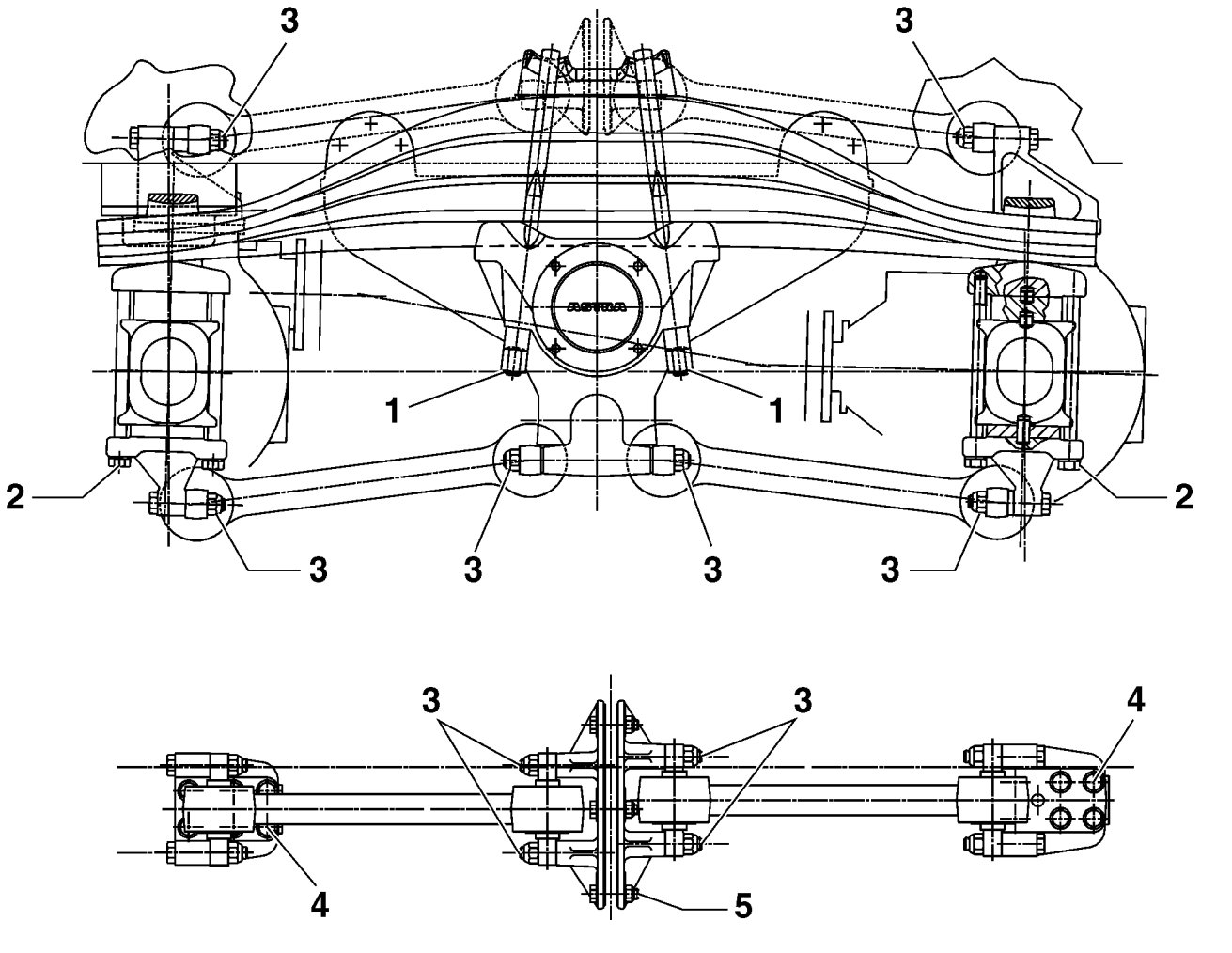
1781413

Front suspension

PART		TORQUE	
		Nm	(Kgm)
1.	Leaf spring retaining stirrup nuts	485	50
2.	Shackle pin fastening bolts	625	65
3.	Spring mounting screws on chassis	310	32
4.	Roll bar mounting screws	180	19
5.	Leaf spring pin cap fastening screws	130	13,5

3 and 4-axle vehicles

Figure 6



1781414

Front suspension

PART	TORQUE	
	Nm	(Kgm)
1. Leaf spring retaining stirrup nuts	855	88
2. Retaining stirrup bolts at axle	390	40
3. Reaction bar fastening bolts	600	62
4. Reaction bar screws on chassis	380	39
5. Central reaction bar fastening bolts	250	25.5

TOOLS

TOOL NO.	DESCRIPTION
99306064	Trolley for leaf spring support during removal-replacement
99321024	Trolley for wheel removal
0/72512	Oscillating central carriage locking ring pre-assembly support

LEAF SPRING REMOVAL-REPLACEMENT (2-axle vehicles)

Removal

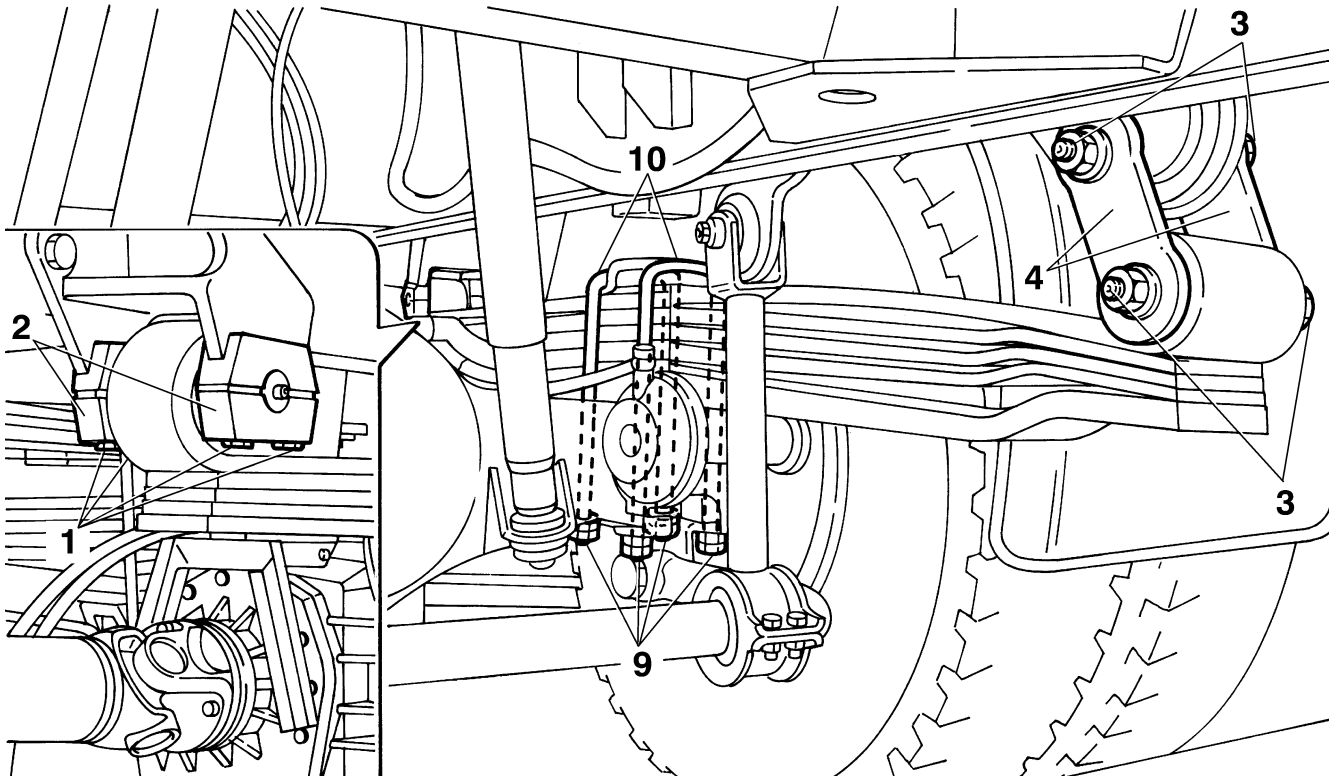
To remove one of the rear leaf springs, proceed as follows:

- ❑ Park the vehicle in a flat area and lock the front wheels
- ❑ Loosen the wheel nuts of the corresponding rear wheel
- ❑ Lift the front of the vehicle with a hydraulic jack and rest it on the two support stands
- ❑ Remove the rear wheel
- ❑ Unscrew the leaf spring front mounting (2) lower cap screws (1)
- ❑ Remove the upper and lower leaf spring shackle plate bolts (3)
- ❑ Remove the spring anchor plates (4)
- ❑ Unscrew the nuts (9) and remove the leaf spring fastening stirrup (10)
- ❑ Lower the axle with the hydraulic jack in order to remove the centring pin and extract the leaf spring.

Replacement

Repeat the removal operations in reverse order

Figure 7



1781415

REMOVING - REFITTING THE LEAF SPRING (3-axle and 4-axle vehicles)

Removal

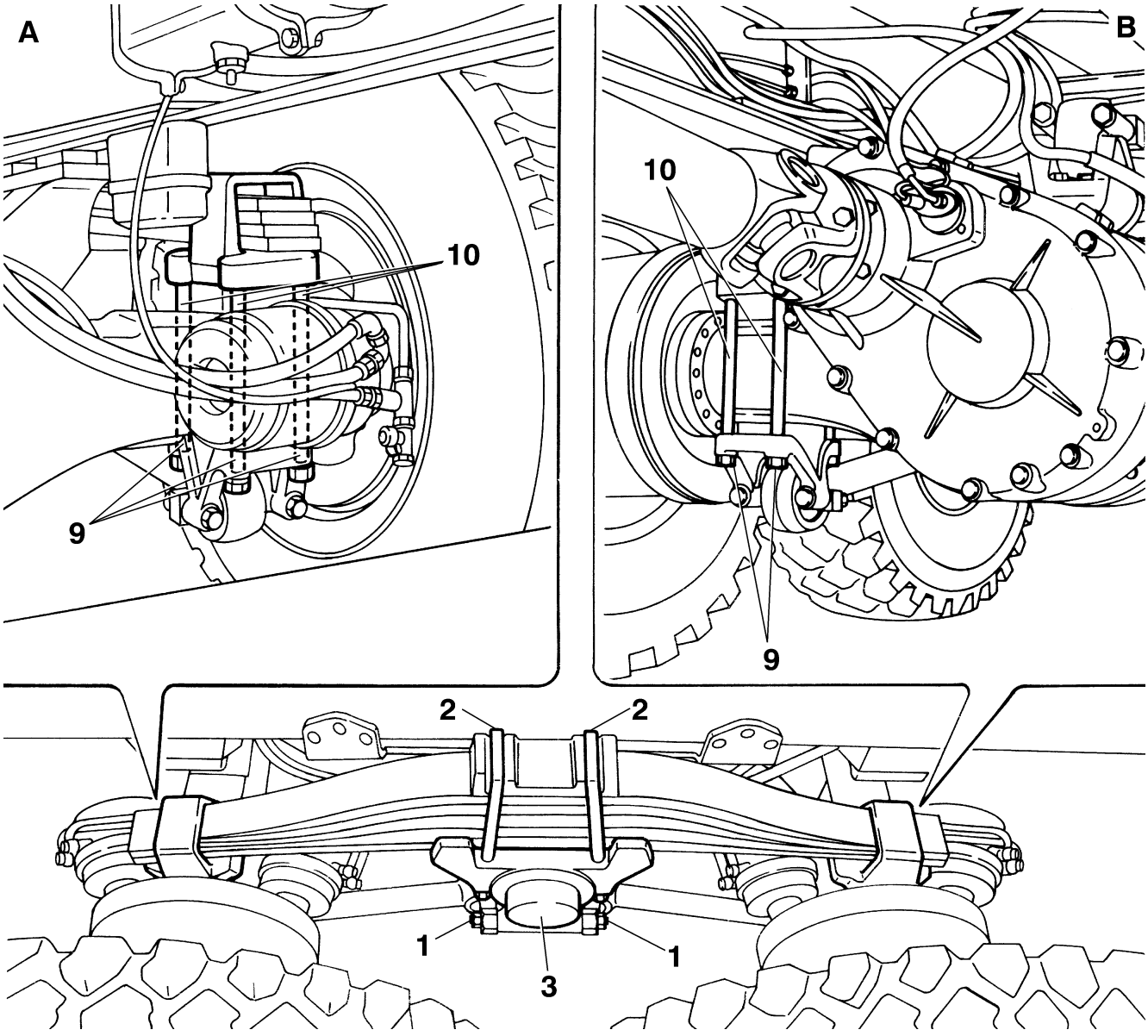
To remove the leaf spring proceed as follows:

- ❑ place the vehicle on a flat ground and suitably lock the front wheels;
- ❑ loosen rear wheel fastening nuts on the side of the leaf spring to be replaced;
- ❑ using a hydraulic jack lift the rear part of the vehicle (side of leaf spring to be replaced) and rest it on two stands;
- ❑ remove both rear wheels;
- ❑ unscrew nuts (9) and lift leaf spring fixing brackets (10) on rear axle (A) and intermediate axle (B);
- ❑ unscrew nuts (1) and take away the brackets (2) fixing the leaf spring to the floating support (3);
- ❑ operate the hydraulic jack and lower the rear axle to take away the dowel and remove the leaf spring by suitable movements.

Replacement

To refit, follow the removal operations in reverse order.

Figure 8



1781416

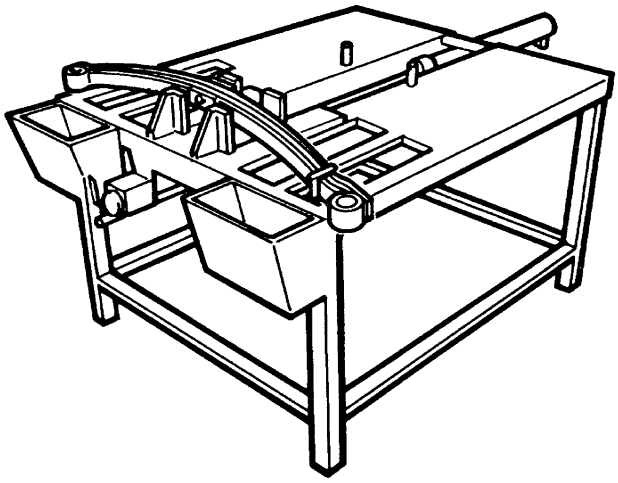
REPAIR OPERATIONS

Leaves are not to be replaced if the faulty spring is made up of less than three leaves.

The remaining leaves of the faulty spring that need not be replaced must not have visible scores or any shape deformation that could compromise the conformity to the working drawing.

Removing the rear leaf spring

Figure 9



38745

Set the leaf spring in the vice on the bench (15) clamping it near the central pin.
Remove the relevant nut and withdraw the central coupling pin.
The individual leaves that make up the leaf spring will now be free.

Checks

Use diesel or a suitable solvent to clean all the components.

Fitting in place the leaf springs

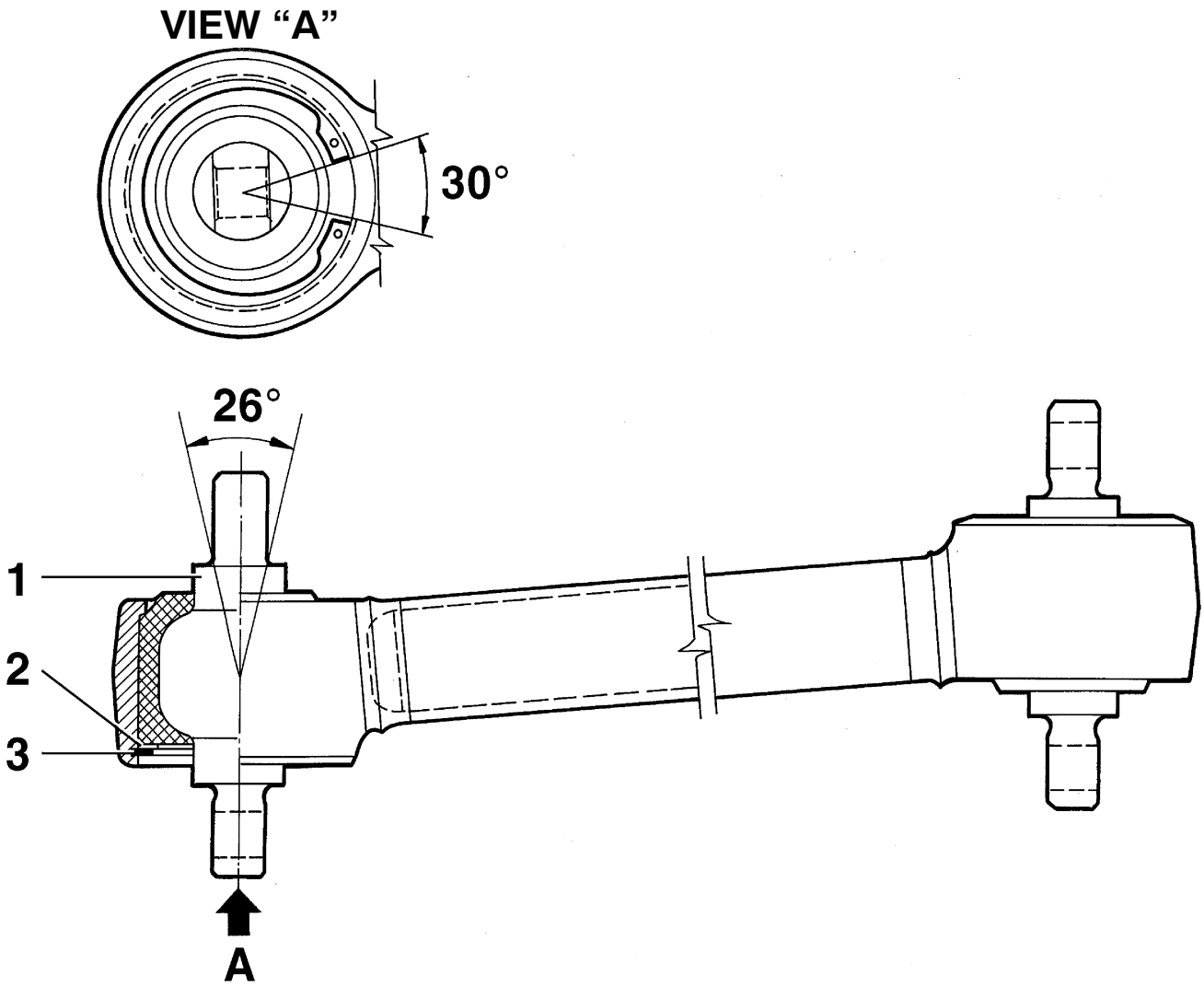
Ensure that the leaf contact surfaces are perfectly clean and smooth.
Place together the leaves that form the pack, setting the relevant spacers between them and aligning the central holes for the insertion of the coupling pin.
Lock the leaves between the vice clamps and insert the central pin into the side coupling clips, and locking with the relevant nut.
After assembly, use a punch to fit the central pin and clip pins so that they are securely locked.

At every overhaul operation the spring centre pin with related absorber nut.

ASTRA PARTS

REPLACING THE FLOATING ARM PIN (3-axle and 4-axle vehicles)

Figure 10



Removal

With a press and a suitable beater compress the flexible part of the pin (1) to enable the removal of the split ring (3) and the ring (2) underneath with the relevant pliers. Remove the pin (1) from the floating arm.

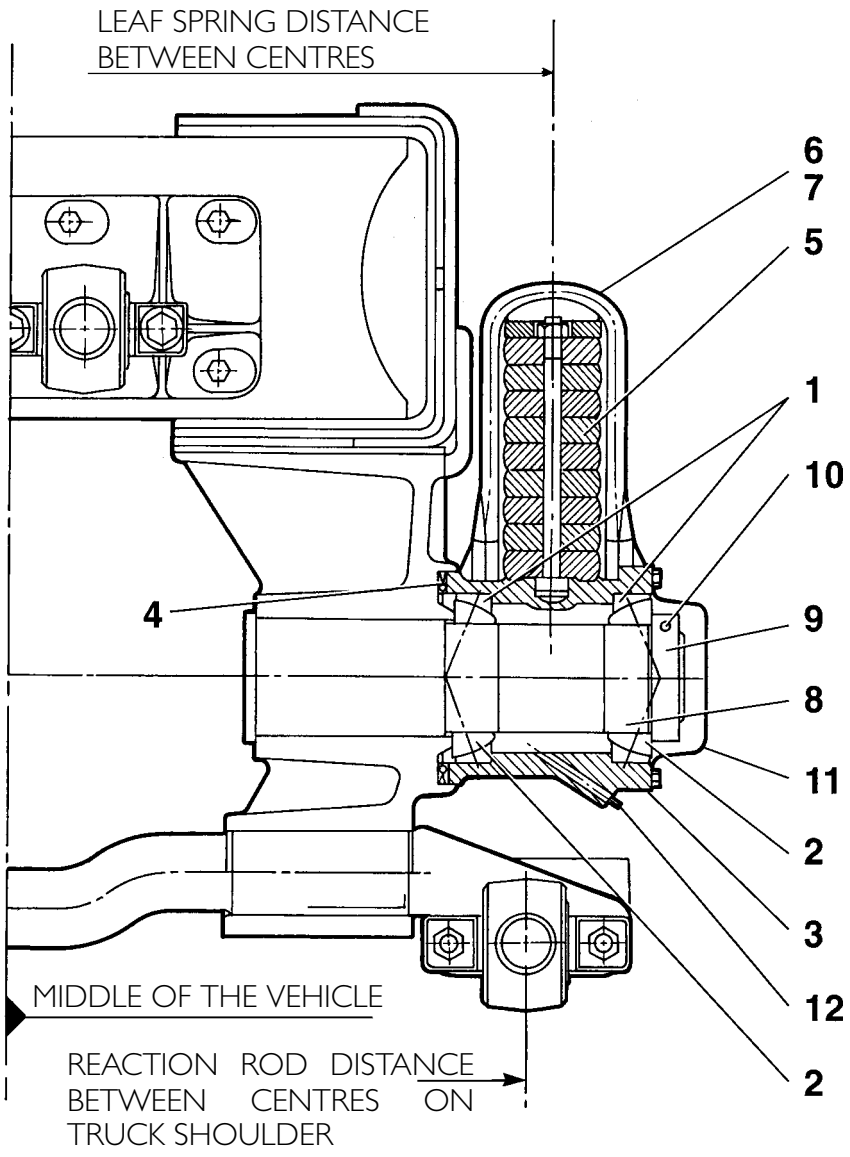
Fitting in place

Reverse the removal instructions but remember that the flexible pin (1) contact surface must be 90° from the floating arm longitudinal axis and the split ring opening (3) is to be positioned as shown in the figure detail.

REFITTING AND ADJUSTING THE FLOATING SUPPORT (3-axle and 4-axle vehicles)

- ❑ put the races (1) of the ball supports (2) on the floating support (3) and fit the sealing gasket (4);
- ❑ fit the leaf spring (5) on the floating support and tighten gradually and evenly the leaf spring fixing brackets (6 and 7) to the required torque;
- ❑ set internal ball support race (2) on truck pin (8), fit the floating support and set the external ball support race (2) on truck pin. Both ball support races must be hot-assembled (Temp. =80° - 100°);
- ❑ take service ring nut (9) (tool 0/72511 for 1st type truck pin, tool 0/72512 for 2nd type truck pin), and tighten it to remove floating support end play;
- ❑ replace the service ring nut with the clamp ring nut, put it in touch with the floating support and then loosen it 18 ± 3°, check whether the end play is 0.1 ± 0.05 mm;
- ❑ ring nut (9) must be fitted with strong thread-locker extra-quick LOCTITE 270. (Extra-quick LOCTITE 601 as an alternative);
- ❑ the floating support must be rotated manually, otherwise the above operations shall be repeated;
- ❑ tighten ring nut screw (10) to 32 Nm torque. Screw (10) must be fitted with average thread-locker extra-quick LOCTITE 242. Fit the cap (11) filled with grease, then grease using the grease nipple (12) until grease is coming out from the sealing gasket (4)

Figure 11



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STEERING SYSTEM

SECTION 15

SECTION 15

Steering system

DESCRIPTION
2-axle and 3-axle vehicles

The provided steering system is of the power steering type.

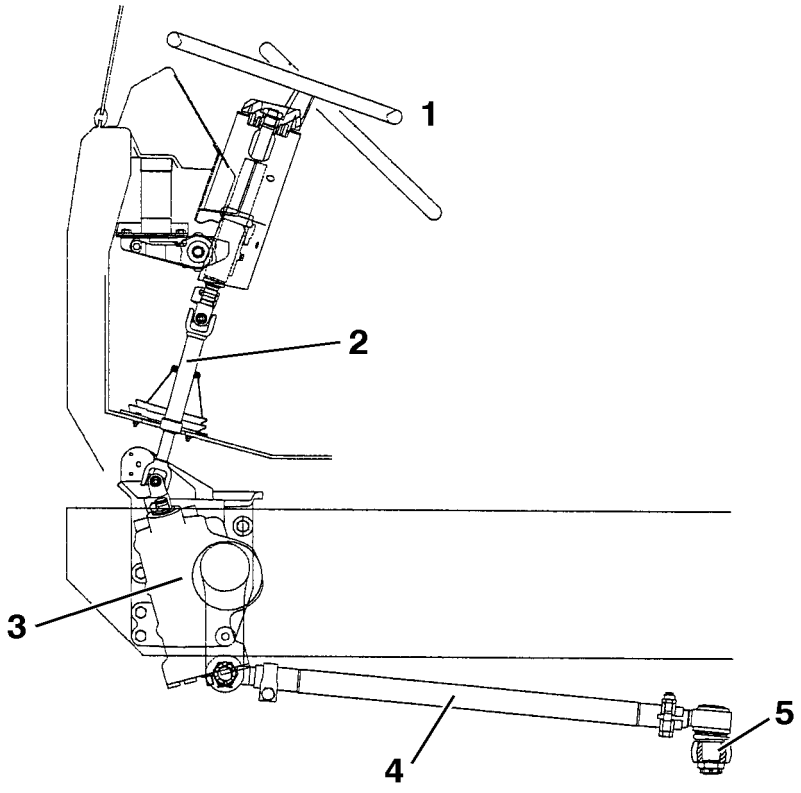
Purpose of this type of system is to reduce the driver's efforts on the steering wheel to obtain vehicle steering.

The steering wheel (500 mm diameter) operates the ZF power steering, which performs a direct mechanical connection with the steering lever on the left wheel hub which operates the right-hand wheel through the quadrilateral steering links.

The power steering is controlled by a pump fitted on the engine and supplied by a tank.

A pressure relief valve protects the system against excess pressure.

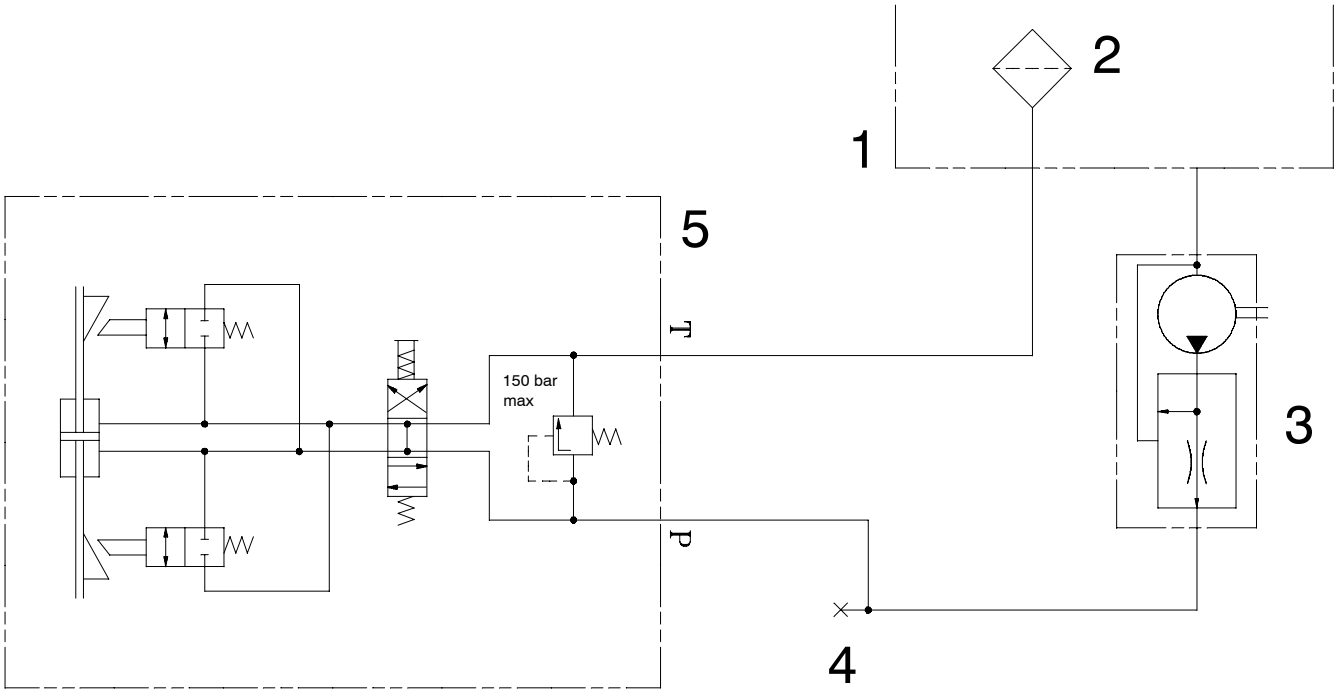
Figure 1



1. Steering wheel - 2. Steering column - 3. Steering box - 4. Steering link - 5. Steering khuckle lever head

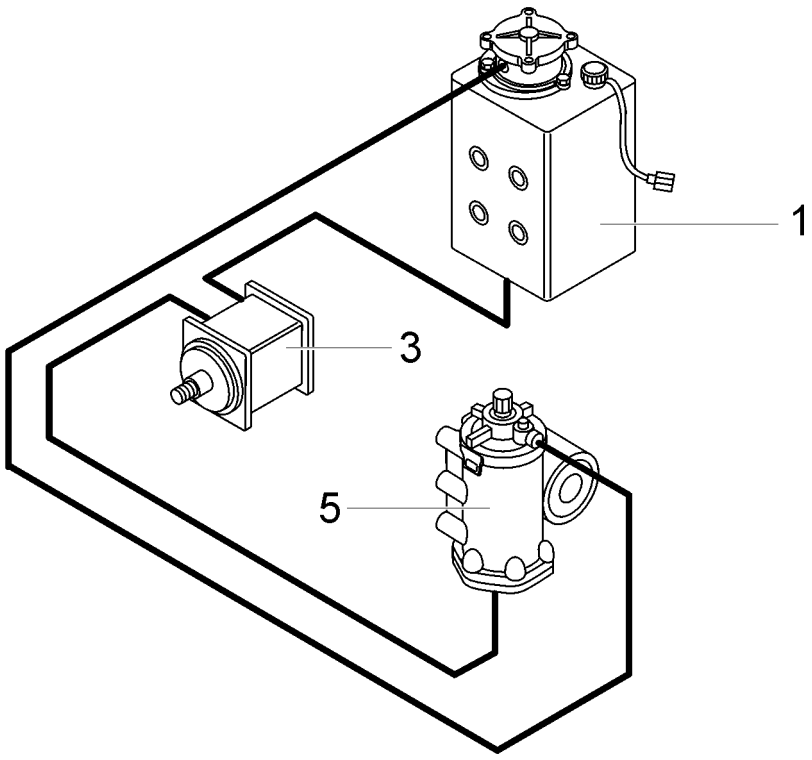
2 and 3-axle vehicle hydraulic servosteering system

Diagram



1781509

Illustration



1781508

1. Reservoir. - 2. Filter. - 3. Pump. - 4. Tester connection. - 5. Servosteering unit.

4-axle vehicles

The provided steering system is of the power steering type.

Purpose of this type of system is to reduce the driver's efforts on the steering wheel to obtain vehicle steering.

Mechanical steering, hydraulically assisted, operating on 1st and 2nd axle wheels.

The steering wheel (500 mm diameter) operates the ZF power steering, which performs a direct mechanical connection with the steering lever on the left wheel hub of the 1st axle and, through transmission, with the steering lever on the left wheel hub of the 2nd axle which operate the other two wheels by means of the two quadrilateral steering links.

This operation is assisted by two hydraulic cylinders:

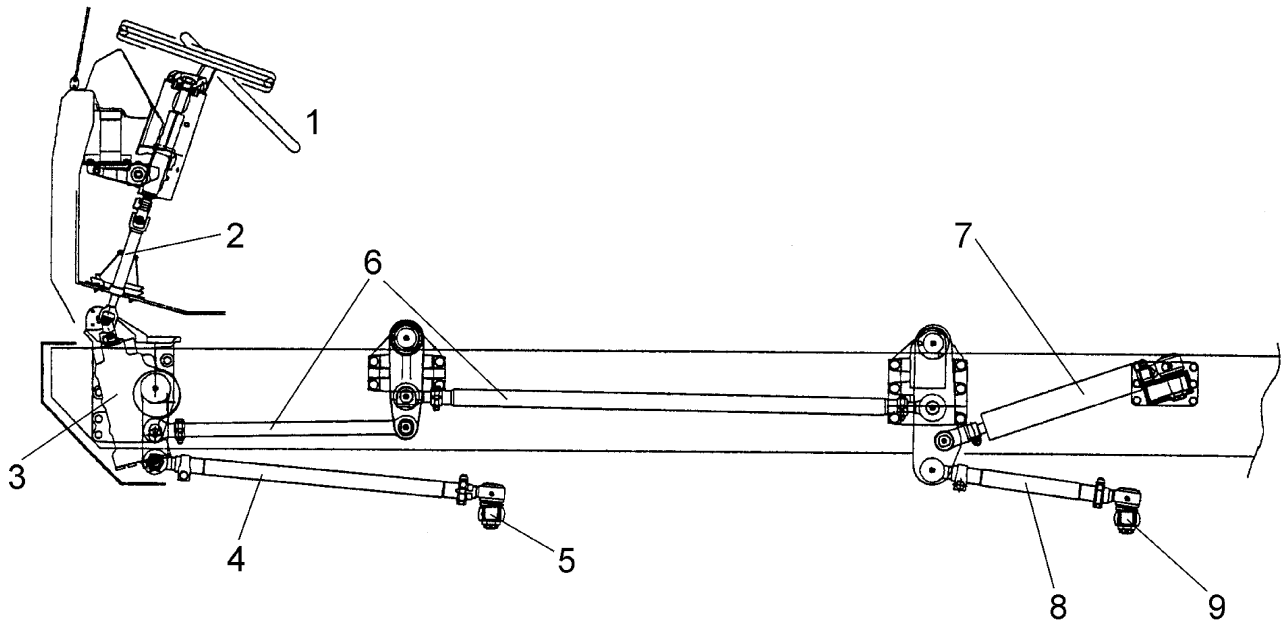
- the first cylinder is housed in the power steering and works on the first axle;
- the second cylinder is fitted separately and works on the second axle.

The power steering is controlled by two main pumps fitted on the engine and one emergency pump fitted on transmission.

The system is provided with two tanks connected with each other and feeding the three pumps.

A pressure relief valve protects the system against excess pressure.

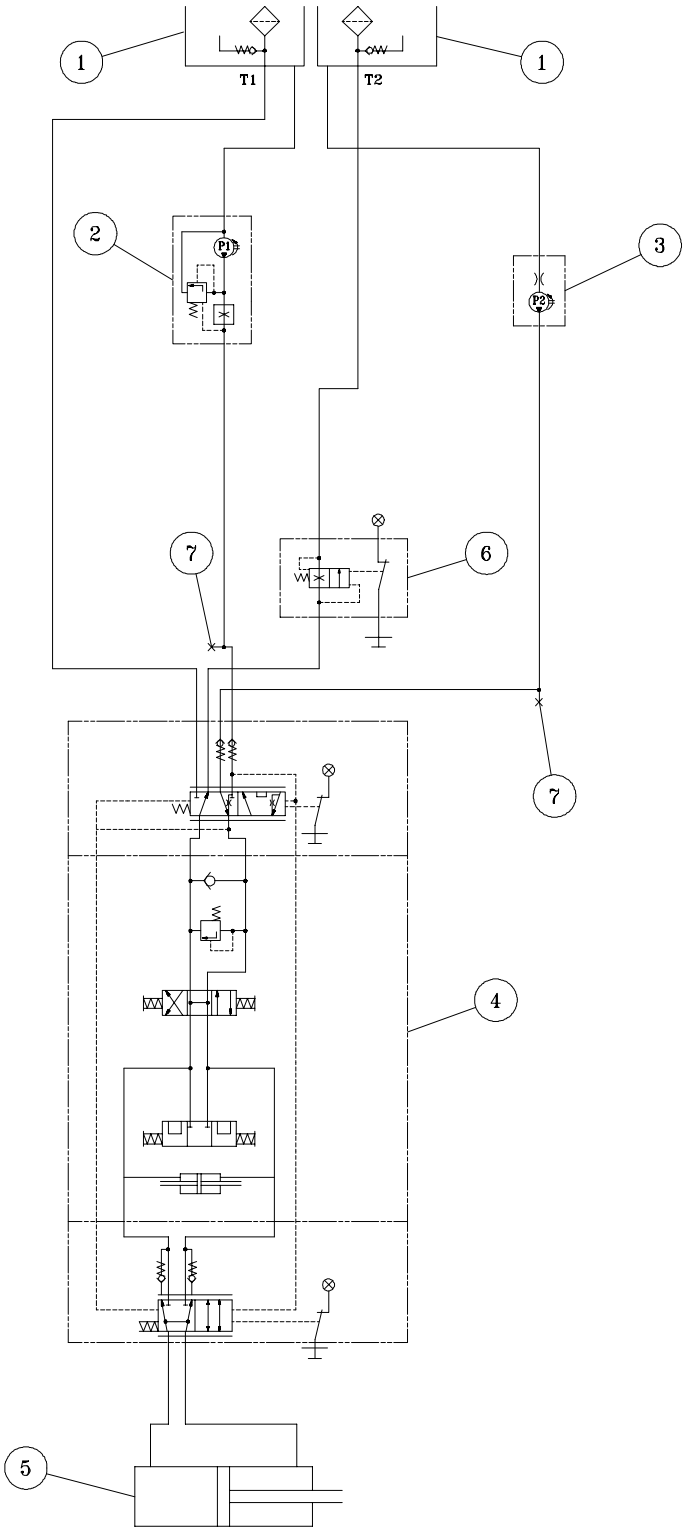
Figure 2



2151501

1. Steering wheel - 2. Steering column - 3. Steering box - 4. Steering rod - 5. First axle stub - 6. Second axle control linkages - 7. Second axle steering cylinder - 8. Steering cylinder rod - 9. Second axle stub

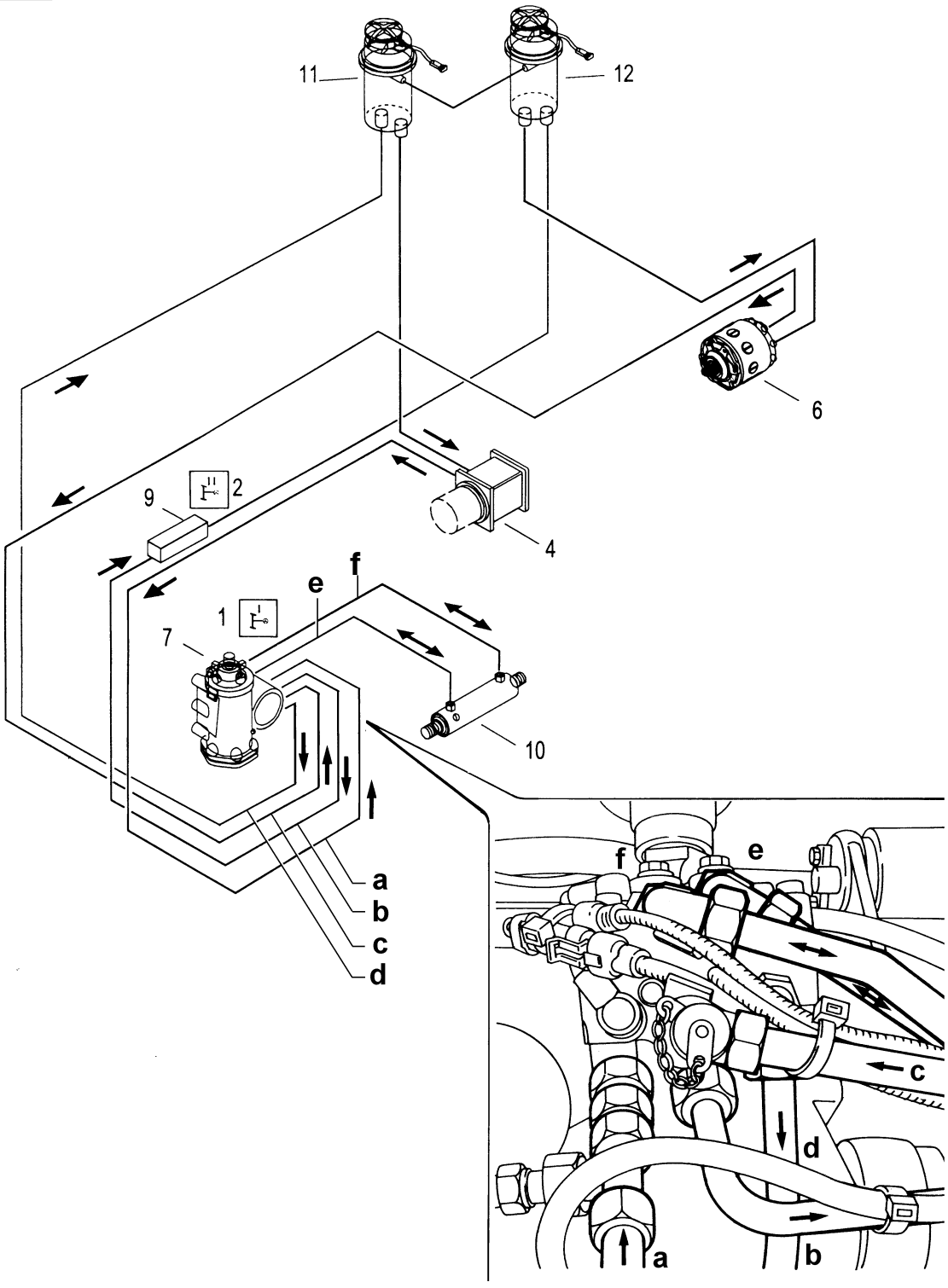
4-axle vehicle hydraulic power steering system



1. Power steering fluid reservoir - 2. Vane pump (on compressor) - 3. Piston pump (on transmission) - 4. Power steering (working pressure 140+14 bar) - 5. Operator cylinder - 6. Flow indicator - 7. Test connector

Scheme

Figure 3



1. Main circuit failure warning light - 2. Secondary circuit failure warning light - 3. Not used - 4. Paddle pump on compressor - 5. Not used - 6. Piston pump on driveline - 7. Power steering - 8. Not used - 9. Flow indicator - 10. Operator cylinder - 11. Reservoir - 12. Reservoir

Power steering - 2 axles and 3 axles vehicles

The power steering is ball bearing mounted and essentially consists of the steering box and the mechanical part of the steering line, a command valve and an operating cylinder.

Rotation of the steering wheel is transmitted friction-free by the bearing mounted steering column and then transformed into axial movement of the piston.

The teeth of the piston in the box engage with the teeth of the sector type shaft, rotating the shaft.

The steering rod linked to this shaft transfers torque to the steering linkages on the wheel.

This exclusively mechanical steering action is assisted by pressurised oil delivered by a pump driven by the engine.

The command valve consists of a rotary distributor, supported by rollers in the worm screw and with six command grooves on the perimeter, the end of the worm screw supported in the steering box and with equally as many command grooves.

The rotary distributor also serves as the lower connection of the shaft from the box and turns with the worm screw when the steering wheel is turned.

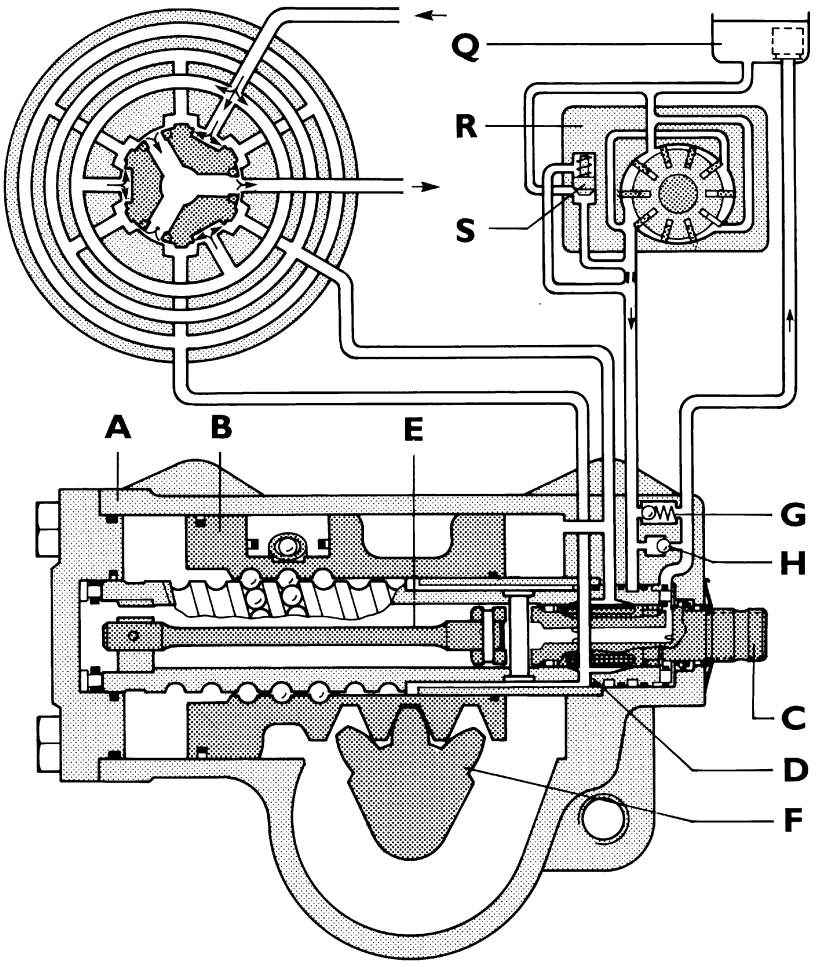
This synchronous rotary motion is due to the fact that the worm screw (D) and the rotary distributor (CI) are connected by a torque bar (E) that holds the command valve in neutral position (driving straight) until the wheel is turned.

When torque is applied to the steering wheel or by the wheels to the worm screw, elastic deformation is applied to the torque bar undergoes elastic deformation, creating a relative motion between the rotary distributor (CI) and the end of the worm screw (D) that serves as command box .

This shifts the distributor command grooves with respect to those on the end of the worm screw shifting the command valve from neutral position to operative.

The pressurised oil at the command valve (G) is now free to pass through the open command grooves and penetrate one of the two operator cylinder chambers, assisting the steering manoeuvre through pressure on the piston surface.

Figure 4



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A. Box - B. Piston - C. Rotary distributor/steering shaft - D. command box/worm screw - E. Torque bar - F. Toothed sector output shaft - G. Pressure regulator valve - H. Re-intake valve - Q. Oil tank - R. Paddle pump - S. Flow rate regulator valve

Power steering - 4 axles vehicles

The power steering is ball bearing mounted and essentially consists of the steering box and the mechanical part of the steering line, a command valve and an operating cylinder.

Rotation of the steering wheel is transmitted by the bearing mounted steering column (E) through a worm screw (H) and then transformed into axial movement of the piston (D).

The teeth of the piston in the box engage with the teeth of the sector type shaft (G), rotating the shaft

The steering rod linked to this shaft transfers torque to the steering linkages on the wheel.

This exclusively mechanical steering action is assisted by pressurised oil delivered by a pump (A) driven by the engine.

There is also an emergency pump (O) driven by the driveline.

The command valve consists of a rotary distributor, supported by rollers in the worm screw and with six command grooves on the perimeter, the end of the worm screw supported in the steering box and likewise with equally as many command grooves.

The rotary distributor also serves as the lower connection of the shaft from the box and turns with the worm screw when the steering wheel is turned.

This synchronous rotary motion is due to the fact that the worm screw (H) and the rotary distributor (E) are connected by a torque bar (I) that holds the command valve in neutral position (driving straight) until the wheel is turned.

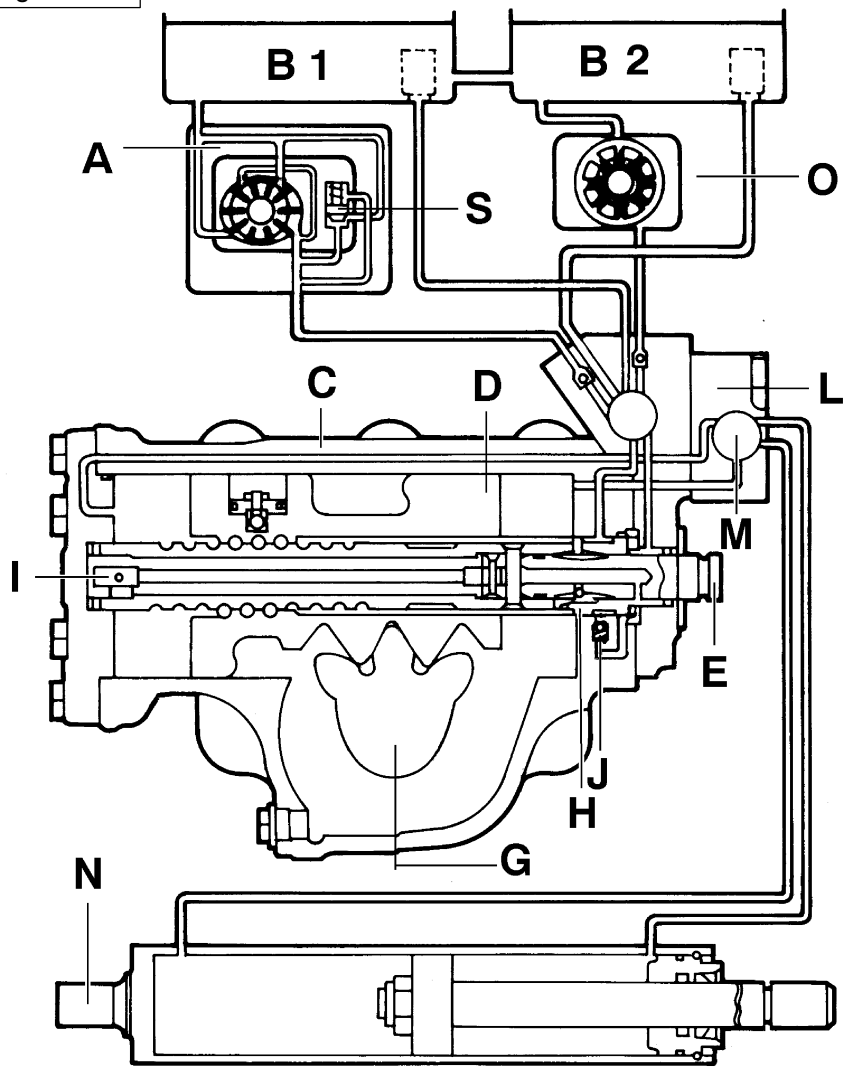
When torque is applied to the steering wheel or by the wheels to the worm screw, the torque bar undergoes elastic deformation, creating a relative motion between the rotary distributor (E) and the end of the worm screw (H) that serves as command box .

This shifts the distributor command grooves with respect to those on the end of the worm screw shifting the command valve from neutral position to operative.

The pressurised oil at the command valve is now free to pass through the open command grooves and penetrate one of the two operator cylinder chambers, assisting the steering manoeuvre through pressure on the piston surface (D).

This pressure is also delivered through the distributor valve to the second steering axle operator cylinder (N).

Figure 5



A. Main pump
B1. Oil reservoir
B2. Oil reservoir
C. Box
D. Piston
E. Rotary distributor/ steering column
G. Output shaft segment toothed
H. Command box/worn screw
I. Torque bar
J. Limiter valve pressure
L. Distributor valve
N. Operator cylinder
O. Emergency pump
S. Limiter valve flow-rate

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Steering hydraulic limitation

Steering regulation is achieved by two valves "T" and "U" axially arranged in piston "B". These are fitted with spring loaded actuators pistons with stems protruding from the front right and left surfaces of the piston itself.

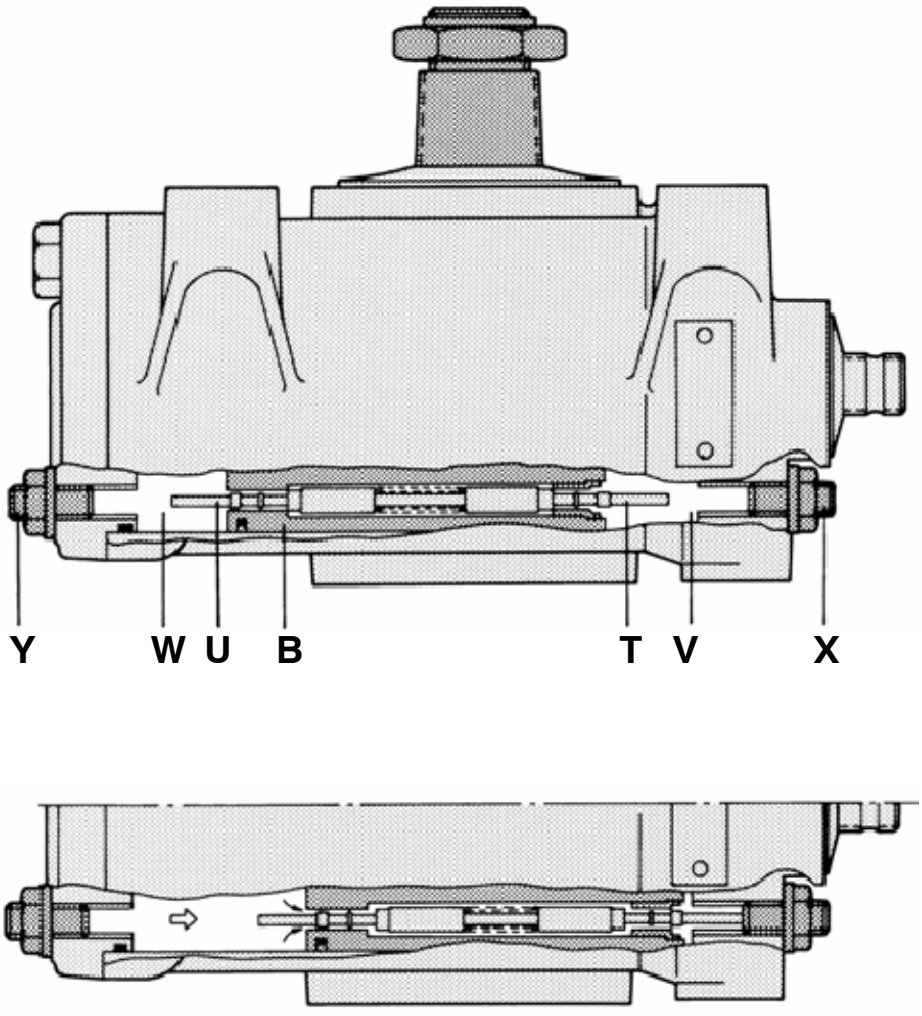
When the piston move right or left toward the limit the stems come into contact with shift bushes "Y" and "X" in the box and in the cover and consequently compress. Both regulation valves remain closed until one of the stems touches the shift bush.
If for example the piston shifts right for "left turn" the right steering limit valve "T" is opened by bush "Y" before the piston can reach the limit stop.

In this way pressurised oil present in the operator cylinder left chamber can penetrate into the right chamber, flowing around the piston shifted by valve "U" and through open right valve "T" to reach the return circuit.

If the piston is moved to the left for "right steering", valve "U" opens after the predetermined stroke and the pressurised oil in the right chamber of the cylinder flows into the cylinder to reach the return circuit, reducing pressure in the circuit chamber.

When the steering regulator valve is open, hydraulic servo power is significantly reduced and the steering wheel can only be turned by applying greater force up to the steering or wheel limit

Figure 6



B. Piston - T. Right steering limit valve - U. Left steering limit valve - V. Cylinder right chamber - W. Cylinder left chamber - X. left adjuster screw - Y. right adjuster screw

Automatic steering regulation

With the automatic steering limit regulation device, manual adjustment of hydraulic limit is no longer necessary.

Steering regulation is achieved by two valves "T" and "U" axially arranged in piston "B". These are fitted with spring loaded actuators pistons with stems protruding from the front right and left surfaces of the piston itself.

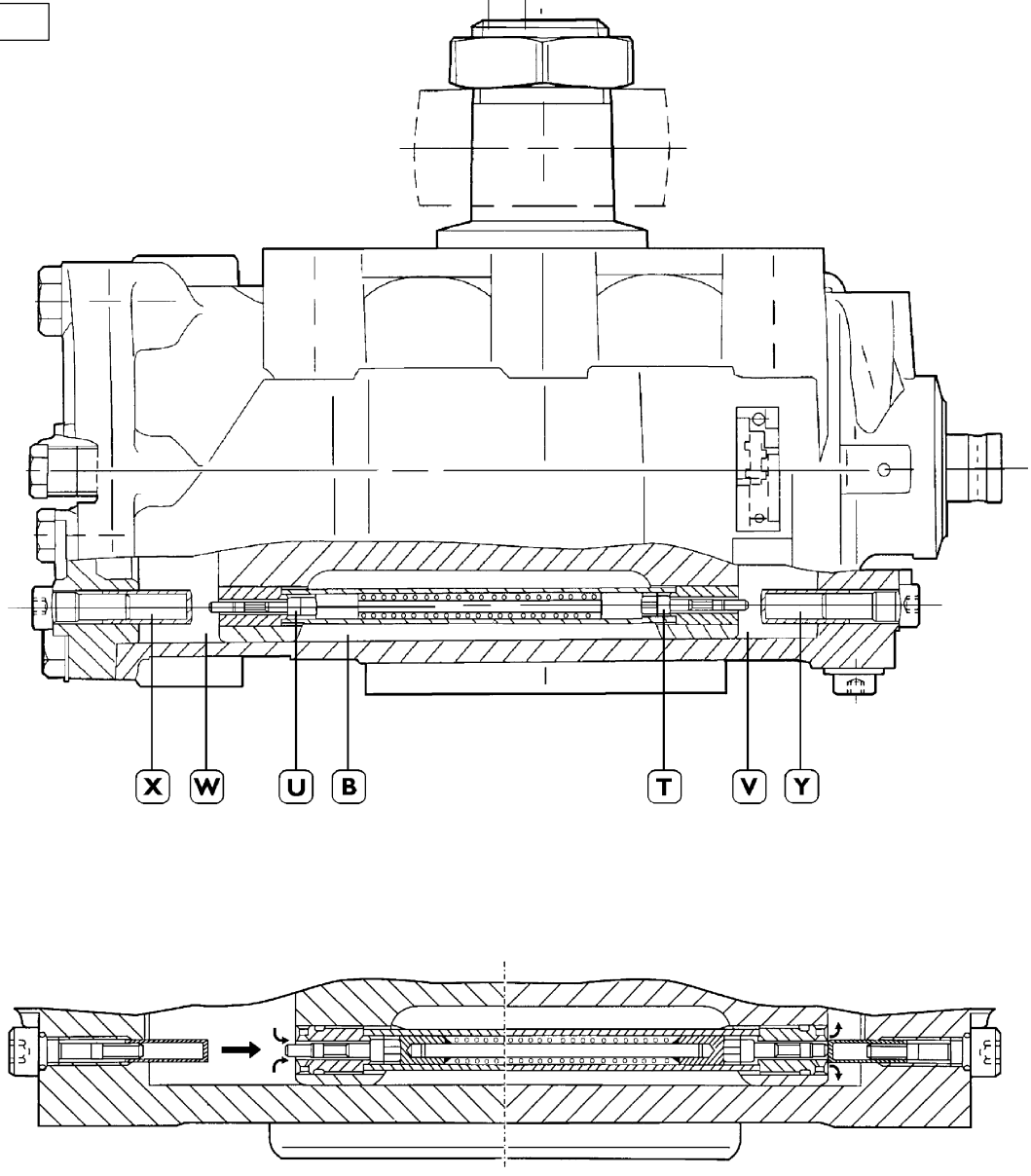
When the piston moves right or left toward the limit the stems come into contact with shift bushes "Y" and "X" in the box and in the cover and consequently compress. Both regulation valves remain closed until one of the stems touches the shift bush.

If for example the piston shifts right for "left turn" the right steering limit valve "T" is opened by bush "Y" before the piston can reach the limit stop.

In this way pressurised oil present in the operator cylinder left chamber can penetrate into the right chamber, flowing around the piston shifted by valve "U" and through open right valve "T" to reach the return circuit.

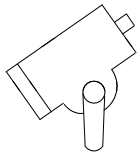
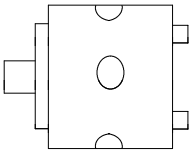
When the steering regulator valve is open, hydraulic servo power is significantly reduced and the steering wheel can only be turned by applying greater force up to the steering or wheel limit

Figure 7



B - Piston - T – Right steering limit regulator valve - U – Left steering limit regulator valve - V – Cylinder right chamber - W – Cylinder left chamber - X – Left adjuster screw - Y – Right adjuster screw

SPECIFICATIONS AND DATA
2 and 3 axle vehicles

POWER STEERING			
	TYPE		ZF 8098 bearing mounted with built-in pressure regulator valve
	Working pressure	bar	150^{+15}
	Variable reduction ratio		Steering centre 22.2: 1 Full steering 26.2: 1
POWER STEERING PUMP			
	TYPE		BOSCH GEAR PUMP
	N° rpm minimum	rpm	3000
	Maximum pressure	bar	190
	Flow rate	$dm^3/1'$	16

Steering angle and toe-in - 2 and 3 axle vehicles

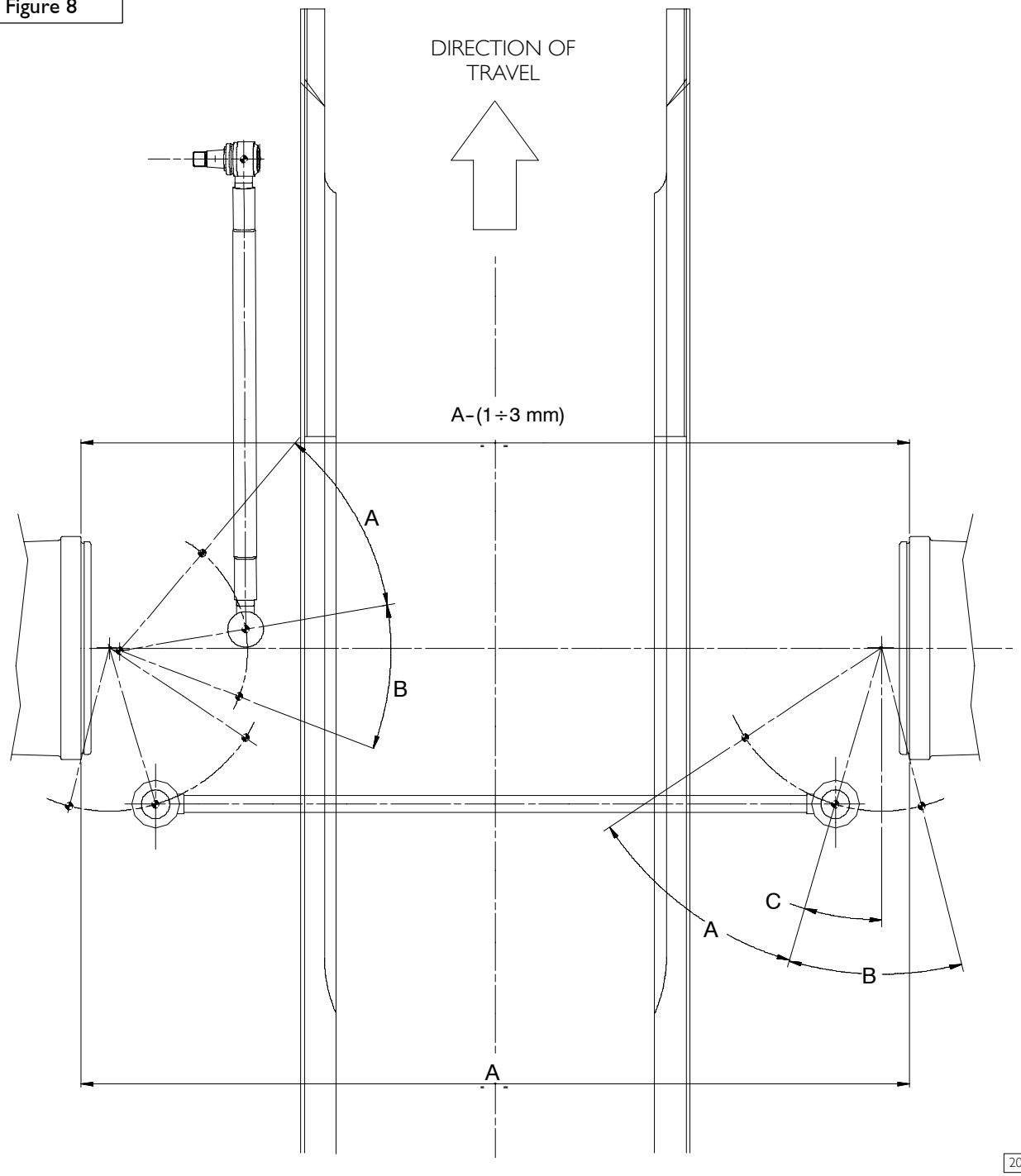
6x4 vehicles

tyres / angles	A	B	C
13 R 22,5	45°	35°30'	12°52'
12.00.20	45°	35°30'	12°52'
315/80	45°	35°30'	12°52'
12.00.24	40°	32°42'	12°52'
14.00.20	40°	32°42'	12°52'

4x4 and 6x6 vehicles

tyres / angles	A	B	C
13 R 22,5	45°	33°02'	16°23'
12.00.20	45°	33°02'	16°23'
315/80	45°	33°02'	16°23'
12.00.24	40°	30°45'	16°23'
14.00.20	40°	30°45'	16°23'

Figure 8



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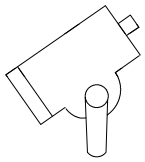
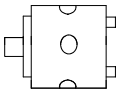
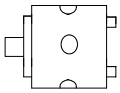
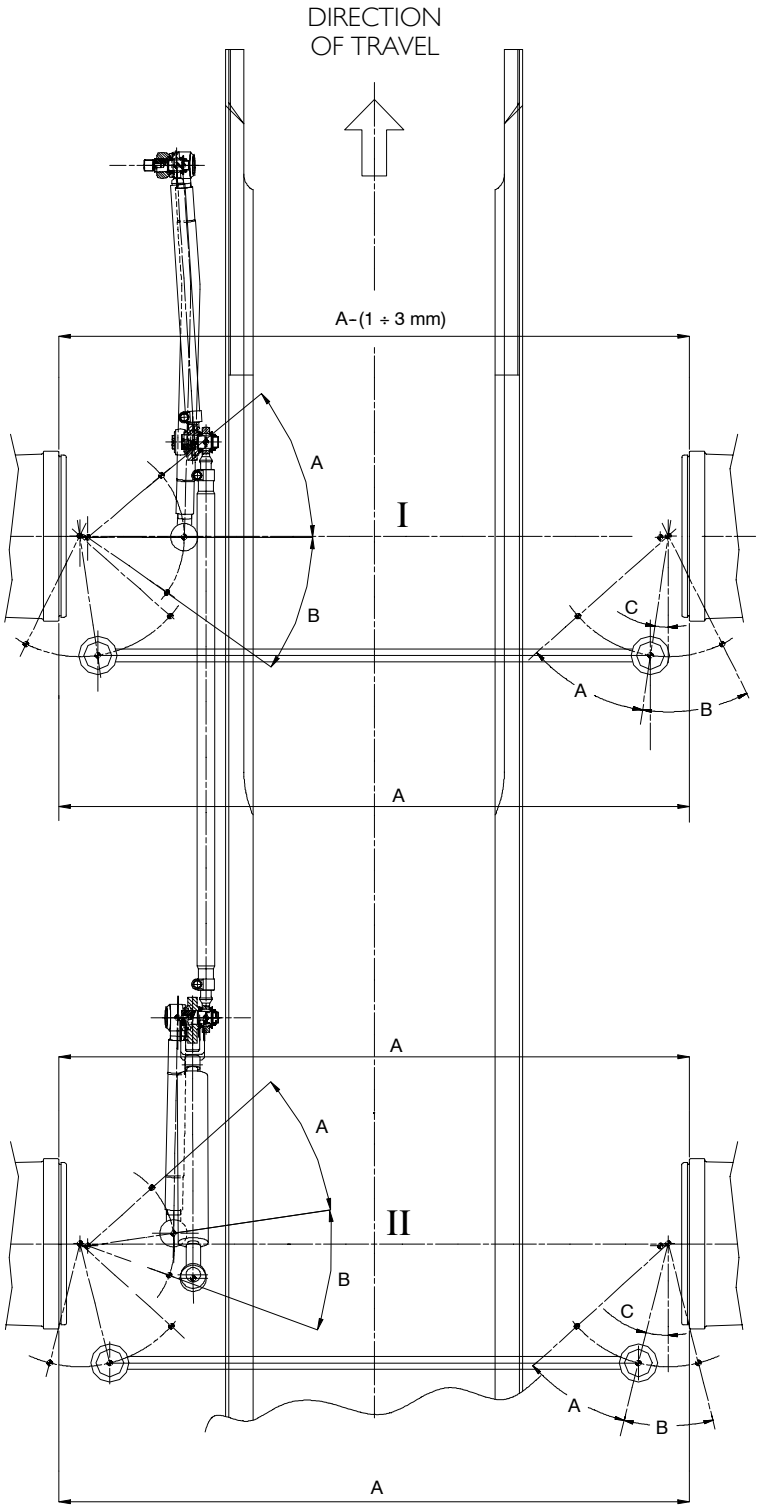
Hydraulic system - 4 axle vehicles

HYDRAULIC STEERING			
	Type		ZF 8099 Bearing mounted, dual circuit with pressure regulator valve
	Working pressure	bar	140^{+14}
	Variable reduction ratio		Steering centre 22,2:1 Maximum lock 26,2:1
POWER STEERING PUMP on compressor			
	Type		ZF Paddle type
	Minimum speed	rpm/min	500
	Maximum speed	rpm/min	3000
	Maximum pressure	bar	165
	Flow-rate	dm^3/min	25
POWER STEERING PUMP on gearbox (auxiliary)			
	Type		ZF Piston type
	Minimum speed	rpm/min	4500
	Maximum pressure	bar	180
	Flow-rate	dm^3/min	16

Steering angle and toe-in - 4 axle vehicles

Figure 9



FIRST AXLE/AXLE SET STEERING ANGLE

8x4 vehicles

tyres / angles	A	B	C
13 R 22,5	45°	35°30'	12°52'
12.00.20	45°	35°30'	12°52'
315/80	45°	35°30'	12°52'
12.00.24	40°	32°42'	12°52'
14.00.20	40°	32°42'	12°52'

SECOND AXLE/AXLE SET STEERING ANGLE

8x4 vehicles

tyres / angles	A	B	C
13 R 22,5	35°48'	26°49'	19°59'
12.00.20	35°48'	26°49'	19°59'
315/80	35°48'	26°49'	19°59'
12.00.24	32°07'	24°56'	19°59'
14.00.20	32°07'	24°56'	19°59'

DIAGNOSTICS

Main power steering operating faults :

1 - Steering stiff when turning right and left
2 - Steering stiff only when turning left or right
3 - Steering stiff when the wheel is turned quickly
4 - When steering, heavy jolts are felt at the wheel
5 - Torsional vibration of the steering wheel
6 - Excessive play at the steering wheel
7 - Loss of fluid
8 - Insufficient pressure in the circuit

1 STEERING STIFF WHEN TURNING RIGHT AND LEFT

Insufficient fluid in system – YES → Check fluid level with motor running, top up fluid to upper mark on dipstick and bleed system

NO

Air in hydraulic system – YES → Check suction tube and pump shaft seal for leaks. Top up fluid and bleed system

NO

Pump regulating valve jammed or blocked – YES → Dismantle valve, wash and check. Throttling orifice must not be blocked

NO

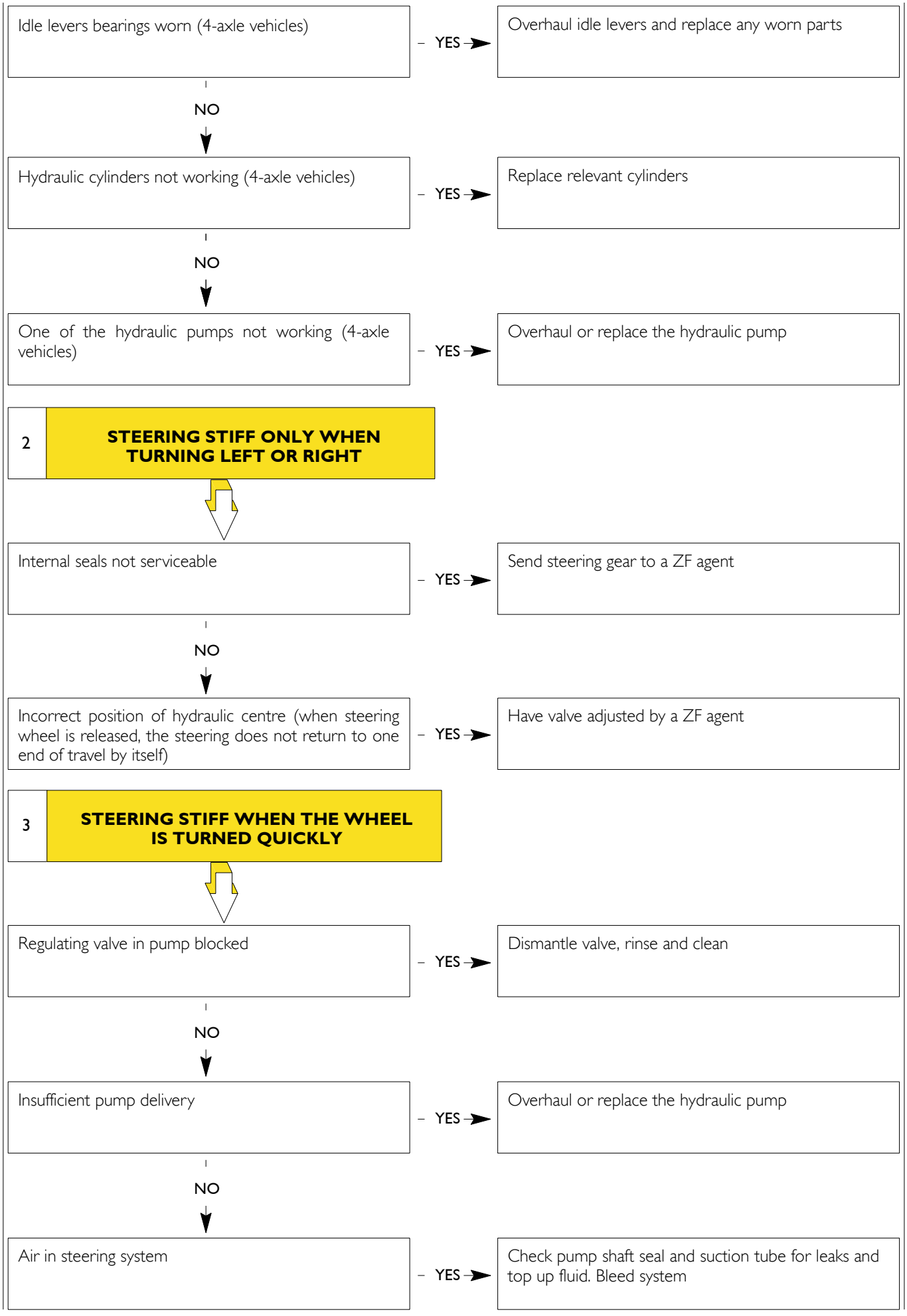
Insufficient fluid pump delivery – YES → Overhaul or replace pump

NO

Universal joint slides with difficulty – YES → Make joint free to slide by moving it to and fro several times so that it tilts under its own weight

NO

Bearings for idle levers insufficiently lubricated – YES → Lubricate idle levers bearings


Idle levers bearings worn (4-axle vehicles)
YES
Overhaul idle levers and replace any worn parts
NO
Hydraulic cylinders not working (4-axle vehicles)
YES
Replace relevant cylinders
NO
One of the hydraulic pumps not working (4-axle vehicles)
YES
Overhaul or replace the hydraulic pump
2
STEERING STIFF ONLY WHEN TURNING LEFT OR RIGHT
Internal seals not serviceable
YES
Send steering gear to a ZF agent
NO
Incorrect position of hydraulic centre (when steering wheel is released, the steering does not return to one end of travel by itself)
YES
Have valve adjusted by a ZF agent
3
STEERING STIFF WHEN THE WHEEL IS TURNED QUICKLY
Regulating valve in pump blocked
YES
Dismantle valve, rinse and clean
NO
Insufficient pump delivery
YES
Overhaul or replace the hydraulic pump
NO
Air in steering system
YES
Check pump shaft seal and suction tube for leaks and top up fluid. Bleed system

4 WHEN STEERING, HEAVY JOLTS ARE FELT AT THE WHEEL

Play in universal joint – YES → Fit a new seal

NO

Internal failure of power steering unit – YES → Send steering unit to a ZF agent

NO

Insufficient fluid in system – YES → Top up fluid and bleed system

NO

Wheel geometry incorrect – YES → Check and adjust

NO

Wheels out of balance – YES → Balance in accordance with instructions given in the section "Wheels and tyres"

NO

Steering rod joints loose on the arms – YES → Replace any worn parts

NO

Irregular hydraulic pump operation – YES → Check, overhaul or replace pump if necessary.

NO

Leakage of fluid from power steering circuit couplings – YES → Check coupling seals for serviceability, replacing any which are worn

5 TORSIONAL VIBRATION OF THE STEERING WHEEL

Wheels out of balance – YES → Balance in accordance with instructions given in the section "Wheels and tyres"

NO

Front wheels geometry incorrect – YES → Adjust in accordance with characteristic data given in relevant section

NO

Air in hydraulic system – YES → Check pump shaft seal and suction tube for leaks. Top up fluid and bleed system

6 EXCESSIVE PLAY AT THE STEERING WHEEL

Clearance in ball joints and/or flexible supports loose – YES → Replace ball joints

NO

Play in universal joint – YES → Replace universal joint

NO

Internal failure of power steering unit – YES → Send power steering unit to a ZF agent

7 LOSS OF FLUID

Tank cover not secured – YES → Secure cover

NO

Deterioration of gaskets and seals – YES → Replace, top up fluid and bleed

In every case it is necessary to establish where and why hydraulic fluid is being lost, eliminate the cause and, with the engine running, top up fluid to upper mark on dipstick.

8 INSUFFICIENT PRESSURE IN THE CIRCUIT

Pump not operating correctly – YES → Overhaul or replace hydraulic pump

NO

Fluid leaking from couplings in power steering circuit – YES → Check coupling seals for serviceability, replacing any which are worn

NO

Insufficient fluid level in the tank – YES → Top up level and bleed circuit

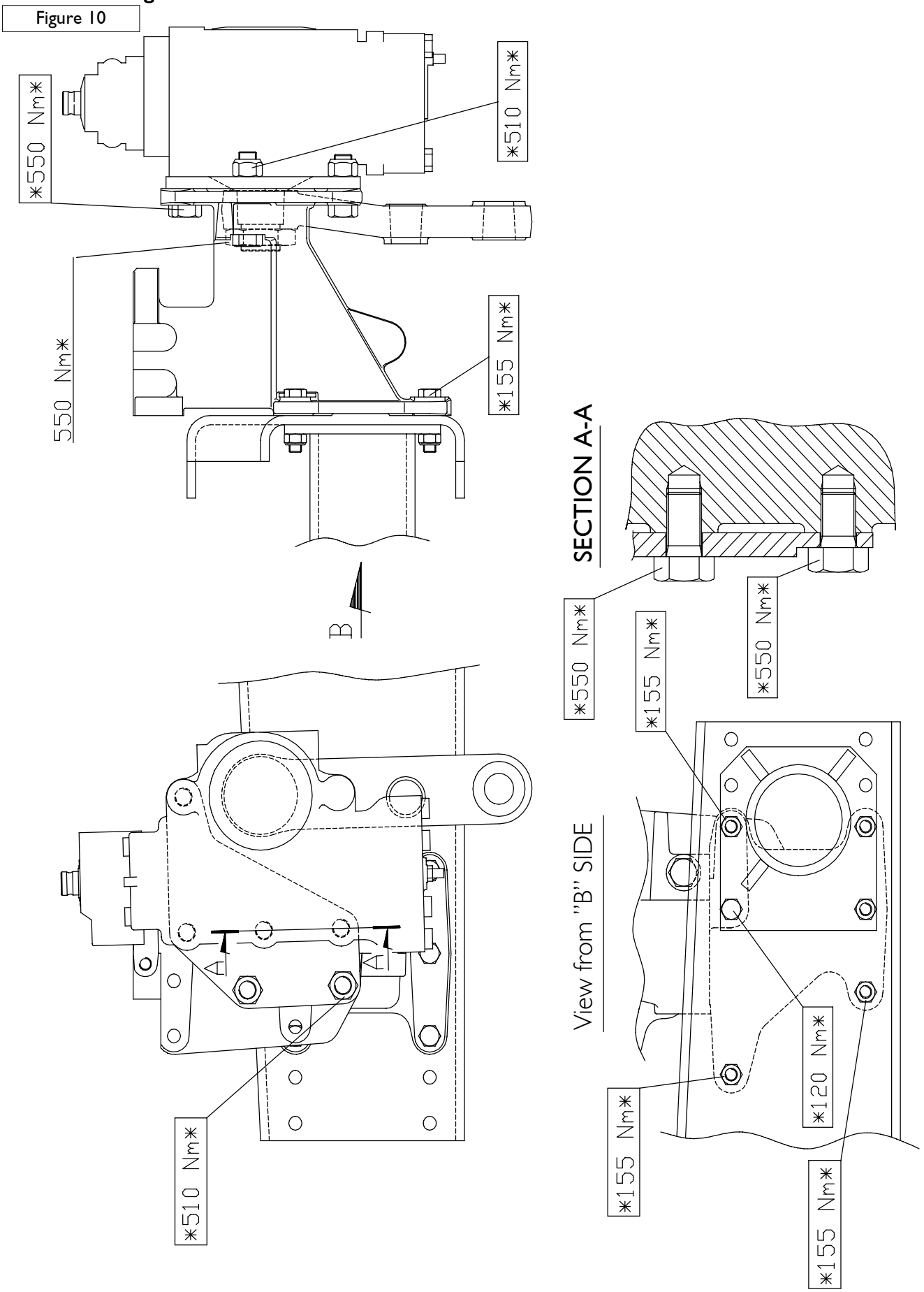
NO

Fluid leaking from gaskets in hydraulic circuit (4-axle vehicles) – YES → Replace faulty cylinder

TIGHTENING TORQUES

Power steering box

Figure 10

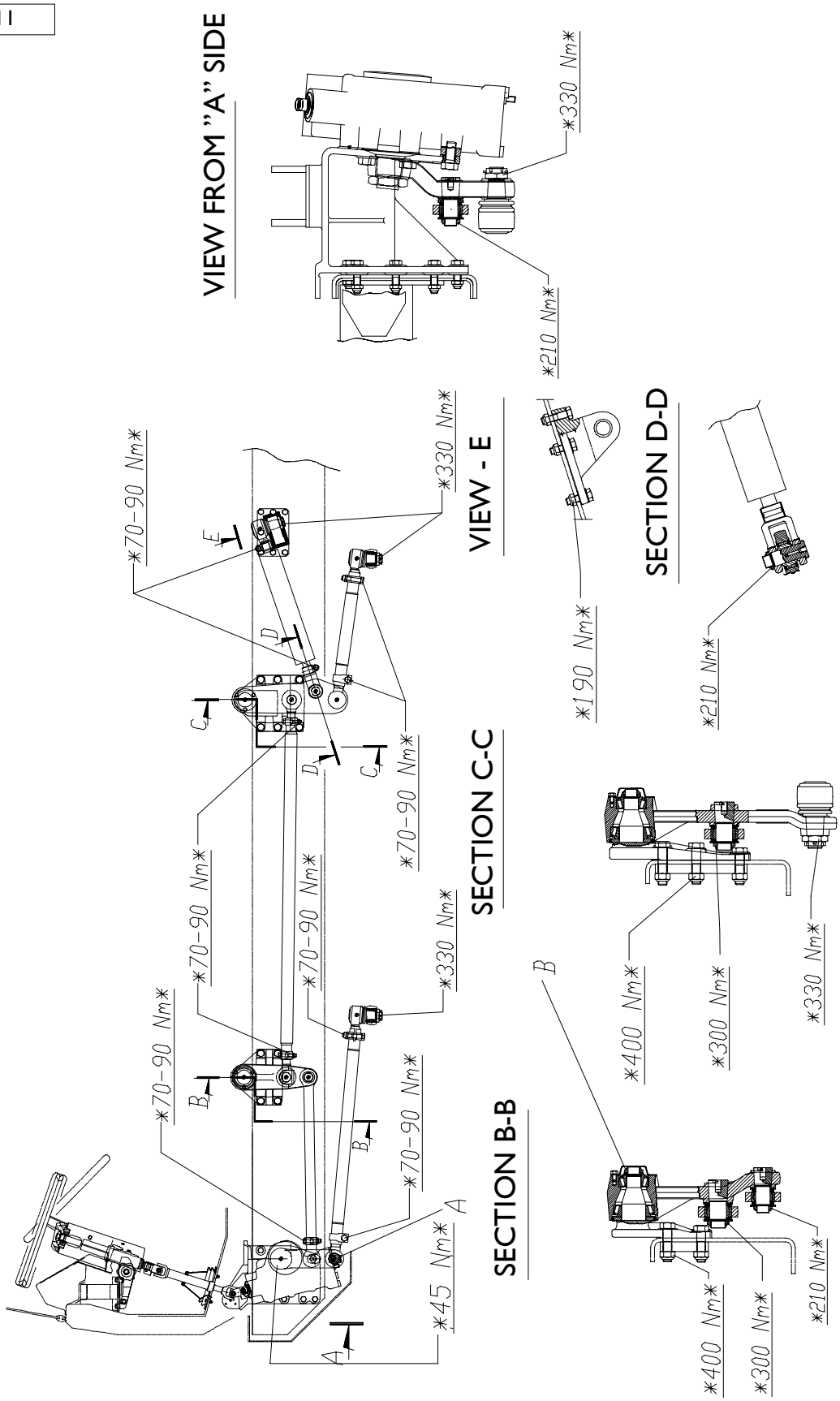


Linkage

A. Check for split pins correct assembling. Should the notch be not coinciding with the hole at the required torque, continue tightening until fitting the split pin.

B. Tighten the ring nut to 50 Nm, turning the lever to stop the bearings.

Figure 11



TOOLS

TOOL NO.	DESCRIPTION
99347068	Puller for drag link pivots
99370006	Interchangeable handle for beaters
0/72051	Kit for testing steering system hydraulic pressure
99374399	Expanders to lock the wheel in straight running position

STEERING BOX REMOVAL-REPLACEMENT
2 and 3-axle vehicles
Removal

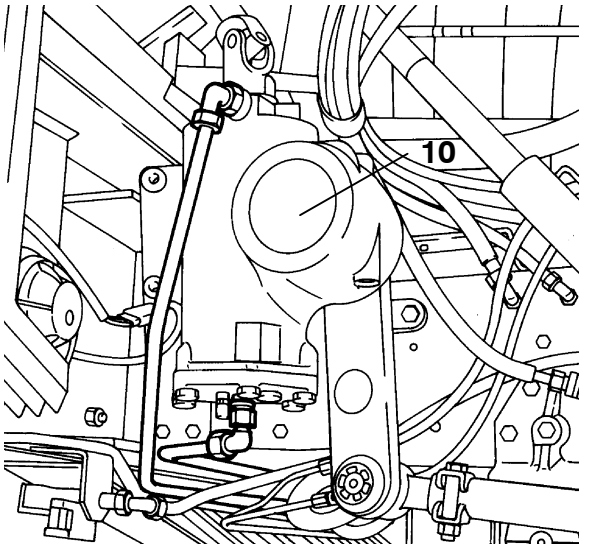
Proceed as follows:

- ❑ Drain the servosteering hydraulic circuit as described below:

It is strictly forbidden to dispose of exhausted fluid incorrectly or in the municipal sewer system.

- ❑ Disconnect the delivery pipe to the reservoir (a) and return pipe from the pump (b);
- ❑ Disconnect the steering column joint (13);
- ❑ Unscrew the connector bolt to disconnect the steering lever (11) from the steering bar (1);
- ❑ Support the steering box (10) and remove the fastening bolts.

Figure 12



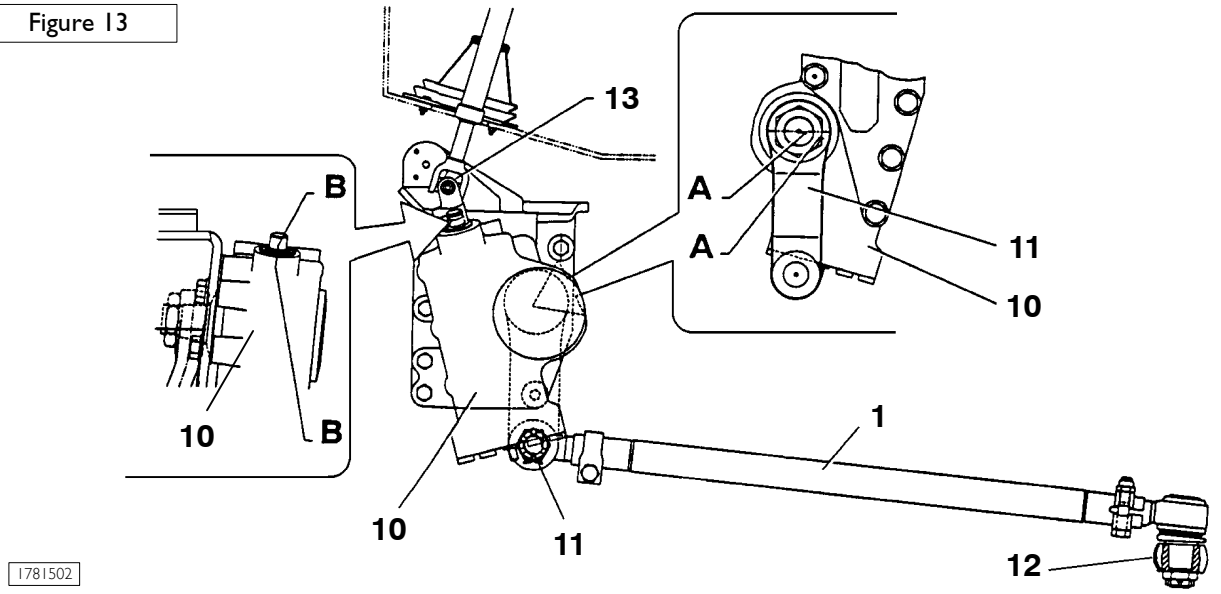
- ❑ Disconnect the steering column joint (13);
- ❑ Unscrew the respective connector bolts from the steering bar (1) and tie bar (4) to disconnect the steering lever;
- ❑ Support the steering box (10) and remove the fastening bolts.

Replacement

Proceed as follows:

- ❑ Fit the steering box (10) to its mounting bracket, tightening the bolts to the specified torque;
- ❑ Set the steering lever (11) such that the notches A-A and B-B coincide perfectly;
- ❑ Position the tyres for straight driving, observing the convergence value given in the tables given later on;
- ❑ Adjust the length of the tie bar (1) until it is possible to insert the heads into the respective seats of the steering lever (11) and axle (12) without altering the position of the seats and without forcing, then tighten the fastening clamps to the specified torque;
- ❑ Proceed to connect the steering column joint (13), taking care to centre the steering wheel;
- ❑ Reconnect the hydraulic lines;
- ❑ Fill and bleed the hydraulic circuit as described later;
- ❑ Check the excursion limit settings as described later (only for versions with hydraulic steering limiter).

Figure 13



4-axle vehicles
Removal

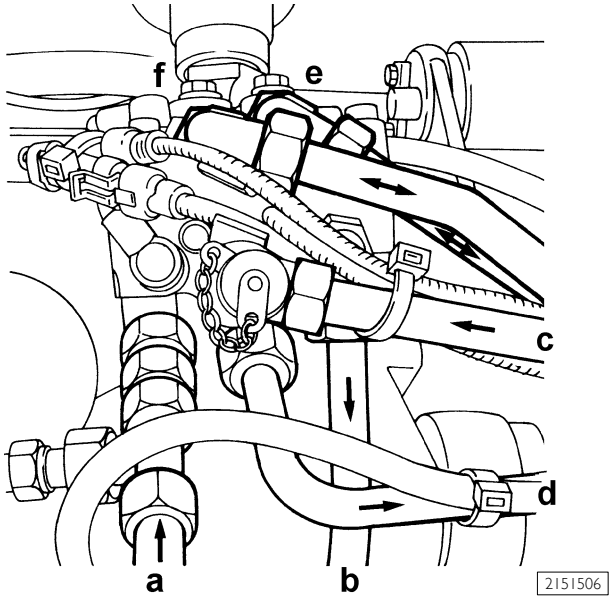
Proceed as follows:

- ❑ drain the steering hydraulic circuit as instructed below

It is strictly forbidden to dispose of exhausted fluid incorrectly or in the municipal sewer system.

- ❑ disconnect the hydraulic lines:
  - a delivery from main pump
  - b return to reservoir
  - a delivery from auxiliary pump
  - d return to reservoir
  - e to second axle cylinder
  - f to second axle cylinder

Figure 14



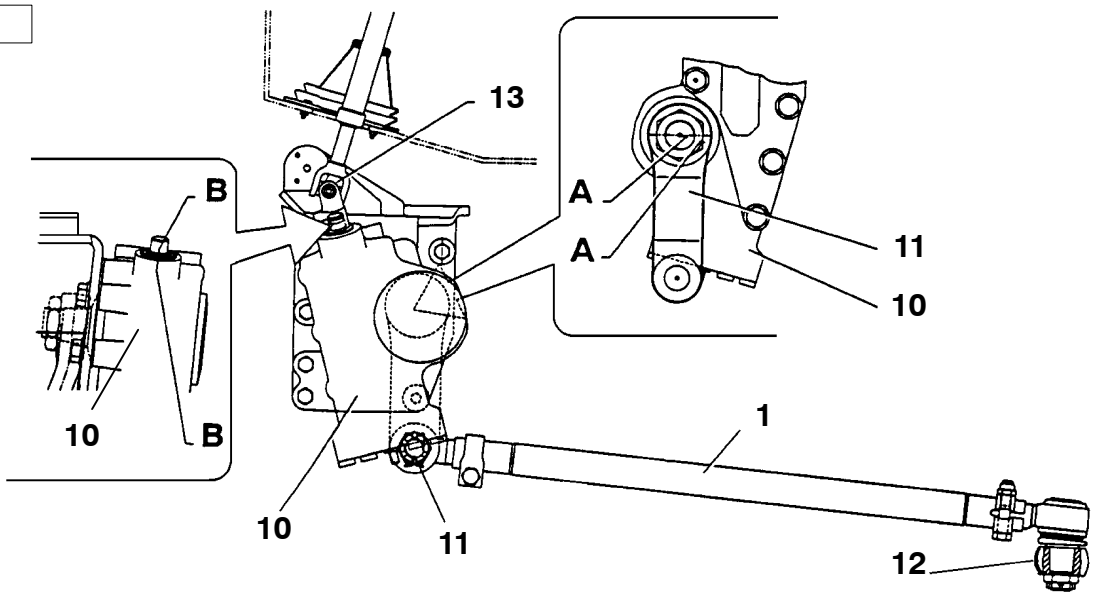
- ❑ disconnect the steering column joint (13);
- ❑ disconnect the steering lever (11) from the steering rod (1) and track rod (4) removing the corresponding bolts;
- ❑ suitably support the steering box (10) and remove it by removing the nuts.

Replacement

Proceed as follows:

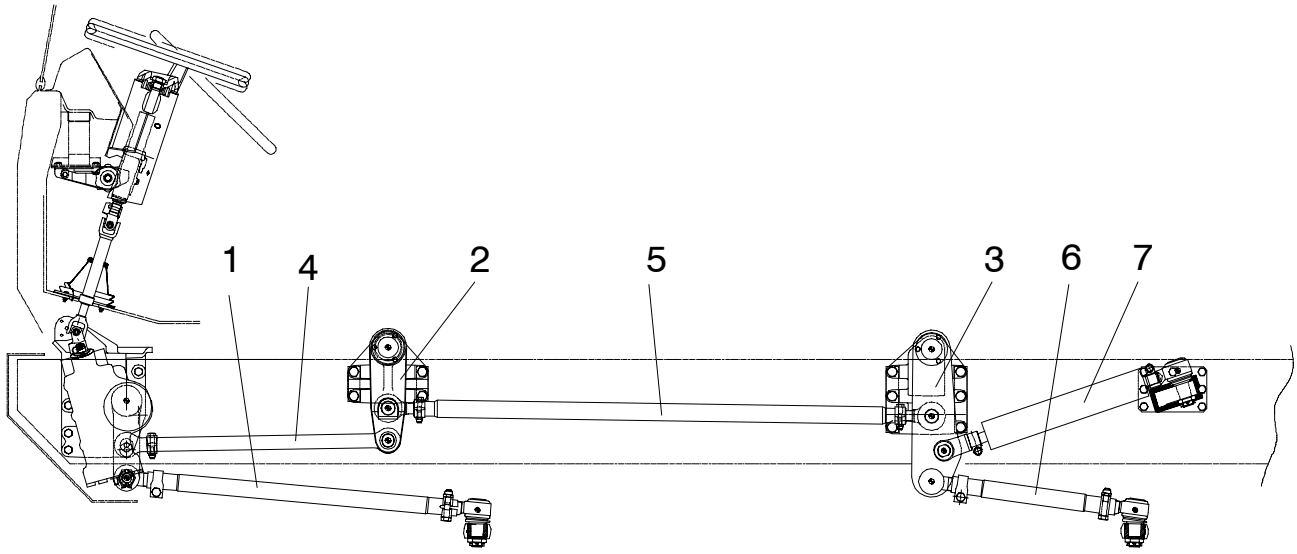
- ❑ fit the steering box (10) on the corresponding support bracket tightening the nuts to the specified torque;
- ❑ arrange the steering lever (11) such that the notches A-A and B-B coincide perfectly;
- ❑ position the tyres for straight running respecting the toe-in value as indicated in the tables given below;
- ❑ adjust the length of the steering rod (1) and link (4) as more specifically instructed in the following paragraph, then tighten the clamps to the specified torque;
- ❑ then connect the steering column joint (13), carefully centring the steering wheel;
- ❑ connect the hydraulic lines;
- ❑ fill and bleed the circuit as instructed below;

Figure 15

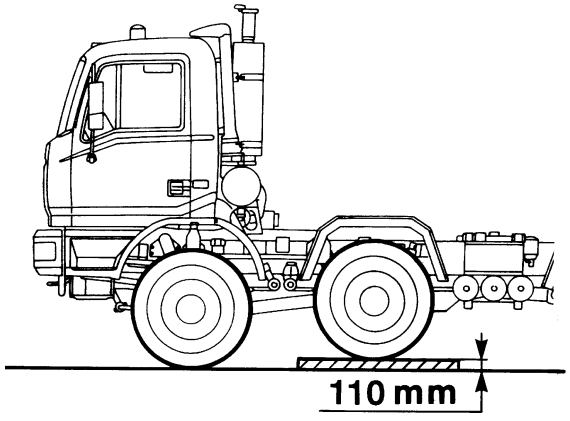


FITTING STEERING LINKS - 4-AXLE VEHICLES

Figure 16



STEERING LINKAGE



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Set vehicle on level ground, in chassis configuration, after climbing a 110 mm step with the second axle.

Disconnect the steering links (1), (4), (5) and (6) and the cylinder (7) from the relevant levers.

First axle

Check for correct power steering installation and lever positioning (see power steering removal-refitting).

Set wheels in straight running position, observing the specified toe-in value and adjusting the length of the quadrilateral steering link (see front wheel toe-in check).

Then, adjust steering link (1) length to enable heads fitting into power steering and axle levers, without modifying lever position.

Second axle

Line-up wheels in straight running position and adjust the length of the quadrilateral steering link.

Position the transmission levers (2) and (3) with vertical axis.

Then, adjust the length of the different steering links (4), (5) and (6) and cylinder (7) to enable joints, fork and heads fitting into the relevant seats on the levers, without modifying lever positions.

KINGPINS

Visual inspections

Clean drag link kingpins.

Check components for damages or cracks.

Replace if damaged.

Check steering link clamp screws and nuts for wear and correct tightening torque; steering links shall not be damaged or deformed.

Replace if damaged.

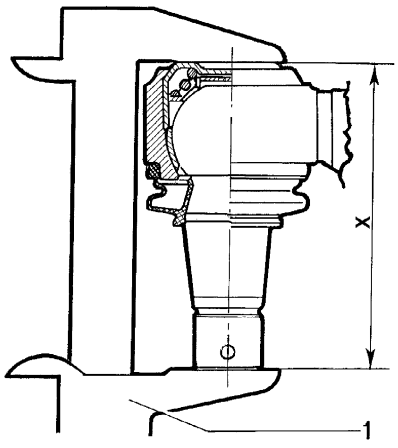
Clearance check

Do not lift the vehicle.

Find distance "X" with a gauge, with the vehicle set in straight running position.

Repeat this measurement in full steering position, left-hand (X1) and right-hand (X2); write down found values.

Figure 17



Calculate clearance "A" by the following formula:

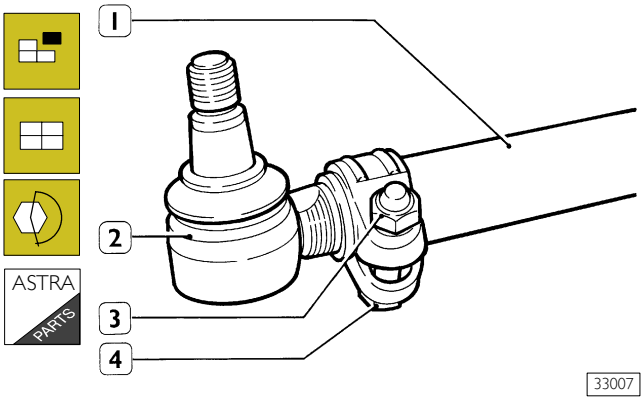
A = B - X

where B is the highest value obtained from X1 and X2.

Replace the kingpin if this value exceeds 2 mm.

Replacement

Figure 18



Lock screw (4), loosen nut (3) and unscrew the drag link (1) joint (2).
Screw the joint into the drag ink and lock it in this position tightening the locking nut to the required torque.

To facilitate drag link refitting and wheel toe-in adjustment, record the number of turns required to unscrew each joint in order to screw the new joints with the same number of turns.

Refit the drag link.

Check and adjust front wheel toe-in if necessary.

CHANGING HYDRAULIC FLUID

When filling and bleeding, the pump must operate at the lowest speed possible.

Draining

Proceed as follows:

- ❑ Raise the vehicle until the front wheels leave the ground;
- ❑ Position a container with adequate capacity and disconnect the delivery (1) and return (2) lines from the steering box. Remove the reservoir filler cap;
- ❑ With the engine stopped turn the steering wheel from one excursion limit to the other until fluid stops draining out;
- ❑ Reconnect the hydraulic lines.

Filling

All the operations listed below must be carried out in scrupulously clean conditions to prevent foreign matter falling into the fluid during filling.

Proceed as follows (with the vehicle raised):

- ❑ Completely fill the hydraulic fluid reservoir;
- ❑ With the engine stopped, turn the steering wheel from one excursion limit to the other while toping up the reservoir and proceed until the fluid level stabilises;
- ❑ Using the starter motor, operate the steering pump in order to fill the circuit with fluid. Since the level will quickly drop during this operation, keep pouring fluid into the reservoir, MAKING ABSOLUTELY SURE that no air is drawn in;
- ❑ When the fluid level remains constant between the two notches on the dipstick, the engine can be started.

Bleeding

- ❑ Turn the steering wheel from one excursion limit to the other with the engine idling to bleed any remaining air bubbles from the system.

The fluid level must be continually monitored during this operation. If the above instructions have been correctly followed, when the engine is stopped the fluid level must not exceed the upper notch by more than ½ cm, nor should it emulsify suddenly.
This phenomenon indicates a strong presence of air in the circuit due to incorrect filling.

A: 2-axle and 3-axle vehicles

B: 4-axle vehicles

Figure 19

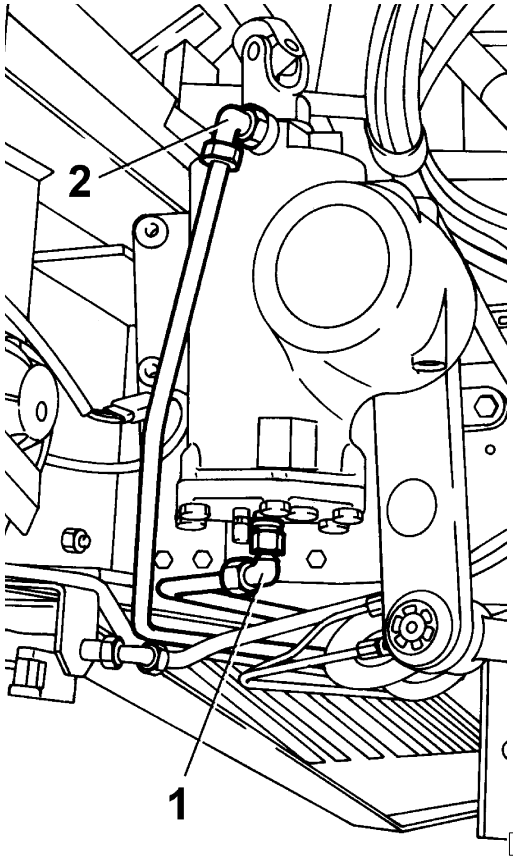
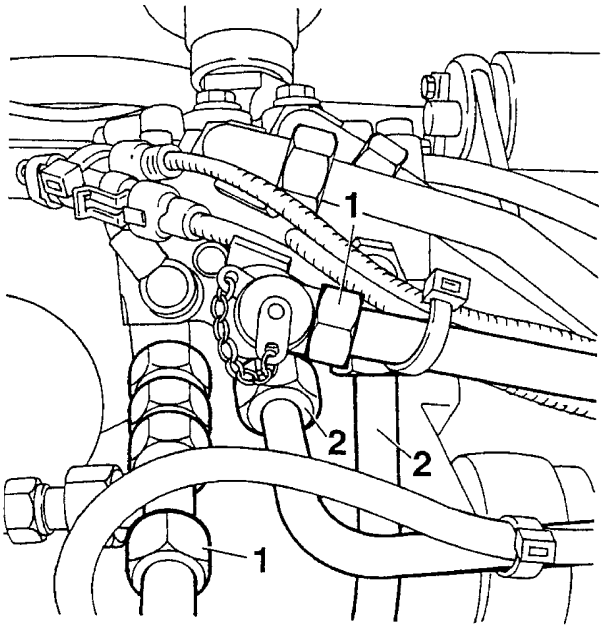


Figure 20



CHECKING WHEEL TOE-IN

Before checking the toe-in ensure that:
the vehicle is on a level surface and unladen;
the tyres are inflated to the correct pressure.

Proceed as follows:

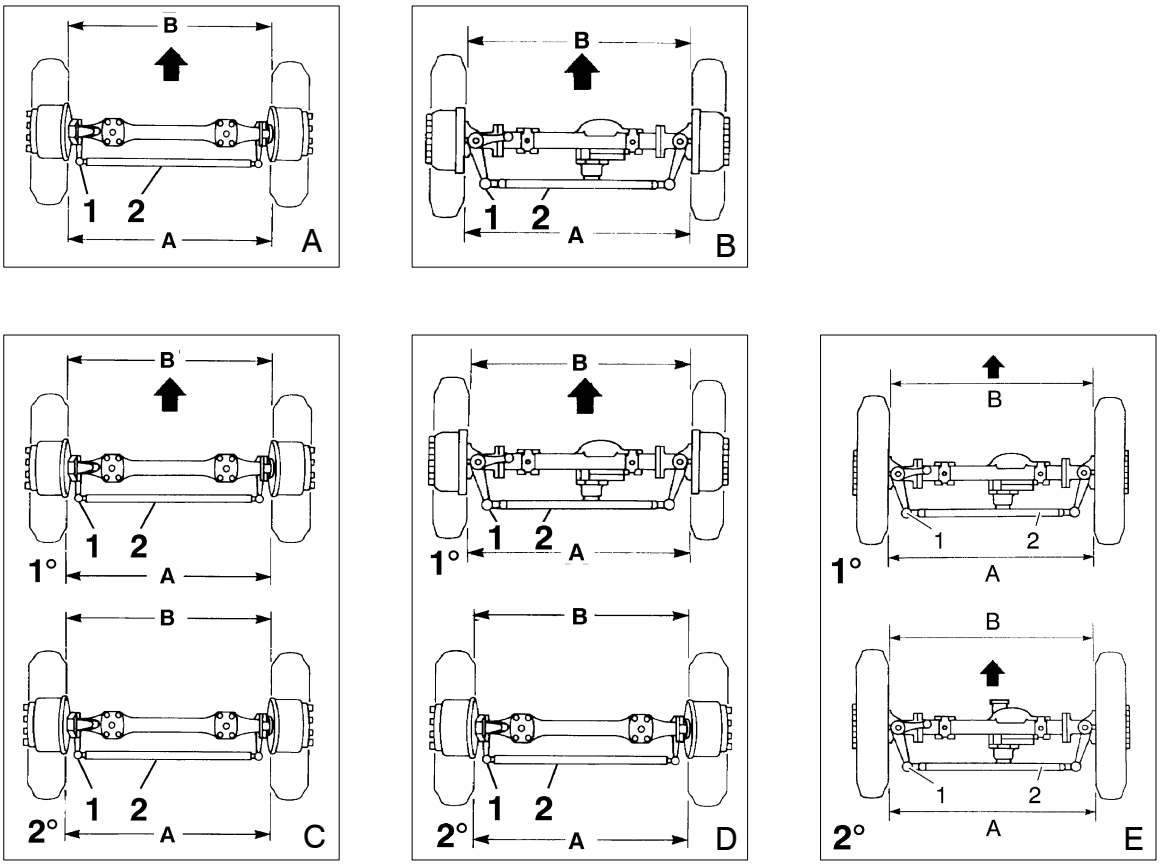
- ❑ set the wheels so that they are pointing forwards;
- ❑ check that the distances A and B measured along the centreline of the rims at the same height from the ground, correspond to the specified values:

If this is not the case, adjust as follows:

- ❑ loosen the bolts securing the ball joints (1) to the coupling rod (2);
- ❑ remove ball joint from lower steering lever;
- ❑ turn the rod right or left just enough to obtain the measurement required;
- ❑ tighten the bolts securing the ball joints;
- ❑ move the vehicle straight forwards or backwards by at least one turn of wheels, and check toe-in again.

Reference	Vehicle	Forecarriage	Measure
A	2-axle - 3-axle vehicles	axle set	B = A - (1 / 3 mm)
B	2-axle - 3-axle vehicles	axle	B = A - (1 / 3 mm)
C	4-axle vehicles	1st axle set	B = A - (1 / 3 mm)
		2nd axle set	B = A
D	4-axle vehicles	1st axle	B = A - (1 / 3 mm)
		2nd axle set	B = A
E	4-axle vehicles	1st axle	B = A - (1 / 3 mm)
		2nd axle	B = A

Figure 21



ADJUSTING HYDRAULIC STEERING MODULATION DEVICES AND CHECKING MECHANICAL STOPS
2-axle and 3-axle vehicles

This power steering system is fitted with automatic hydraulic steering modulation device.
Hence, with disassembled power steering or disconnected linkage, it shall be controlled in both directions without hydraulic assistance and to 33° steering lever max. angle and ≤ 10 N force measured on the steering wheel (steering wheel diameter: 500 mm).

Described procedure must be performed after wheel toe-in adjustment.

Proceed as follows:

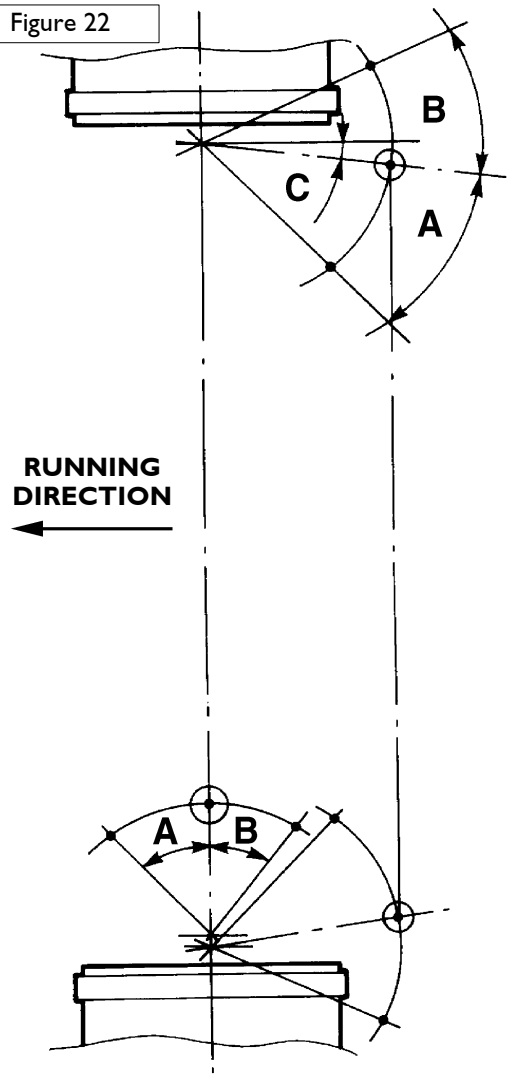
- ❑ operate with unladen vehicle;
- ❑ set each front wheel on a turntable;
- ❑ connect gauge 99374393 on power steering pump delivery pipe connection as shown in the diagram;

The new steering box (spare part) is adjusted to the max. steering angle. For this reason, when replacing the steering box with a new one (spare part), adjustment must be performed by SCREWING the adjusting screws only to avoid removal from their seats due to hydraulic operating pressure.

- ❑ start engine and run it to approx. 1500 rpm by the hand accelerator control;
- ❑ steer until the gauge indicates a pressure drop due to power steering hydraulic stop intervention (which must take place before mechanical stop intervention); in this position the steering geometry shall comply with the specified angle values.

Should the mechanical stop be intervening before the hydraulic one, stop steering to avoid damages to the stop and to the pump components (130 bar max. pressure) and reset a suitable clearance to perform adjustment.

Figure 22



FRONT AXLE STEERING ANGLE

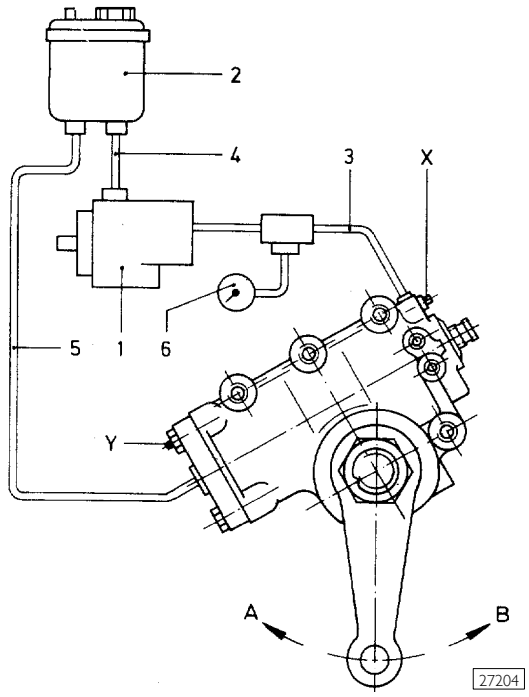
6x4 vehicles

tyres / angles	A	B	C
13 R 22,5	45°	35°30'	12°52'
12.00.20	45°	35°30'	12°52'
315/80	45°	35°30'	12°52'
12.00.24	40°	32°42'	12°52'
14.00.20	40°	32°42'	12°52'

4x4 and 6x6 vehicles

tyres / angles	A	B	C
13 R 22,5	45°	33°02'	16°23'
12.00.20	45°	33°02'	16°23'
315/80	45°	33°02'	16°23'
12.00.24	40°	30°45'	16°23'
14.00.20	40°	30°45'	16°23'

Figure 23



1 Pump - 2 Reservoir - 3 Delivery pipe - 4 Suction pipe - 5 Return pipe - 6 Pressure gauges

X = hydraulic steering limiter adjusting screw for rotation in direction A of steering control arm.

Y = hydraulic steering limiter adjusting screw for rotation in direction B of steering control arm.

❑ If these values are not found, proceed with adjustment operating respectively:
on screw X for rotation in direction A of the steering arm;
on screw Y for rotation in direction B of the steering arm.

When the required angle has been obtained but the pressure drop has not took place yet, screw (clockwise) the corresponding steering modulating valve until obtaining the correct adjustment.

When the required angle is not obtained but the pressure drop has already took place, unscrew (anticlockwise) the corresponding steering modulating valve until obtaining the correct adjustment.

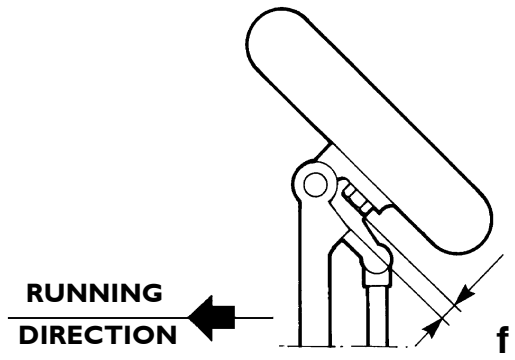
❑ Tighten then the lock nut to 30 ± 5 Nm (3 ± 0.5 kg); proceed in the same way to adjust the wheel stop on the opposite side.

❑ Once the hydraulic steering modulating device is adjusted, check whether, when steering down in both directions up to hydraulic pressure drop, distance "f" between axle and setscrew on wheel hub is falling within the specified values.

f = 1,5 ÷ 2 (mm)

Adjust the setscrews if these values are not found.

Figure 24



Checking the steering hydraulic modulation device with the vehicle running

The steering hydraulic modulation check is made with the vehicle in full load condition, running at low speed.
Turn the steering wheel until the hydraulic servocontrol no longer operates.
In this position it should still be possible to turn the steering wheel to reach the striker plate between the wheel stop components; if it is not possible, adjust again.

4-axle vehicles

This power steering system is fitted with automatic hydraulic steering modulation device.
Hence, with disassembled power steering or disconnected linkage, it shall be controlled in both directions without hydraulic assistance and to 33° steering lever max. angle and ≤ 10 N force measured on the steering wheel (steering wheel diameter: 500 mm).

Described procedure must be performed after wheel toe-in adjustment.

Proceed as follows:

- ❑ operate with unladen vehicle;
- ❑ set each front wheel on a turntable.

First axle

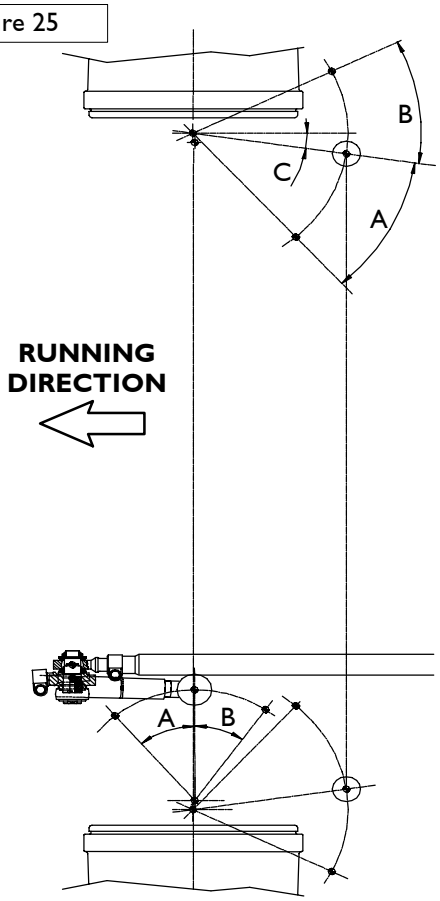
- ❑ connect a gauge to the delivery pipe connection of the power steering servo circuit 1;

The new steering box (spare part) is adjusted to the max. steering angle. For this reason, when replacing the steering box with a new one (spare part), adjustment must be performed by SCREWING the adjusting screws only to avoid removal from their seats due to hydraulic operating pressure.

- ❑ start engine and run it to approx. 1500 rpm by the hand accelerator control;
- ❑ steer until the gauge indicates a pressure drop due to power steering hydraulic stop intervention (which must take place before mechanical stop intervention); in this position the steering geometry shall comply with the specified angle values.

Should the mechanical stop be intervening before the hydraulic one, stop steering to avoid damages to the stop and to the pump components (150 bar max. pressure) and reset a suitable clearance to perform adjustment.

Figure 25

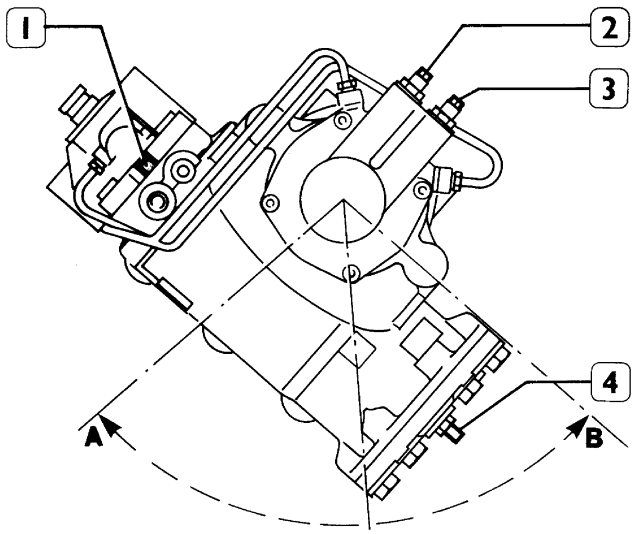


FIRST AXLE STEERING ANGLE

8x4 vehicles

tyres / angles	A	B	C
13 R 22,5	45°	35°30'	12°52'
12.00.20	45°	35°30'	12°52'
315/80	45°	35°30'	12°52'
12.00.24	40°	32°42'	12°52'
14.00.20	40°	32°42'	12°52'

Figure 26



1 - Hydraulic steering limiter adjusting screw for rotation in direction "A" of steering control arm (power steering servo circuit 1).

2 - Hydraulic steering limiter adjusting screw for rotation in direction "B" of steering control arm (operating cylinder servo circuit 2).

3 - Hydraulic steering limiter adjusting screw for rotation in direction "A" of steering control arm (operating cylinder servo circuit 2).

4 - Hydraulic steering limiter adjusting screw for rotation in direction "B" of steering control arm (power steering servo circuit 1).

❑ If these values are not found, proceed with adjustment operating respectively:
on screw 1 for rotation in direction A of the steering arm;
on screw 4 for rotation in direction B of the steering arm.

When the required angle has been obtained but the pressure drop has not took place yet, screw (clockwise) the corresponding steering modulating valve until obtaining the correct adjustment.

When the required angle is not obtained but the pressure drop has already took place, unscrew (anticlockwise) the corresponding steering modulating valve until obtaining the correct adjustment.

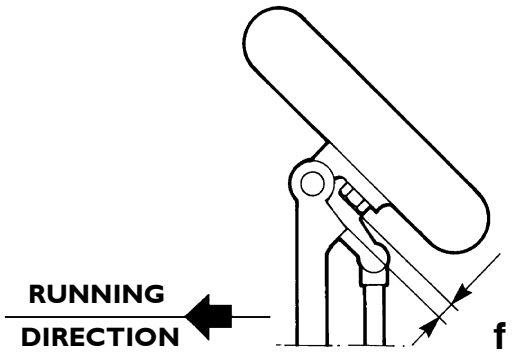
❑ Tighten then the lock nut to 30 ± 5 Nm (3 ± 0.5 kg); proceed in the same way to adjust the wheel stop on the opposite side.

❑ Once the hydraulic steering modulating device is adjusted, check whether, when steering down in both directions up to hydraulic pressure drop, distance "f" between axle and setscrew on wheel hub is falling within the specified values.

f = 1,5 ÷ 2 (mm)

Adjust the setscrews if these values are not found.

Figure 27

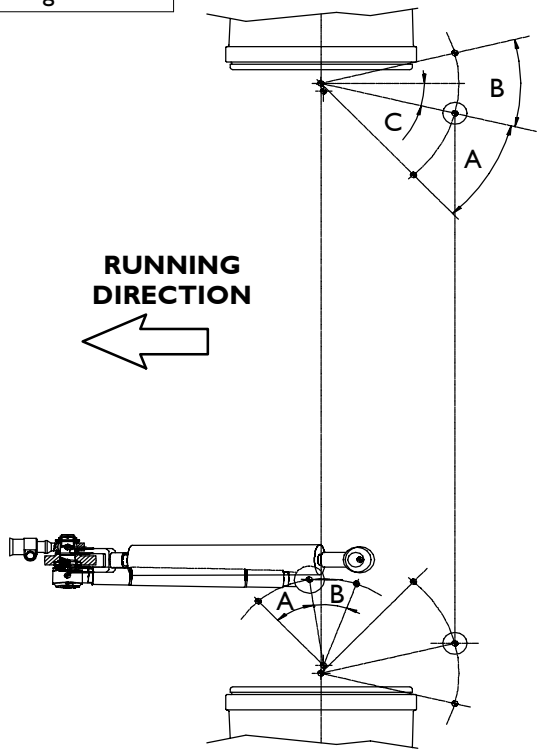


Second axle

Connect the gauge to the delivery pipe of the operating cylinder servo circuit 2.

❑ steer until the gauge indicates a pressure drop due to power steering hydraulic stop intervention (which must take place before mechanical stop intervention); in this position the steering geometry shall comply with the specified angle values.

Figure 28



SECOND AXLE STEERING ANGLE

8x4 vehicles

tyres / angles	A	B	C
13 R 22,5	35°48'	26°49'	19°59'
12.00.20	35°48'	26°49'	19°59'
315/80	35°48'	26°49'	19°59'
12.00.24	32°07'	24°56'	19°59'
14.00.20	32°07'	24°56'	19°59'

- ❑ If these values are not found, proceed with adjustment operating respectively:
  on screw X for rotation in direction A of the steering arm;
  on screw Y for rotation in direction B of the steering arm.

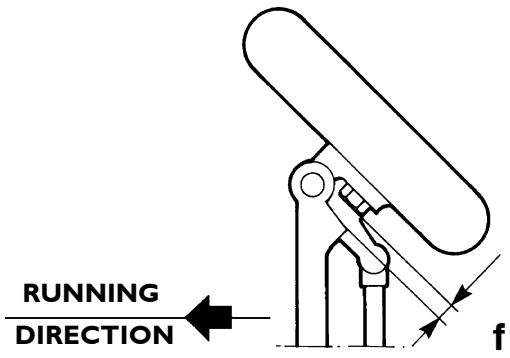
When the required angle has been obtained but the pressure drop has not took place yet, screw (clockwise) the corresponding steering modulating valve until obtaining the correct adjustment.

When the required angle is not obtained but the pressure drop has already took place, unscrew (anticlockwise) the corresponding steering modulating valve until obtaining the correct adjustment.

- ❑ Tighten then the lock nut to 30 ± 5 Nm (3 ± 0.5 kg); proceed in the same way to adjust the wheel stop on the opposite side.
- ❑ Once the hydraulic steering modulating device is adjusted, check whether, when steering down in both directions up to hydraulic pressure drop, distance "f" between axle and setscrew on wheel hub is falling within the specified values.

Adjust the setscrews if these values are not found.

Figure 29



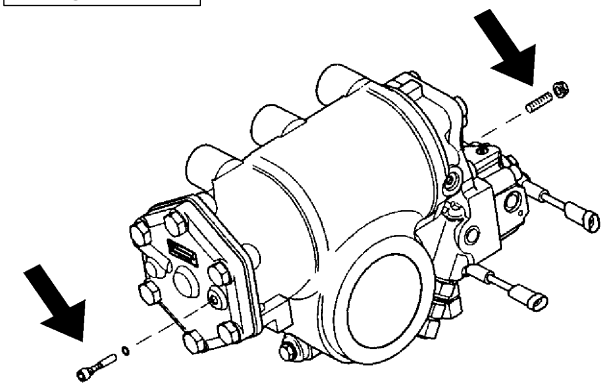
Checking the steering hydraulic modulation device with the vehicle running

The steering hydraulic modulation check is made with the vehicle in full load condition, running at low speed.
Turn the steering wheel until the hydraulic servocontrol no longer operates.
In this position it should still be possible to turn the steering wheel to reach the striker plate between the wheel stop components; if it is not possible, adjust again.

AUTOMATIC STEERING LIMITER ADJUSTMENT

This power steering is fitted with automatic full lock angle limitation.It is absolutely essential that the angular shift of the lever on the steering box BEFORE mounting and/or during adjustment of steering and track rods DOES NOT EXCEED the maximum angular shift reachable AFTER adjustment of hydraulic pressure limitation, because otherwise pressure would not reduce at steering limit due to the altered positioning of the bushes.

Figure 30



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However, if this should happen the adjuster bushes MUST be replaced with new ones (ZF N° 8098 230 102).
For the same reason, if a further reduction to the originally set steering angle is required, new adjuster bushes must be fitted (ZF N° 8098 230 102). An increase in the steering angle is instead always possible.

Proceed as follows:

- ❑ work with the vehicle unladen;
- ❑ position each of the vehicle front wheels on a revolving platform;
- ❑ Fit and adjust the steering rods and limit stops for the axles to the specified steering angle values;
- ❑ adjust front wheel toe-in;
- ❑ start the engine and leave it idling:
  if necessary increase speed by means of the throttle;
- ❑ fully and slowly turn the steering wheel in both directions to reach max steering angle or up to the limit for the axle.

Check that the limit for the axle is effectively reached, otherwise hydraulic power steering power will be significantly reduced before reaching the limit.

It is possible to make a check as follows:

- ❑ insert a pressure gauge (end scale minimum 200 bar) on the check socket on the delivery pipe a between pump and power steering;
- ❑ turn the steering wheel applying torque of 50 ± 20 N m (corresponding to 200 ± 80 N on steering wheel with diameter 500 mm) up to the limit set for the axle;
- ❑ the pressure value must be between the limits of 35 and 70 bar.

if pressure is too high, the adjuster bushes must be replaced with new ones, and the adjustment operation repeated.

In case of excessively low pressure, check hydraulic system function and seal.

PNEUMATIC SYSTEM - BRAKES

SECTION 16

SECTION 16

Pneumatic system - brakes

DESCRIPTION

Service braking

Pneumatically controlled pedal type, operating on all the wheels and the trailer.
It features two separate sections, one to activate the front axle braking components, the other for the rear axle components. A third section, assisting the two distributor sections, brakes the trailer.
The duplex distributor controls the two separate sections and the triple control servo distributor that in its turn controls the third section.
Should a failure occur in one section, the pneumatic system sectioning enables the others to operate efficiently.

Emergency braking

This is combined with the parking braking. The double circuit system enables the braking of one axle even when there is a failure in the braking of the other axle, by means of the service brake pedal and the parking hand lever.

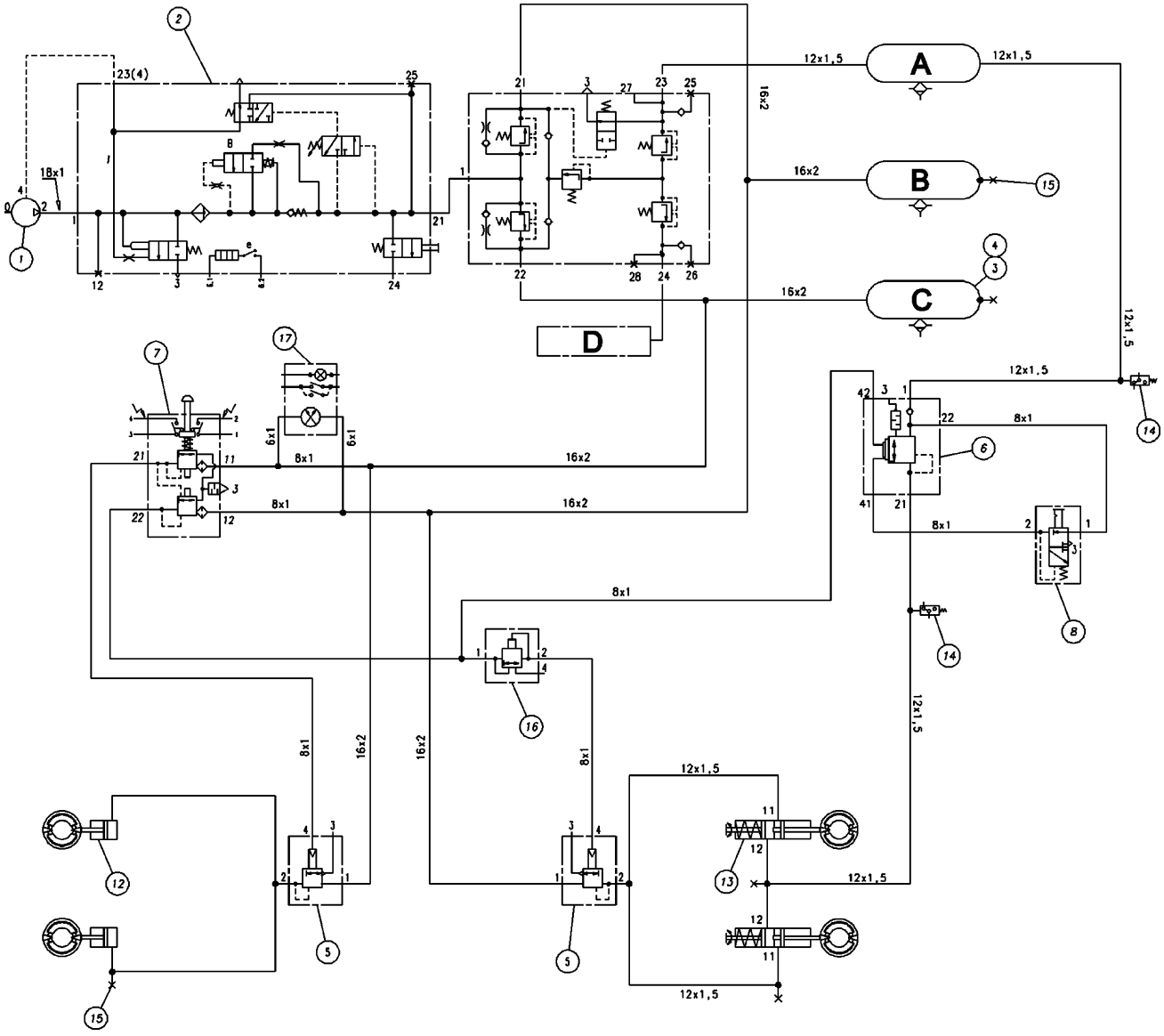
Slow-down braking

This is obtained by the annulling of the injection pump and at the same time the temporary closure of the throttle valve on the discharge manifold through the separate pedal control.

Parking braking

This is mechanical and actuated through the hand distributor set at the end of its stroke. It operates on the rear wheels of the tractor discharging the air from the spring section of the pneumatic cylinder and the servo distributor control section, thus locking the trailer or semi-trailer wheels.
From the driver's seat it is possible to check whether the trailer is able, with the trailer brakes released, to ensure the efficiency of the combined tractor-trailer parking brake.

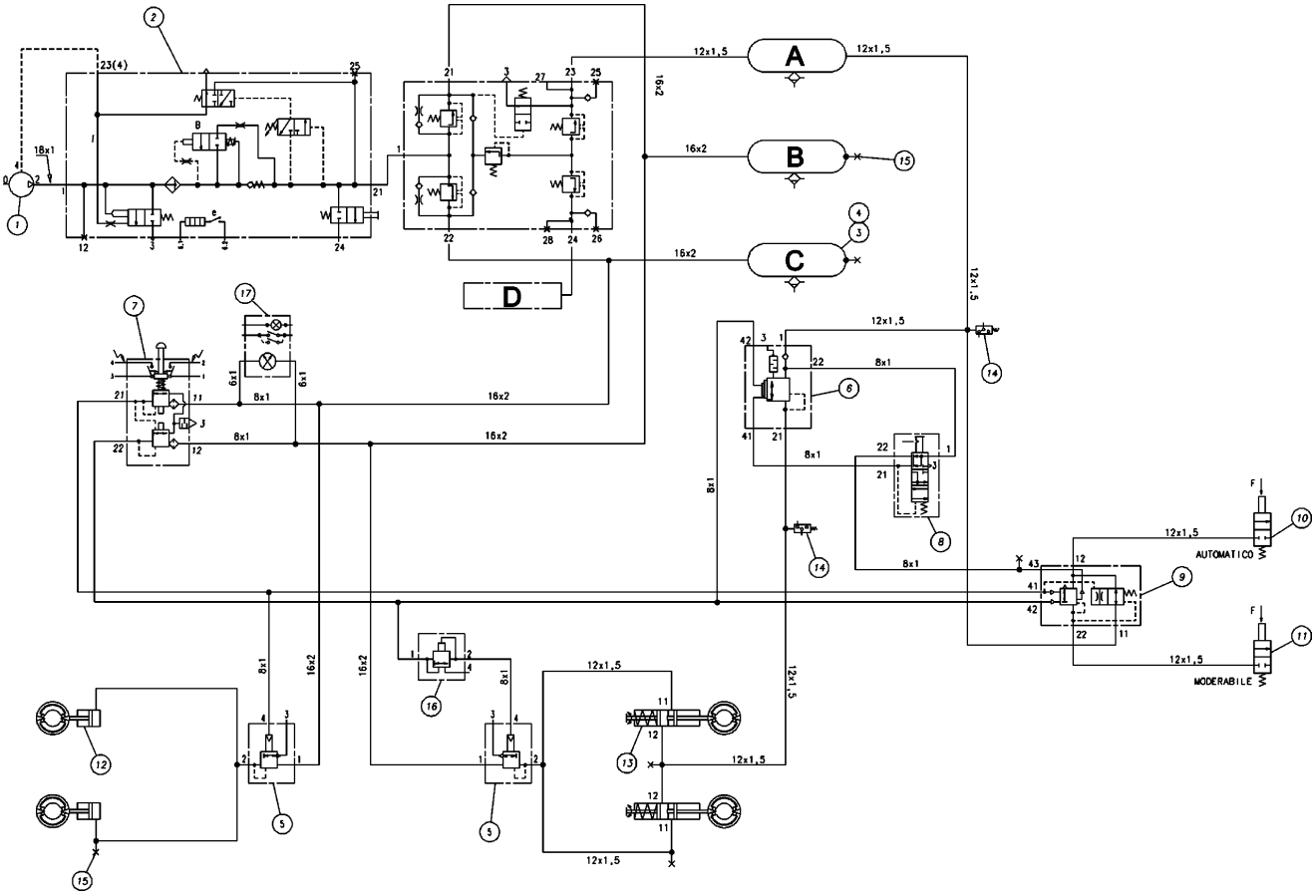
BRAKING SYSTEM DIAGRAM
4x4 vehicles without tow hook



1 Air compressor
2 Air drier
3 Tank (30 l)
4 Condensation drain valve
5 Relay valve
6 Anticompound relay valve
7 Duplex distributor 7.6 bar
8 RVM cock
9 Not used
10 Not used
11 Not used
12 Brake cylinder (22"x 180) 4x4
13 Combined brake cylinder (16"X190/7300N)
14 Pressure switch (6.6 bar)
15 Test union
16 Pressure control
17 Pressure gauge (6.5 bar)

A = Hand brake
B = Rear
C = Front
D = Services

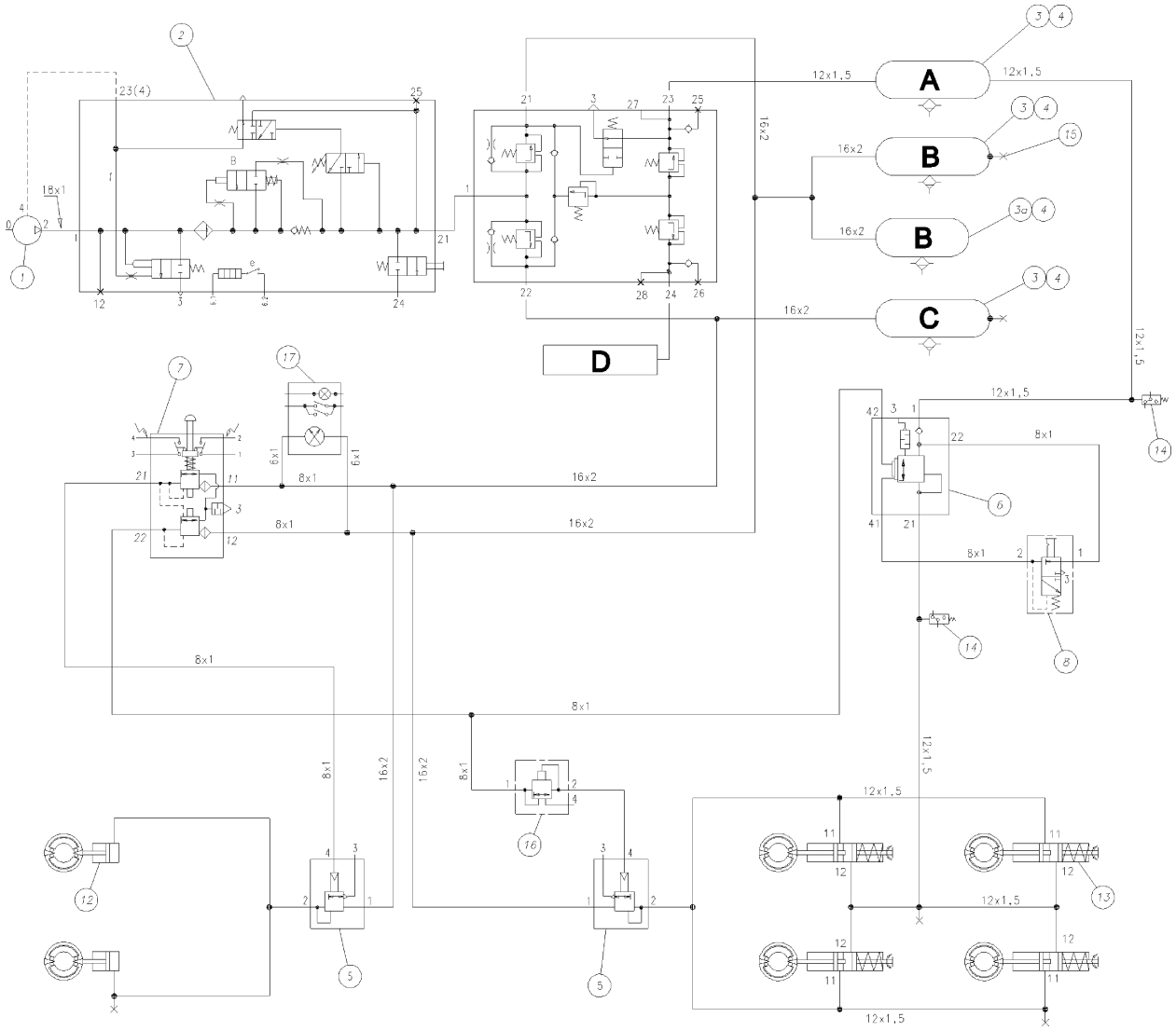
BRAKING SYSTEM DIAGRAM
4x4 vehicles with tow hook



1 Air compressor
2 Air drier
3 Tank (30 l)
4 Condensation drain valve
5 Relay valve
6 Anticompound relay valve
7 Duplex distributor 7.6 bar
8 RVM cock
9 Trailer brake control valve (pred 0.2)
10 Adjustable coupling head
11 Automatic coupling head
12 Brake cylinder (22"x 180) 4x4
13 Combined brake cylinder (Chassis) (16"X190/7300N)
13 Combined brake cylinder (Tractor) (20"X190/7300N)
14 Pressure switch (6.6 bar)
15 Test union
16 Pressure control
17 Pressure gauge (6.5 bar)

A = Hand brake
B = Rear
C = Front
D = Services

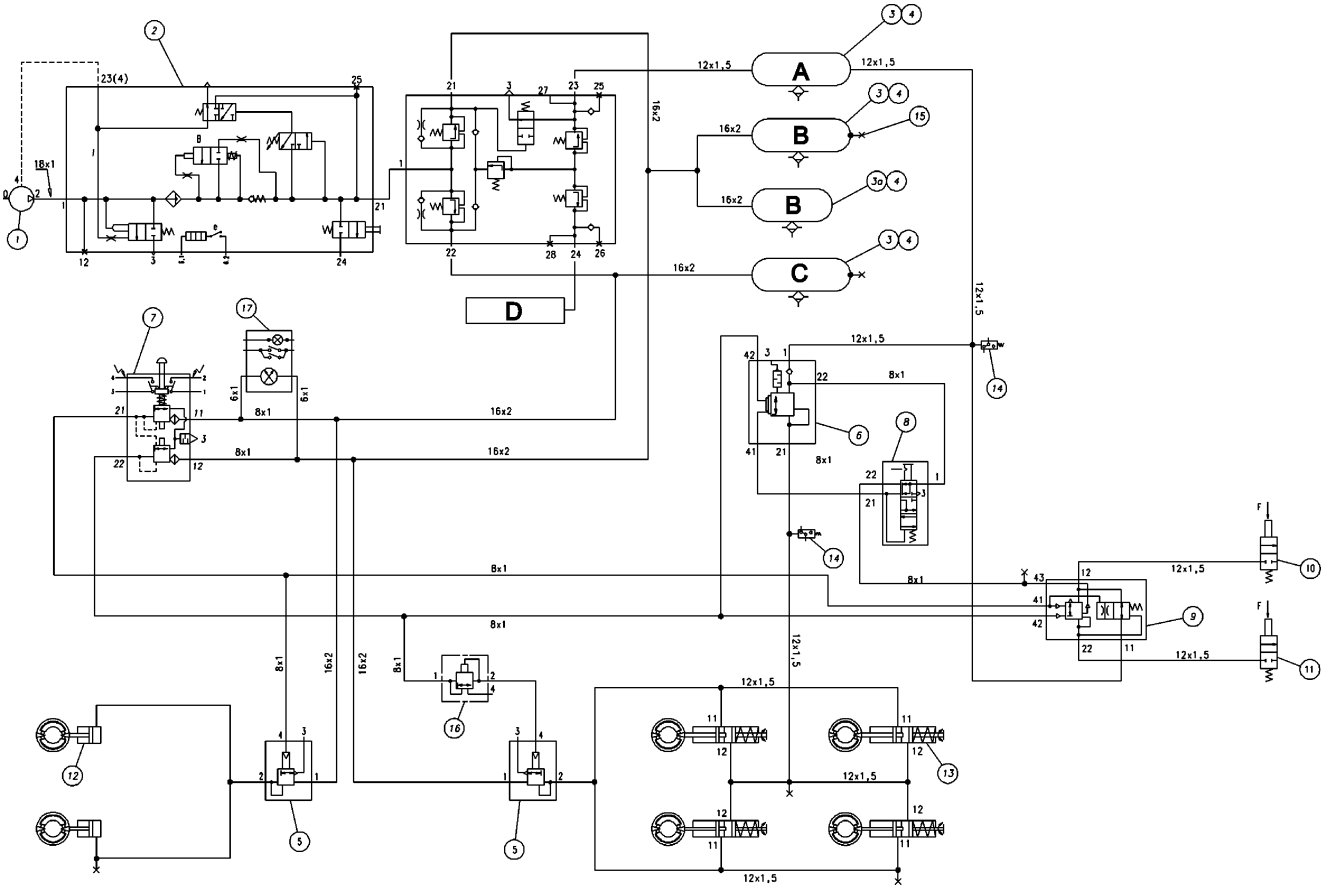
BRAKING SYSTEM DIAGRAM
6x4 and 6x6 vehicles without tow hook



1 Air compressor
2 Air drier
3 Tank (30 l)
3a Tank (20 l)
4 Condensation drain valve
5 Relay valve
6 Anticompound relay valve
7 Duplex distributor 7.6 bar
8 RVM cock
9 Not used
10 Not used
11 Not used
12 Brake cylinder (24"x 275) 6x4
12 Brake cylinder (24"x 180) 6x6
13 Combined brake cylinder (24"x190 / 7300N)
14 Pressure switch (6.6 bar)
15 Test union
16 Pressure control
17 Pressure gauge (6.5 bar)

A = Hand brake
B = Rear
C = Front
D = Services

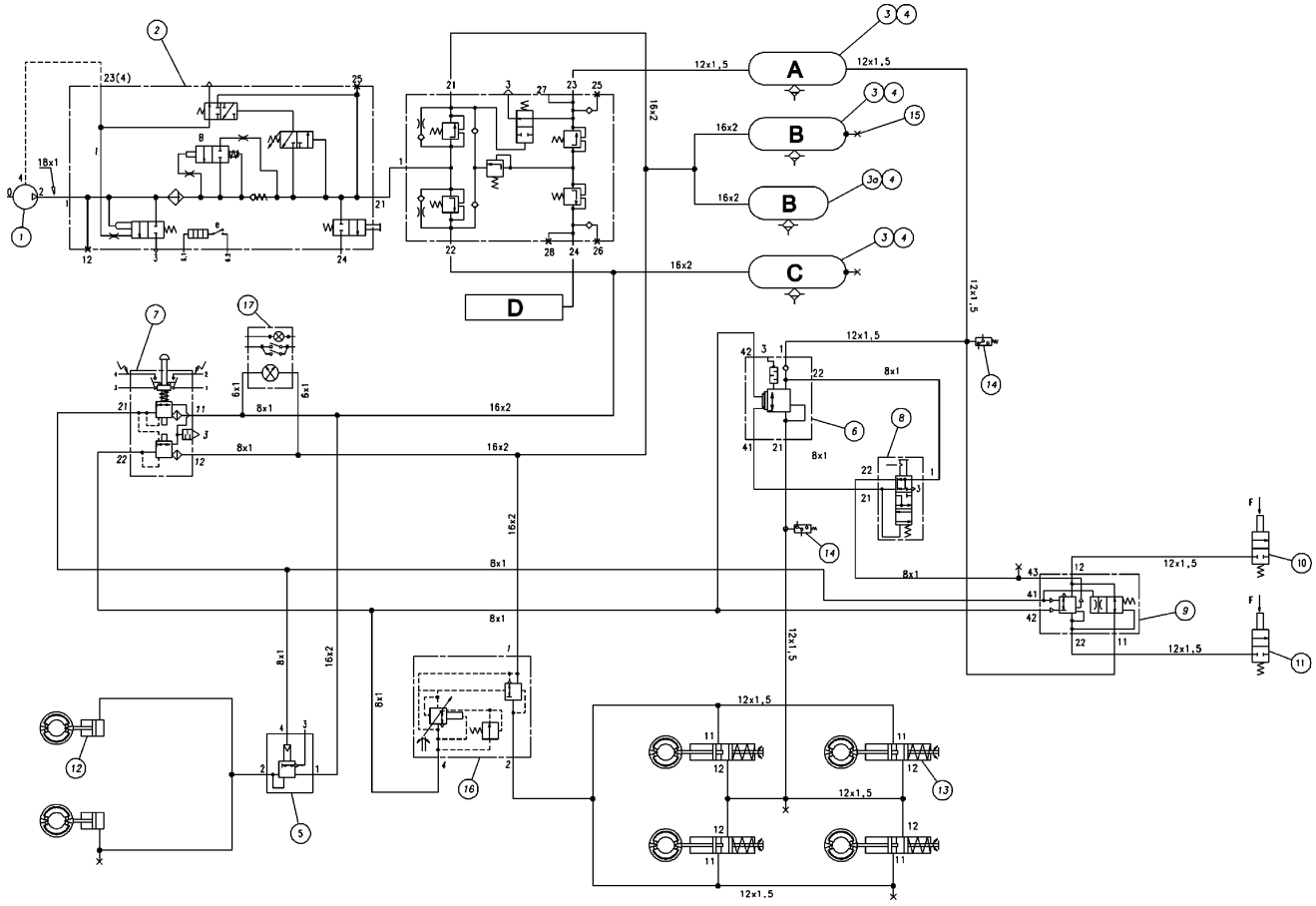
BRAKING SYSTEM DIAGRAM
6x4 and 6x6 vehicles with tow hook



1 Air compressor
2 Air drier
3 Tank (30 l)
3a Tank (20 l)
4 Condensation drain valve
5 Relay valve
6 Anticompound relay valve
7 Duplex distributor 7.6 bar
8 RVM cock
9 Trailer brake control valve (pred 0.2)
10 Adjustable coupling head
11 Automatic coupling head
12 Brake cylinder (24"x 275) 6x4
12 Brake cylinder (24"x 180) 6x6
13 Combined brake cylinder (24"x190/7300N)
14 Pressure switch (6.6 bar)
15 Test union
16 Pressure control
17 Pressure gauge (6.5 bar)

A = Hand brake
B = Rear
C = Front
D = Services

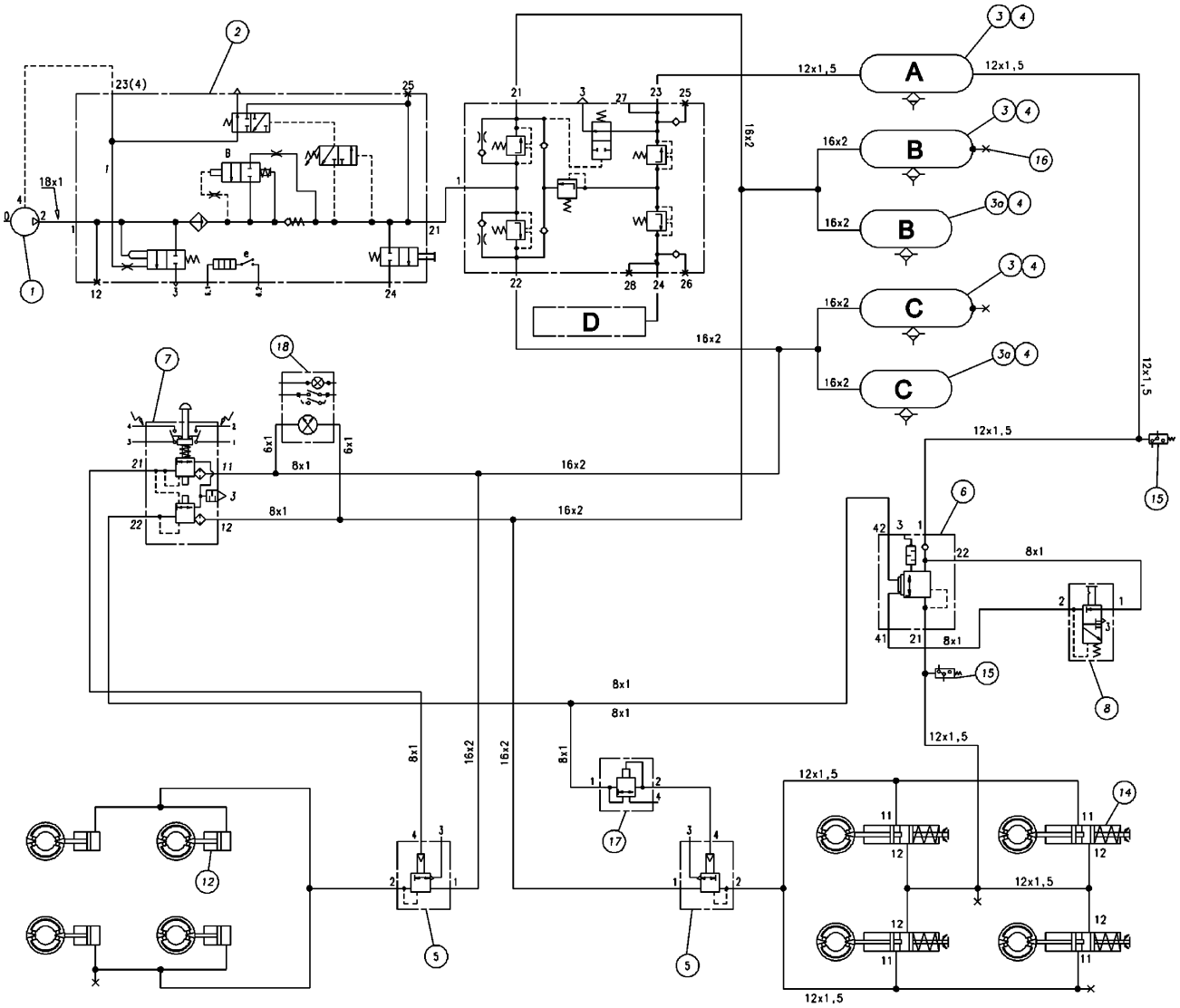
BRAKING SYSTEM DIAGRAM
6x4T and 6x6T vehicles with tow hook



1 Air compressor
2 Air drier
3 Tank (30 l)
3a Tank (20 l)
4 Condensation drain valve
5 Relay valve
6 Anticompound relay valve
7 Duplex distributor 7.6 bar
8 RVM cock
9 Trailer brake control valve (pred 0.2)
10 Adjustable coupling head
11 Automatic coupling head
12 Brake cylinder (24"x 275) 6x4
12 Brake cylinder (24"x 180) 6x6
13 Combined brake cylinder (24"x190 / 7300N)
14 Pressure switch (6.6 bar)
15 Test union
16 Pressure control
17 Pressure gauge (6.5 bar)

A = Hand brake
B = Rear
C = Front
D = Services

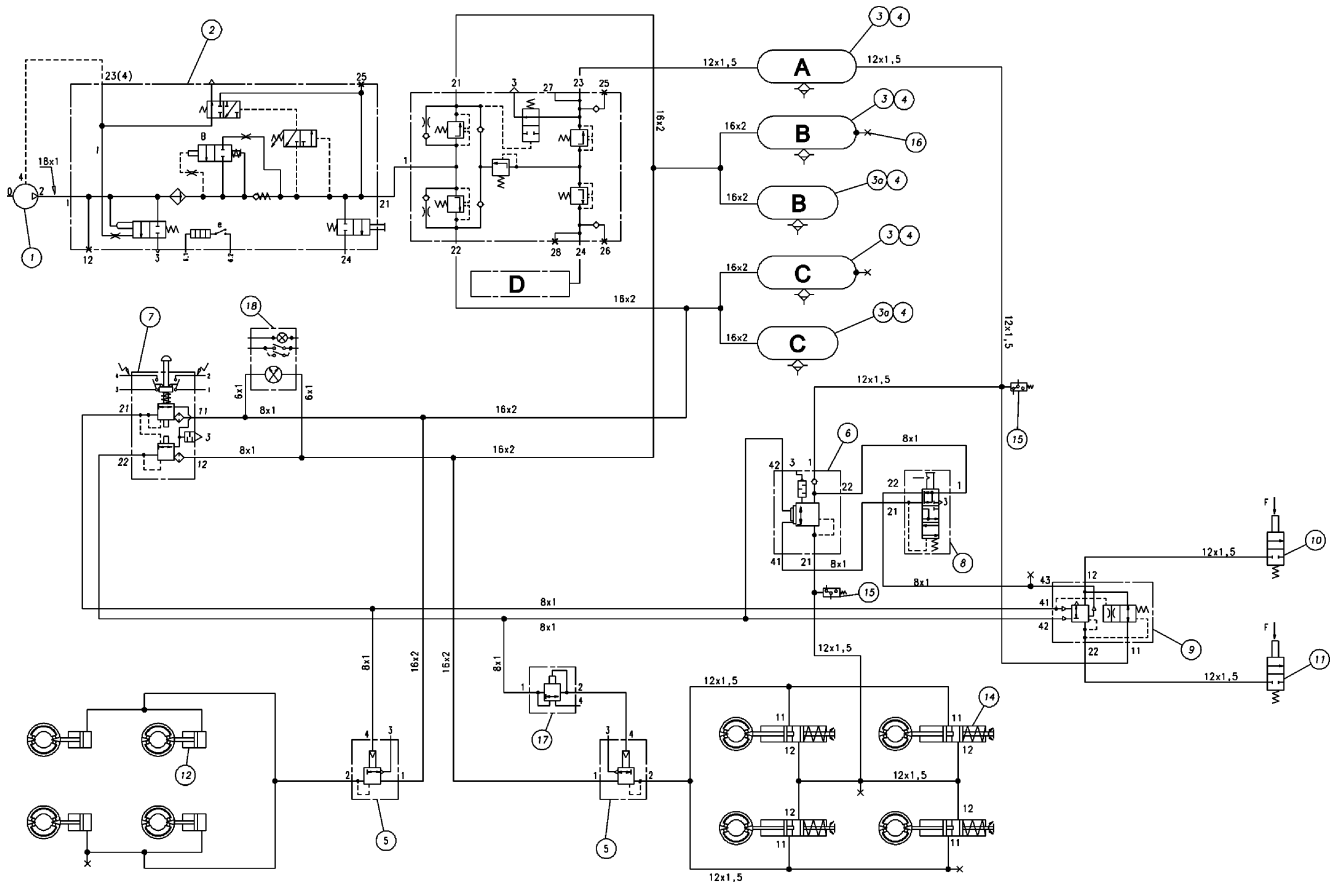
BRAKING SYSTEM DIAGRAM
8x4 vehicles without tow hook



1 Air compressor
2 Air drier
3 Tank (30 l)
3a Tank (20 l)
4 Condensation drain valve
5 Relay valve
6 Anticompound relay valve
7 Duplex distributor 7.6 bar
8 RVM cock
9 Not used
10 Not used
11 Not used
12 Brake cylinder (24"x 275) 8x4
13 Not used
14 Combined brake cylinder (16"X190/7300N)
15 Pressure switch (6.6 bar)
16 Test union
17 Pressure control
18 Pressure gauge (6.5 bar)

A = Hand brake
B = Rear
C = Front
D = Services

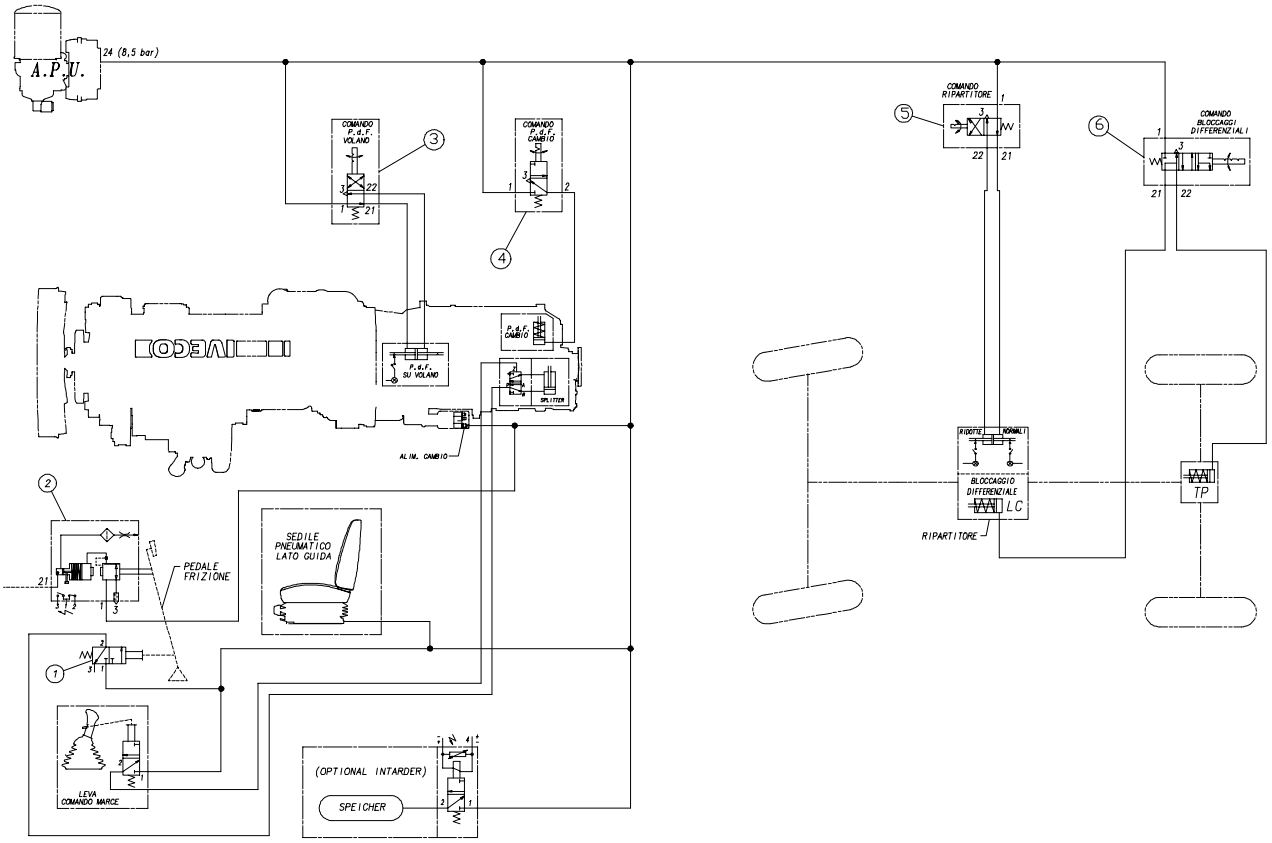
BRAKING SYSTEM DIAGRAM
8x4 vehicles with tow hook



1 Air compressor
2 Air drier
3 Tank (30 l)
3a Tank (20 l)
4 Condensation drain valve
5 Relay valve
6 Anticompound relay valve
7 Duplex distributor 7.6 bar
8 RVM cock
9 Trailer brake control valve (pred 0.5)
10 Adjustable coupling head
11 Automatic coupling head
12 Brake cylinder (24"x 275) 8x4
13 Not used
14 Combined brake cylinder (16"X190/7300N)
15 Pressure switch (6.6 bar)
16 Test union
17 Pressure control
18 Pressure gauge (6.5 bar)

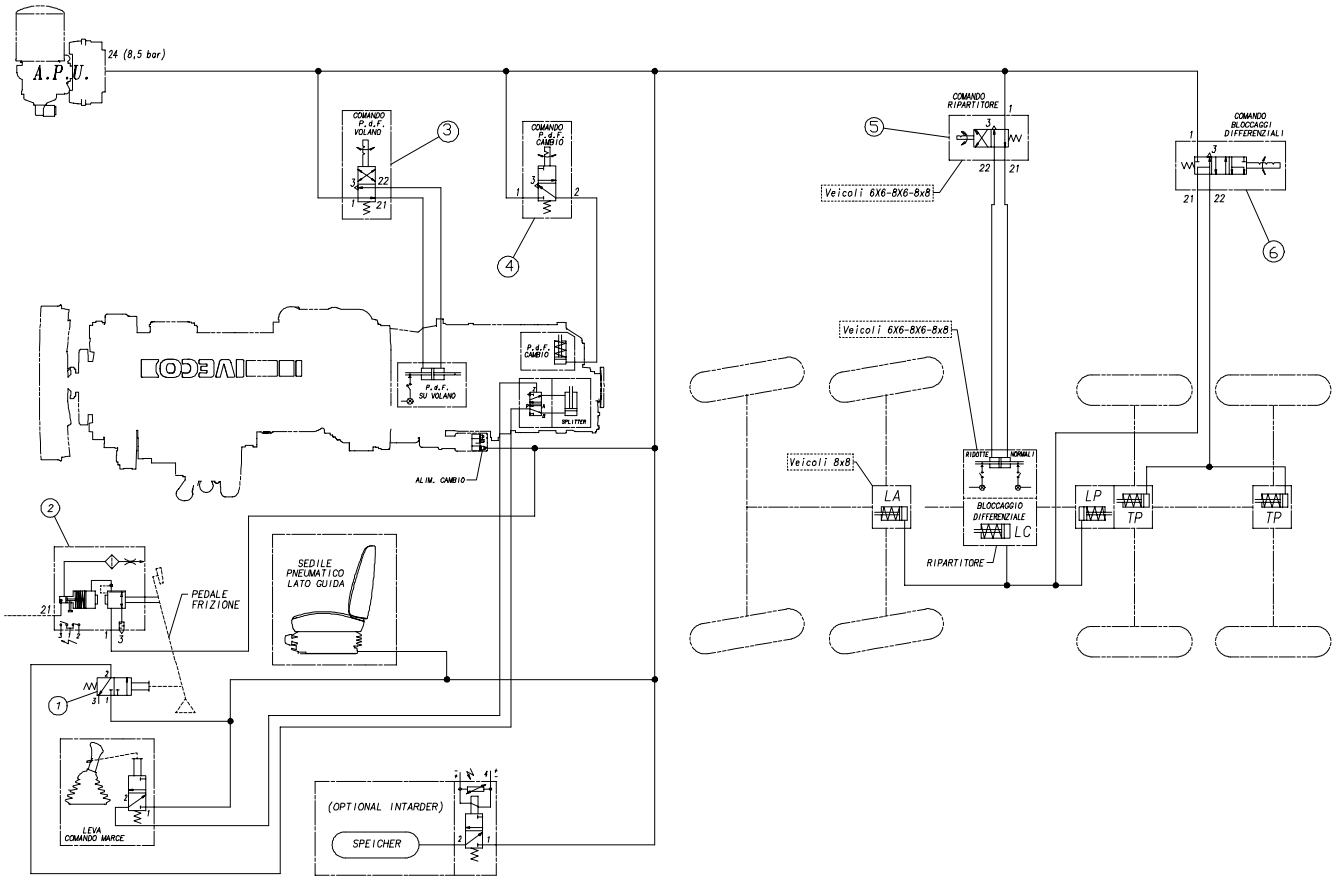
A = Hand brake
B = Rear
C = Front
D = Services

PNEUMATIC SYSTEM DIAGRAM (SERVICES)
2-axle vehicles



1 Valve (splitter enabling)
2 Midiservo
3 Valve (PTO flywheel control)
4 Valve (PTO gearbox control)
5 Valve (transfer control)
6 Valve (locking control)

PNEUMATIC SYSTEM DIAGRAM (SERVICES)
3-axle and 4-axle vehicles



1 Valve (splitter enabling)
2 Midiservo
3 Valve (PTO flywheel control)
4 Valve (PTO gearbox control)
5 Valve (transfer control)
6 Valve (locking control)

DIAGNOSTICS

Main operating faults in the brake system :

1 - Recharging of the system poor or erratic
2 - Rear axle service braking poor or erratic
3 - Front axle service braking poor or erratic
4 - Trailer service braking poor or erratic
5 - Parking brake poor or inoperative
6 - Parking braking on trailer poor or inoperative
7 - Parking brake slow to release
8 - Trailer parking brake slow to release
9 - Vehicle skids when braking
10 - Inefficient retarder braking on trailer
11 - Rapid brake lining wear
12 - Brake system failure warning light comes on
13 - Parking brake warning light on with lever in drive position

1 RECHARGING OF THE SYSTEM POOR OR ERRATIC

Pneumatic system pipework free from leaks or breaks – YES → Tighten or replace loose or damaged couplings. Replace broken or damaged pipes.

NO

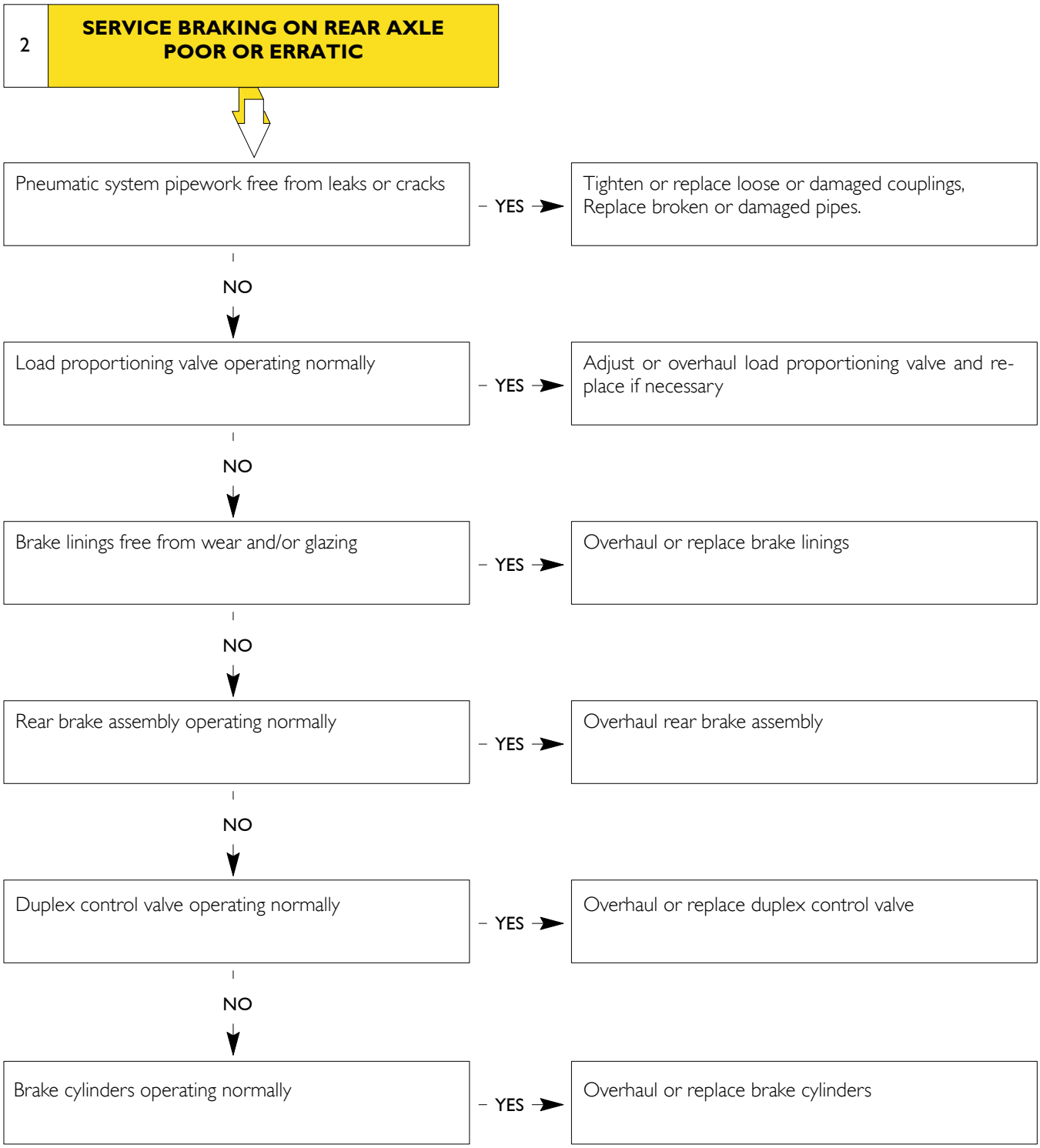
Air compressor operating normally – YES → Overhaul or replace air compressor

NO

Pressure regulator built into humidifier operating normally – YES → Overhaul or replace humidifier

NO

Four-way protection valve operating normally – YES → Overhaul or replace four-way valve


2
SERVICE BRAKING ON REAR AXLE POOR OR ERRATIC
Pneumatic system pipework free from leaks or cracks
YES
Tighten or replace loose or damaged couplings, Replace broken or damaged pipes.
NO
Load proportioning valve operating normally
YES
Adjust or overhaul load proportioning valve and re-place if necessary
NO
Brake linings free from wear and/or glazing
YES
Overhaul or replace brake linings
NO
Rear brake assembly operating normally
YES
Overhaul rear brake assembly
NO
Duplex control valve operating normally
YES
Overhaul or replace duplex control valve
NO
Brake cylinders operating normally
YES
Overhaul or replace brake cylinders

3 FRONT AXLE SERVICE BRAKING POOR OR ERRATIC

Pipework free from leaks or breaks
– YES → Tighten or replace loose or damaged couplings. Replace broken or damaged pipes

NO

Duplex control valve operating normally
– YES → Overhaul or replace duplex control valve

NO

Brake linings free form wear and/or glazing
– YES → Overhaul or replace brake linings

NO

Front brakes operating normally
– YES → Overhaul front brakes

NO

Diaphragm brake cylinders operating normally
– YES → Overhaul or replace diaphragm brake cylinders

4 TRAILER SERVICE BRAKING POOR OR ERRATIC

Pipework free from leaks or breaks
– YES → Tighten or replace loose or damaged couplings. Replace broken or damaged pipes

NO

Triple action servo control valve operating normally
– YES → Overhaul or replace triple action servo control valve

(continued)

Duplex control valve operating normally – YES → Overhaul or replace duplex control valve

NO

Pressure reducer operating normally – YES → Overhaul or replace pressure reducer

NO

Brake linings free from wear and/or glazing – YES → Overhaul or replace brake linings

NO

Trailer brakes operating normally – YES → Overhaul trailer brakes

5 PARKING BRAKE POOR OR INOPERATIVE

Pipework free from leaks or breaks – YES → Tighten or replace loose or damaged couplings. Replace broken or damaged pipes

NO

Combined brake cylinders operating normally – YES → Overhaul or replace combined brake cylinders

NO

Parking brake hand control valve (lever) operating normally – YES → Overhaul or replace lever

(continued)

Brake linings free from wear and/or glazing – YES → Overhaul or replace brake linings

NO

Relay valve operating normally – YES → Overhaul or replace relay valve

6 **PARKING BRAKE ON TRAILER POOR OR INOPERATIVE**

Pneumatic system pipework free from leaks or breaks – YES → Tighten or replace loose or damaged couplings. Replace broken or damaged pipes

NO

Triple action servo control valve operating normally – YES → Overhaul or replace triple action servo control valve

NO

Parking brake hand control valve (lever) operating normally – YES → Overhaul or replace lever

NO

Trailer brake linings free from wear or glazing – YES → Overhaul or replace trailer brake linings

NO

Trailer brake assembly operating normally – YES → Overhaul trailer brakes

7 PARKING BRAKE SLOW TO RELEASE

Pipework free from leaks or breaks
- YES → Tighten or replace loose or damaged couplings. Replace broken or damaged pipes.

NO ↓

Relay valve operating normally
- YES → Overhaul or replace relay valve

NO ↓

Combined brake cylinders operating normally
- YES → Overhaul or replace combined brake cylinders

NO ↓

Parking brake hand control valve (lever) operating normally
- YES → Overhaul or replace lever

NO ↓

Rear brake assembly operating normally
- YES → Overhaul rear brakes

8 TRAILER PARKING BRAKE SLOW TO RELEASE

Pipework free from leaks or breaks
- YES → Tighten or replace loose or damaged couplings. Replace broken or damaged pipes

NO ↓

Triple action servo control valve operating normally
- YES → Overhaul or replace triple action servo control valve

(continued)

Parking brake hand control valve (lever) operating normally – YES → Overhaul or replace lever

NO

Trailer brakes operating normally – YES → Overhaul trailer brakes

9 **VEHICLE SKIDS WHEN BRAKING**

Pipework free from breaks or leaks – YES → Tighten or replace loose or damaged connections. Replace broken or damaged pipes

NO

Duplex control valve operating normally – YES → Overhaul or replace Duplex control valve

NO

Load proportioning valve operating normally – YES → Adjust, overhaul and if necessary replace load proportioning valve

NO

Front brake assembly operating normally – YES → Overhaul front brakes

NO

Rear brake assembly operating normally – YES → Overhaul rear brakes

NO

Triple-action control valve operating normally – YES → Overhaul or replace triple action control valve

10 INEFFICIENT RETARDER BRAKING ON TRAILER

Pipework free from leaks or breaks
- YES → Tighten or replace loose or damaged couplings. Replace broken or damaged pipes

NO

Pressure reducer operating normally
- YES → Overhaul or replace pressure reducer

NO

Triple action control valve operating normally
- YES → Overhaul or replace triple action control valve

NO

Hand control valve (lever) operating normally
- YES → Overhaul or replace lever

11 RAPID BRAKE LINING WEAR

Duplex control valve operating normally
- YES → Overhaul or replace duplex control valve

NO

Load proportioning valve operating normally
- YES → Adjust, overhaul and if necessary replace load proportioning valve

NO

Brake assemblies operating normally
- YES → Overhaul brakes

(continued)

Triple action control valve operating normally – YES → Overhaul or replace triple action control valve

NO

Relay valve operating normally – YES → Overhaul or replace relay valve

12 **BRAKE SYSTEM FAILURE WARNING LIGHT COMES ON**

Pipework free from leaks or breaks – YES → Tighten or replace loose or damaged couplings. Replace broken or damaged pipes

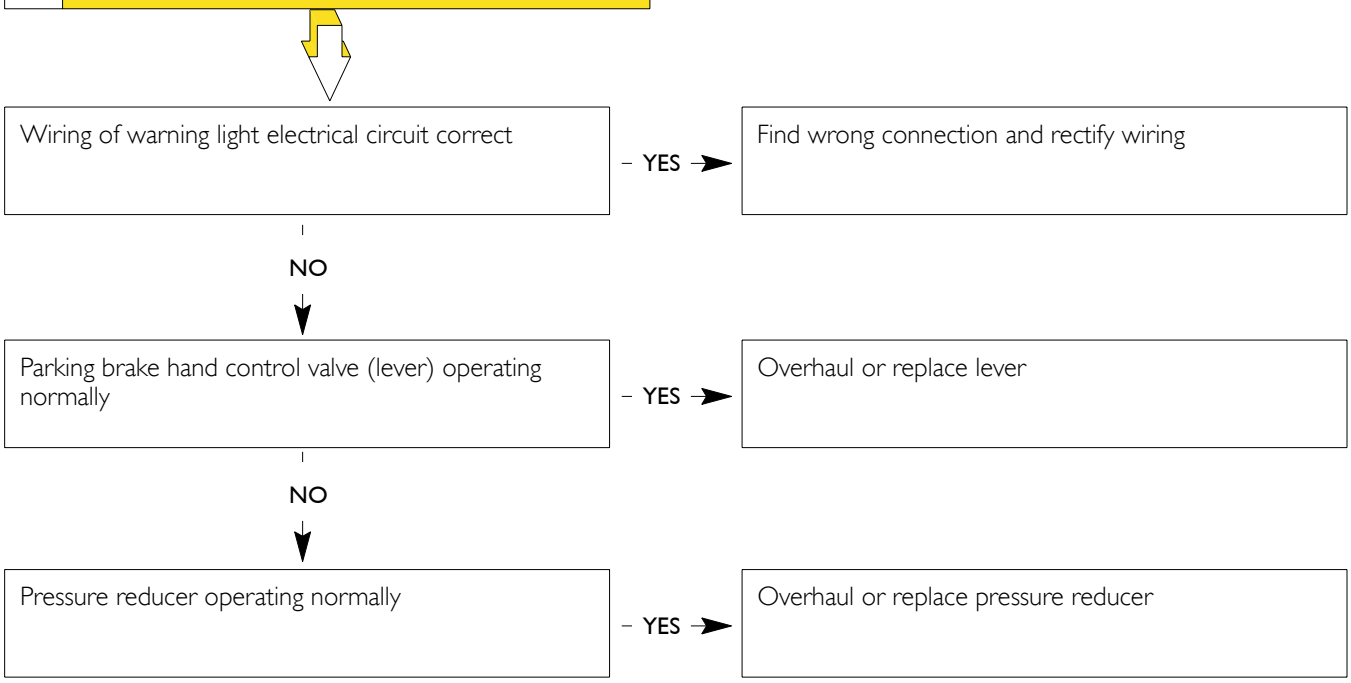
NO

Four way protection valve operating normally – YES → Overhaul or replace four way protection valve

NO

Wiring of warning light electrical circuit correct – YES → Find wrong connection and rectify wiring

13 PARKING BRAKE WARNING LAMP ON WITH HANDLE IN RUNNING POSITION



TIGHTENING TORQUES

DESCRIPTION		TORQUE Nm (Kgm)
Compressor		
Pulley fastening nuts		190 ± 10 (19 ± 1)
Screws to fasten head on 250 cu.cm Bendix compressor	cover to head check screws	24 ± 1 (2,4 ± 0,1)
	head fastening screws	42,5 ± 2,5 (4,3 ± 0,2)
Combined cylinder (actuator)		
Brake cylinder ring nut		314,5 ± 31,5 (32 ± 3,2)
Nuts for spring section to diaphragm section retaining clamp		10 ± 1 (1 ± 0,1)
Screw for manually operated brake release		$15\ ^{+20}_{-0}$ $(1,5\ ^{+2}_{-0})$
Diaphragm brake cylinder (for drum brakes)		
Brake cylinder ring nut		314,5 ± 31,5 (32 ± 3,2)
Nuts for spring section to diaphragm section retaining clamp		10 ± 1 (1 ± 0,1)

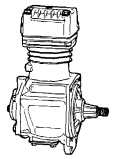
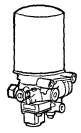
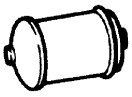
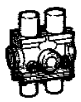
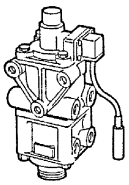
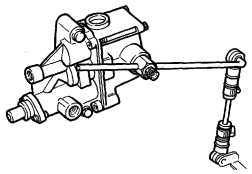
TOOLS

TOOL NO.	DESCRIPTION
99356606	Wrench for removal and re-fitting in place combined brake cylinders ring nut
99387050	Cutting nippers for polyamide hoses
99395216	Pair of protractors for angle tightening

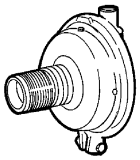
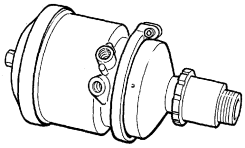
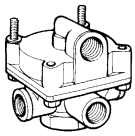
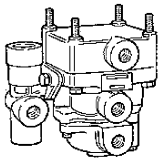
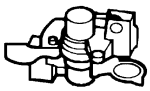
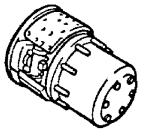
BRAKING SYSTEM MAIN COMPONENTS CHECK

Since the vehicle system is approved according to European road code standards, it is necessary that the efficiency and components are periodically checked using tool 99305117.
The checks are carried out with the vehicle at a standstill, using compressed air from the tanks, recharged, with the engine running, by the compressor.

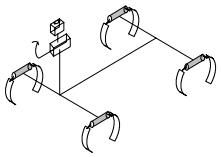
Always check the vehicle before any intervention. Periodically check the gauges by comparison with a sample gauge.

DEVICE	DESIGNATION	CHECKS
	Compressor	Check the tightness of fittings and that the compressor is securely fastened. Make sure the cooling fins are not dirty.
	Drier (optional)	Operate on a bleeder valve or loosen a screwed plug (with integrated bleeder hole) to check that the air drier is operating correctly. The air should come from the tank with no signs of condensate water.
	Air tanks for : Front axle Rear axle Parking+trailer Services Regeneration	Check the seal and anti-rust protection. Discharge the condensate from the tanks through the bleeder valve
	Four way safety valve	Check : Maximum opening pressure 8 bar Static closing pressure 6.5 bar
	Duplex distributor	Press the pedal to the end of its stroke, releasing the pedal it should return immediately to its home position. Pressure restriction 7.6 ± 0.3 bar Check that the pedal gasket is not worn, that the brake control rods are well secured and lubricated with no strain. Check that the lever housings are not worn or oxidized.
	Pneumatic pressure control socket	Ensure that the protection plugs are inserted
	Parking brake distributor (with checking position)	Operate on the parking brake distributor until it triggers, the gauge on the control socket is to indicate the pressure discharge 0 bar in 1 second. The automatic coupling joint pipe and the gauge are to indicate at the same time a pressure of 8.5 bar
	Engine brake control pedal distributor	Check functioning and seal
	Braking control	The plate indicates all the set values to be compared to those found when checking and adjusting.

(cont'd)

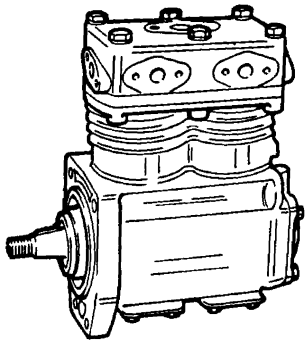
	**Diaphragm cylinder**	Check fastening, integrity and seal The bleeder hole should be directed downwards and not clogged
	**Combined cylinder**	Check fastening, integrity and seal. The bleeder hole should be directed downwards and not clogged
	**Relay valve**	Check operation and seal assessing the speed of brake cylinder activation
	**Engine brake control operator cylinder**	Check operation and seal
	**Pressure reducer**	Check set pressure (see specifications and data table) Check operation
	**Triple control servo distributor for trailer braking, with incorporated modulated power steering**	Fill the tank. Connect a gauge to the automatic coupling head and to a variable coupling head. At a pressure of 1 bar, coming from the duplex distributor, the variable coupling head should have a pressure between 0.8 and 1.5 bar. Make a full braking (vehicle at a standstill). Prescribed pressure must result at the coupling head, or a pressure that is 0.5 bar less. Activate the parking brake; at the variable coupling head the pressure should remain the same, or reduced by 0.5 bar.
	**Coupling heads**	Check there is no dirt or damage on the coupling guides. After coupling,operate the brake pedal and check the seal and stability between the coupling heads when delivering air at 7.5 bar. Check there are no air leaks from the coupling gaskets.
	**Rear drum brakes**	Releasing the pedal the shoes should return quickly and evenly to home position. Check backlash between shoes and drum. Check thickness of brake linings.

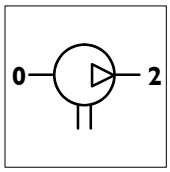
(cont'd)

	**Pipes and fittings**	Ensure that metal pipes are in perfect condition, with no dents or cracks. Polyamide hoses must have no cracks, cuts or scores. Also make sure that they are not near sharp edges of the bodywork or chassis that could damage them. Check that all the brackets fastening the pipes are securely fixed - loose fastenings cause vibrations that could give rise to breakages. Check that polyamide hoses are not in contact with oil or mineral grease, rubber solvents. Press hard on the brake pedal and check that the pipes are not blown. Check there are no leaks from fittings, otherwise tighten them fully, taking care when tightening not to cause irregular pipe torsion. In all the above cases the parts are to be replaced if there is a minimum of doubt as to their efficiency. Apart from their condition, it is recommended to replace hoses after considerable mileage, or after a period of long vehicle use. This will avoid sudden breakages due to age and fatigue.
	Pneumatic system seal with engine off below the starting pressure	This check is made on threaded couplings. Deliver air at a pressure of not less than 5 bar and spread quite thick soapy water on the joints and couplings using a soft brush, then observe carefully for signs of leaks. An air leak is within tolerance if it corresponds to a soap bubble with a diameter of 25 mm in 5 seconds, or a pressure drop within 10 minutes amounting to 2% of the disengagement pressure (0.22 ± 0.02 bar).
	Pneumatic system seal in partial braking range with 3 bar.	For 3 minutes the pressure must remain stabilized in the pneumatic system. The check is made with the parking brake deactivated.

BRAKING SYSTEM MAIN COMPONENTS
Compressor

Figure 1



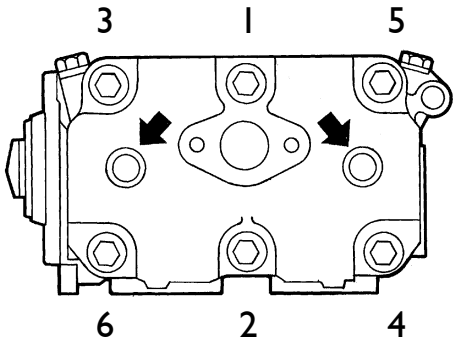


30411

Produces sufficient compressed air to feed the braking system and ancillary services.

Head locking screw torques

Figure 2



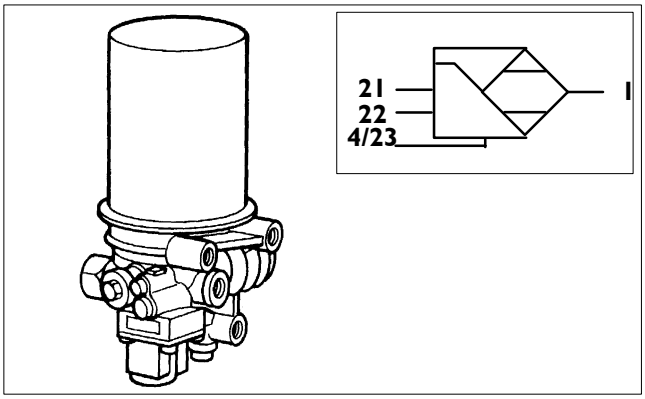
Following the sequence indicated in the figure tighten the cylinder head fastening screws to the prescribed torque. Tighten cylinder head cover fastening screws (arrow) to the prescribed torque.

Diagnostic

TROUBLE	POSSIBLE CAUSES	CURE
Oil leakage from flange on outer side	Incorrect driving torque	Tighten the screws to the prescribed values
	Flange body sealing surface not perfectly flat	Check the sealing surfaces, replace faulty parts or straighten them
	Broken gasket	Replace the gasket
	Shaft gasket damaged	Replace the gasket
Oil leakage from head	Damaged scraper ring (this can be seen because the whole seal seat is shiny)	Replace the entire piston
	Scraper ring is badly fitted	Fit in place with the TOP inscription turned towards the compressor head
	Scraper rings and piston rings are all on the same vertical line.	Fit in place at 120° with reference to each other
	Scored or ovalized cylinder	Grind the cylinder and fit a bigger piston
No compression at all	Deteriorated compression or intake valve	Replace the faulty parts
	Piston rings are all on the same vertical line	Fit the rings at 120° with reference to each other
	Piston perforated or piston elements broken	Replace the entire piston
	Damaged gasket	Replace the gaskets
	Energy-saving device set on open during charging stage.	Replace the cylinder heads
Poor efficiency	Worn piston rings	Replace the piston (and piston rings)
	Air leakage between cylinder and head	Replace the gasket and tighten the screws to the prescribed torque
	Deteriorated energy saving unit, intake or compression valves	Replace the faulty parts
	Too much backlash between piston and cylinder	Grind the cylinder and fit a bigger piston
	Particles of carbonized oil between the intake and compression valves	Clean the valves
Mechanical noises	Too much backlash between small end and pin, between pin and piston hole, between shaft and big end, between shaft and bronze caps and between flanges and shaft.	Check the tolerances of the couplings involved
	Too much backlash between piston and cylinder	Grind the cylinder and fit a bigger piston
	Excessive deposits between piston and cylinder head caused by burnt oil.	Clean the incrustations and replace the valves
Water seepage	Head gasket or contact surfaces scored and uneven.	Replace the faulty parts

Drier

Figure 3



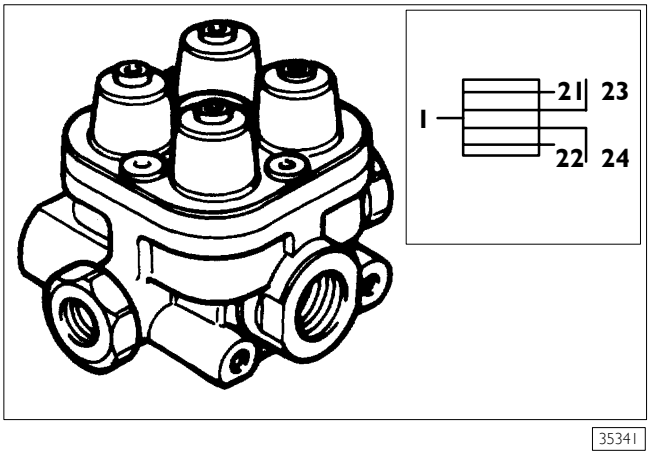
The drier reduces the humidity content of the compressed air coming from the compressor to prevent condensate accumulating in the system. The compressed air flows through a granular material and the condensate water is absorbed by its cristalline structure. After the regulator triggers the air in the regenerating tank regenerates the material absorbed.
The unit features three main parts: a cartridge containing the absorbent material, a control section and a pressure regulator which, besides regulating the functioning of the entire system, also switches the unit from "Drying" to "Regeneration".

Diagnostic

PROBLEM	POSSIBLE CAUSE	REMEDY
Too much condensate in the circuit	Clogged filter cartridge	Replace the cartridge
The set pressure is not reached in the tank	Air leaking from safety valve	Overhaul the equipment and replace worn components
	Worn sealing gaskets	Overhaul the equipment and replace worn components
Air loss at discharge	Piston seal is insufficient	Overhaul the equipment and replace worn components

Four-way safety valve

Figure 4



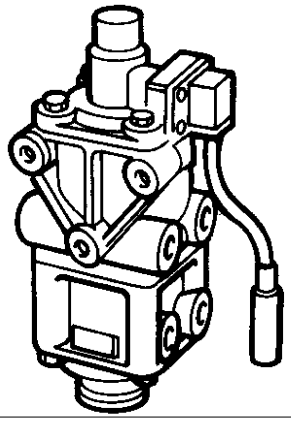
The unit ensures that the compressor, in the case of a fault in one section, charges the tanks connected to the operational sections with a pressure equal to the set pressure of the faulty section.
The unit has four similar valve units.

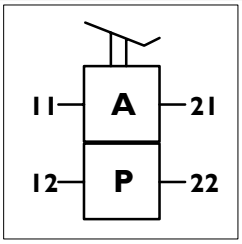
Diagnostic

PROBLEM	POSSIBLE CAUSE	REMEDY
Air leakage around the plugs	Leakage in the four valve sections	Overhaul the unit and replace worn components
Air leakage when there is a faulty section	Check valves are faulty	Overhaul the unit and replace worn components, if necessary replace the unit

Duplex distributor

Figure 5





33545

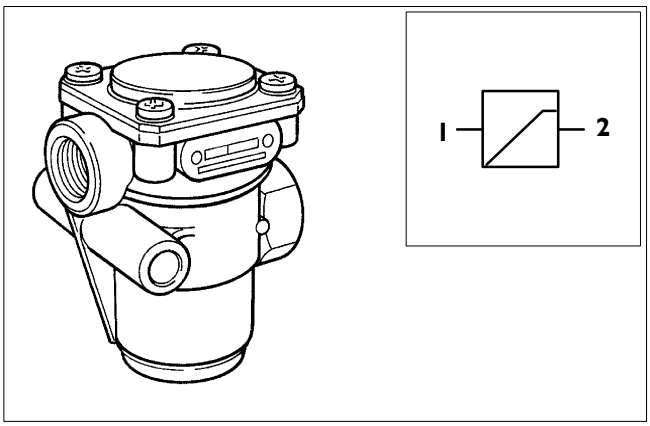
Takes the air from the tank and distributes it to the braking elements. It is autorestrictive i.e. it limits the air output to an established maximum pressure and as a result there is a greater availability of energy and a maximum constant braking pressure regardless of the pressure variations in the tanks.
On vehicles fitted out as trucks duplex distributors are fitted to correct the braking force of the front axle elements according to the corrections made by the braking control.

Diagnostic

PROBLEM	POSSIBLE CAUSE	REMEDY
Air escapes from the discharge hole	Leaks from outlet ducts due to wear on seal gaskets	Overhaul the device and replace worn components
Irregular autorestriction of distributor	Auto restriction higher or lower than required	Adjust the device through the relevant screw
Vibrations when braking	Worn springs	Overhaul the device and replace faulty components
	Air leaks due to piston gasket seals in the two sections	Overhaul the device and replace faulty components
Irregular operation of stop lamp control switch	The electric circuit does not close	Replace the switch
	The electric circuit does not open	Replace the switch

Pressure reducer

Figure 6



34953

Cuts off the compressed air flow to the user when the pressure in the latter reaches a determined value (set point).

Setting at the bench

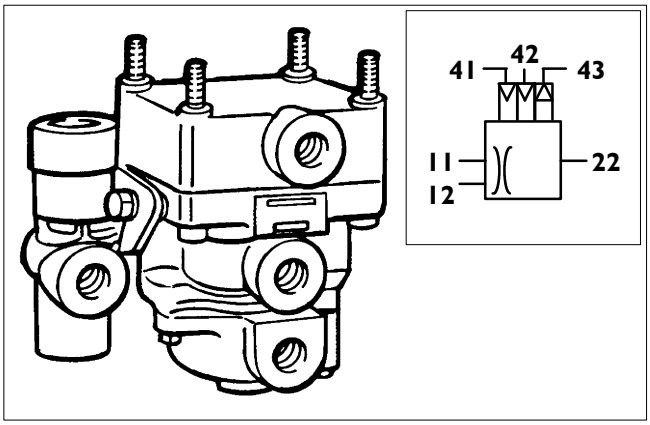
Set the element on the test bench and connect fittings **1** and **2** through the pipes to the gauge and the air supply.
Correct to the prescribed value through the adjusting screw and at the same time check the perfect seal of the unit.

Diagnostic

PROBLEM	POSSIBLE CAUSE	REMEDY
Pressure at the outlet fitting is different to the set value	Valve not adjusted properly Leaks from the seal rings Faulty piston and relevant seat	Adjust the unit Overhaul the unit replacing damaged components Replace the unit

Triple control servo distributor

Figure 7



33986

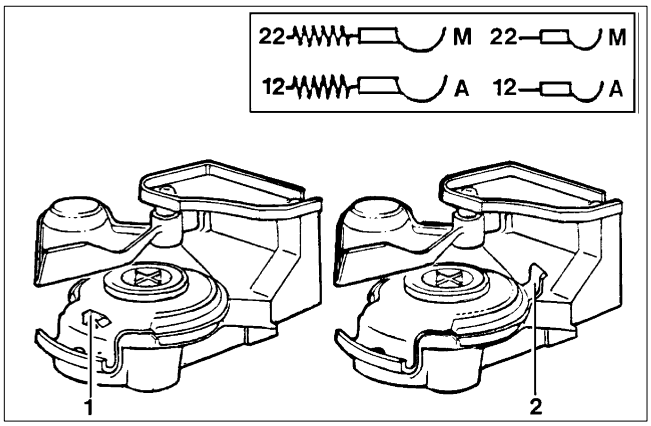
The unit, controlled by two separate circuits of the duplex distributor and the tractor spring brake circuit, controls the trailer braking. It is also equipped with a predominance regulating device fitted on the lower external part.
The unit incorporates a device to actuate the trailer brake should there be a fault in the control pipe.

Diagnostic

PROBLEM	POSSIBLE CAUSE	REMEDY
Air leakage from exhaust when in resting condition	Leaks from sealing gaskets. Faulty exhaust valve and valve seat	Overhaul the unit and replace faulty components Overhaul the unit and replace faulty components
Outlet pressures are different from the established values	Air leakage from sealing gaskets Worn or faulty pistons and seats Strained springs	Overhaul the unit and replace faulty components Overhaul the unit and replace faulty components Overhaul the unit and replace faulty components

Coupling heads

Figure 8

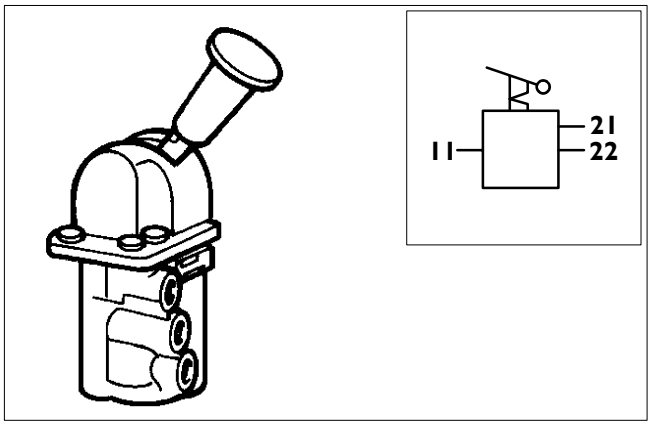


20082

The version for the "Automatic" pipe has a yellow cover and a side safety ridge (2). The safety ridges serve to prevent improper coupling.

Parking brakes control hand distributor

Figure 9

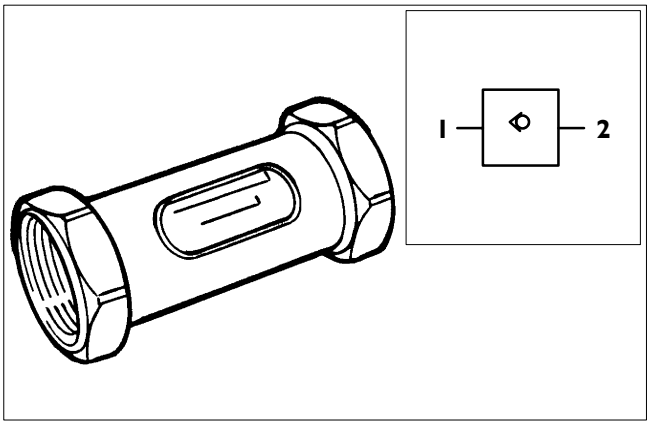


33987

The device enables emergency and parking braking of the tractor and the trailer.
The device also enables the checking of the tractor braking effect. This operation is necessary when the vehicle is parked on very steep roads.

Check valve

Figure 10



35352

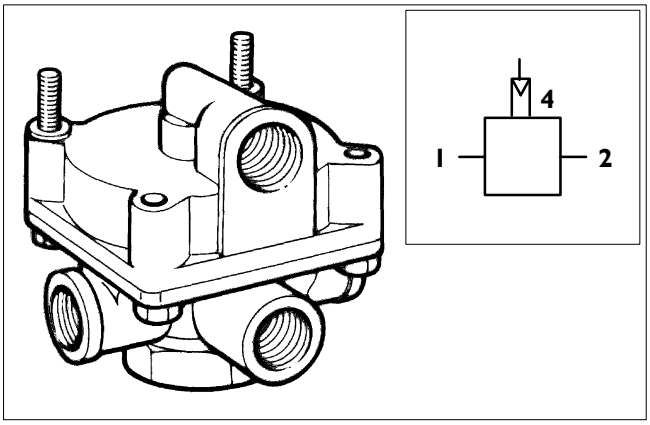
Enables the compressed air to flow in the direction of the arrow marked on the housing and prevents reflux.

Diagnostic

PROBLEM	POSSIBLE CAUSE	REMEDY
Air escapes from the exhaust with control lever		
In braking release position	Faulty exhaust valve, relevant seat or seal ring	Check and overhaul the unit, replace faulty components. Carefully clean the components.
In braking position	Worn control valve, seal rings and component control valve	Check and overhaul the unit, replace faulty components. Carefully clean the components.
It is difficult to turn the control lever	Interference inside the distributor	Overhaul the unit and moisten all the sliding parts.

Relay valves

Figure 11



36743

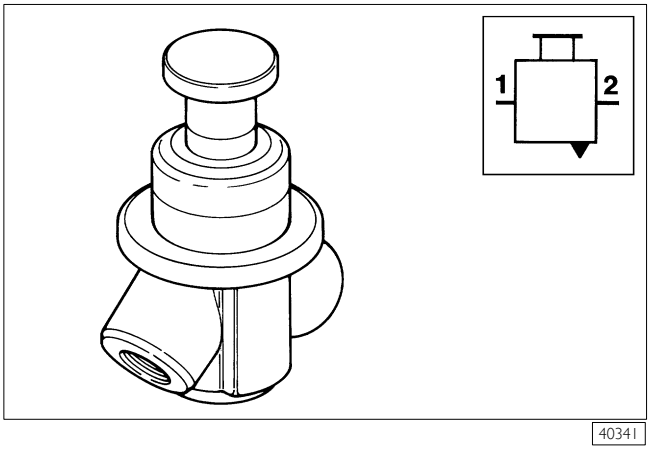
To accelerate the compressed air discharge from the combined cylinder section, thus shortening the braking time.

Diagnostic

PROBLEM	POSSIBLE CAUSE	REMEDY
Air leakage from exhaust with control pipe in discharge condition	Leakage from the delivery or from the seal rings	Overhaul the unit and replace faulty components
Air escapes from the discharge with supply in the control pipe	Leakage from the piston seal rings or from the exahust valve	Overhaul the unit and replace the faulty parts

Engine brake control pedal valve

Figure 12

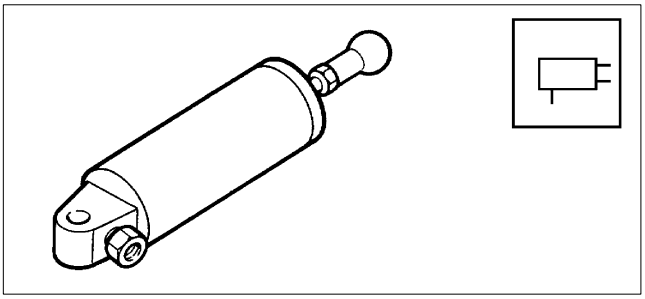


40341

This is an automatic distributor that can be activated from the driver's seat.
It is fitted in the operator elements control of the engine brake

Engine brake control operator cylinder

Figure 13

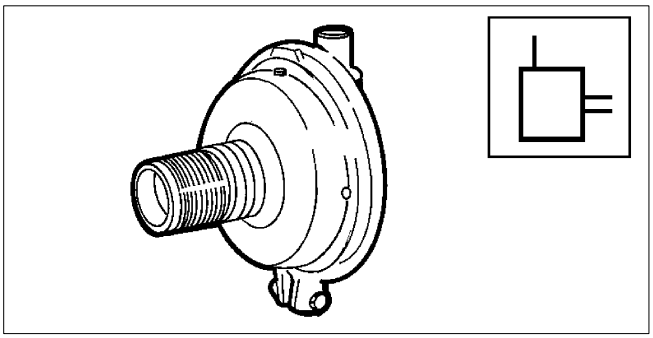


40563

This activates the throttle valve that shuts the engine gas exhaust pipe

Diaphragm brake cylinder

Figure 14

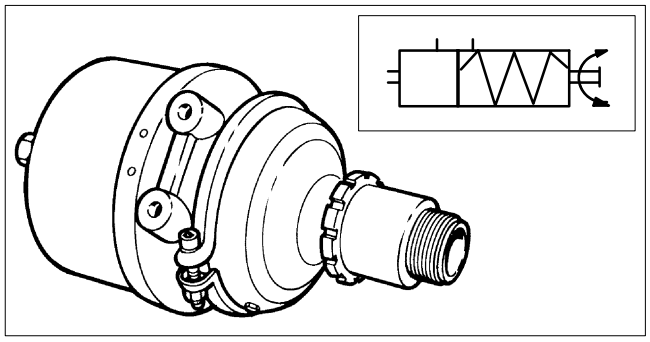


35798

The unit transmits the force impressed by the compressed air when the brake pedal is pressed to the mechanical service braking device. In the case of failure the complete cylinder is to be replaced.

Combined brake cylinder

Figure 15

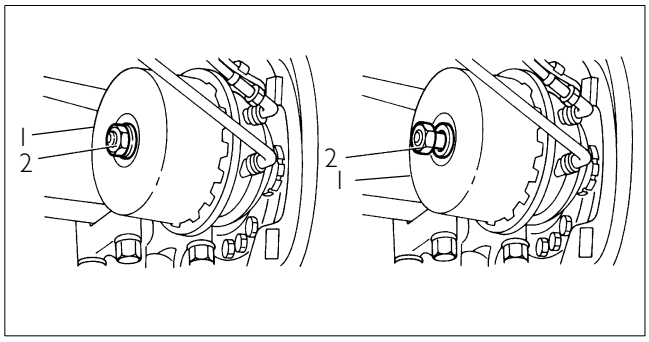


36744

This unit features two parts: one with diaphragm for service braking and one with spring for the parking and emergency braking in the case of failure in the brake system.

Combined cylinder emergency relief device

Figure 16

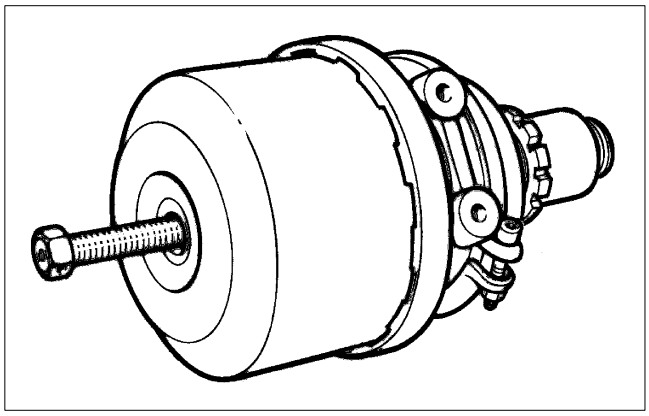


36745

If it is not possible to pneumatically feed the spring section of the combined cylinder (1) it is possible to manually relase the braking to permit towing. To release the brake loosen the screw (2) to the end of its stroke.

Repair operations

Figure 17



36476

Before removing the combined cylinder from the vehicle manually release the braking of the combined cylinder as described above.

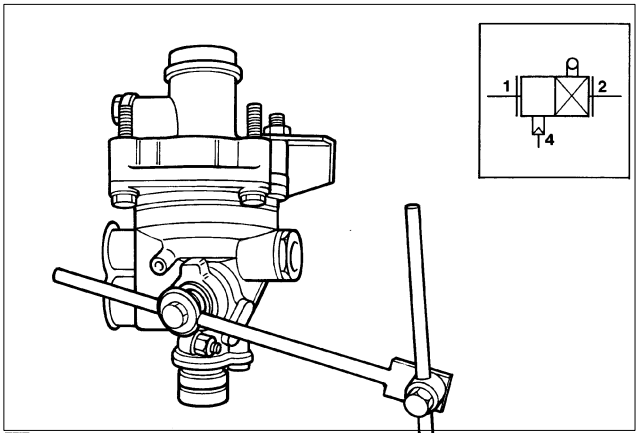
It is recommended, before removal, to carefully clean mud or other impurities from external parts as these could damage the cylinder if they were to infiltrate into it.
Overhaul the unit paying attention to the force produced by the internal spring.

Diagnostic

PROBLEM	POSSIBLE CAUSE	REMEDY
Air escapes from the exhaust or from the check ring.	Perforated or broken diaphragm	Replace the diaphragm
	Diaphragm lip broken	
	Check ring fastening screws have become loose	Tighten the screws
Air escapes from the diaphragm section feed	Spring section components are strained	Overhaul the unit and replace worn components

Braking control

Figure 18



The component automatically regulates the pressure sent by the duplex distributor to the brake cylinders according to the cargo on the rear axle

Diagnostic

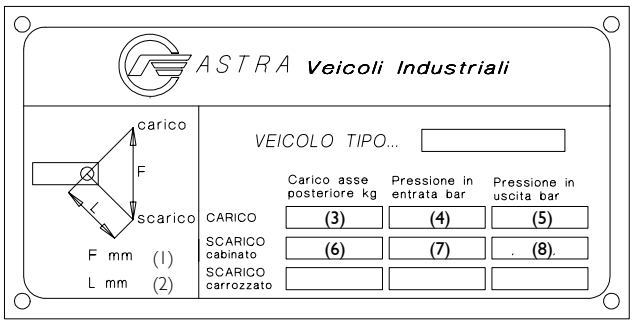
FAULT	POSSIBLE CAUSE	REMEDY
Air leak from outlet during braking	Control piston seals worn	Overhaul the unit and replace worn parts
	Outlet valve or seats defective	Overhaul the unit and replace worn parts
Air leak from connections	Tightening torques not as prescribed	Tighten connections to specified torque

Adjusting the load sensing valve on the vehicle

For braking control adjustment, all the braking components must be in perfect working order. In case of modifications on the suspensions for special outfitting, a new plate is necessary with the values suitably corrected.

To avoid wheel pulling or locking when braking, the device must be checked and if necessary adjusted at regular intervals. This is done by checking that the pressure values are those indicated on the plate applied in the cab.

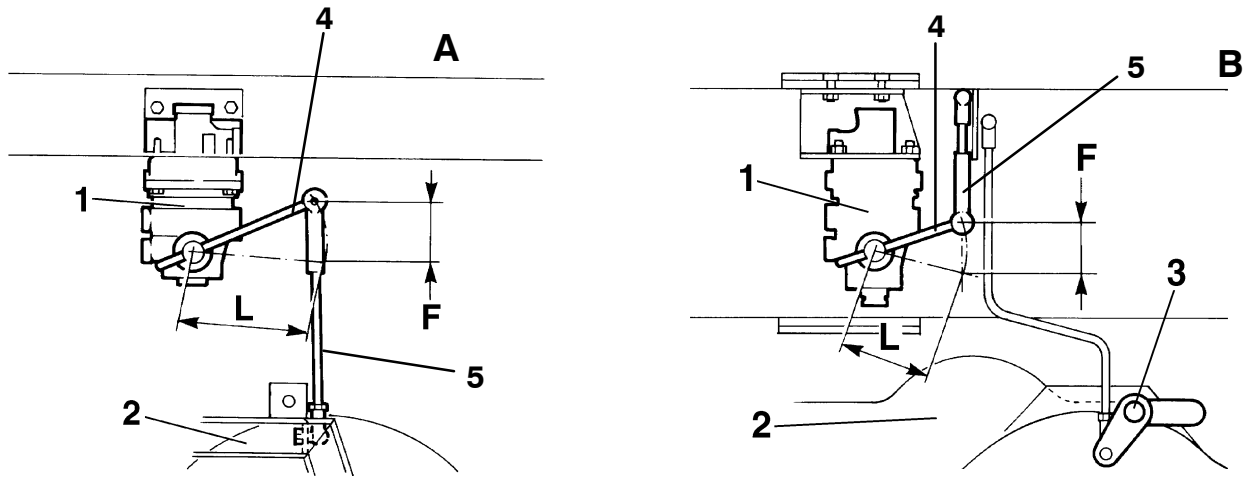
Figure 19



See the table below for numerical values.

Vehicle	Rear leaf spring	Position 1	Position 2	Position 3	Position 4	Position 5	Position 6	Position 7	Position 8
4 x 2	–	75	150	13000	7,6 ± 0,2	7,6 ± 0,2	3300	7,3 ± 0,2	5,2 ± 0,2
4 x 2T	–	67	120	12000	7,6 ± 0,2	7,6 ± 0,2	2500	7,6 ± 0,2	5,2 ± 0,2
4 x 4	–	67	130	13000	7,6 ± 0,2	7,6 ± 0,2	–	7,3 ± 0,2	3,7 ± 0,2
6 x 4	8 LEAVES	55	110	26000	7,6 ± 0,3	7,3 ± 0,3	6550	7,6 ± 0,3	2,2 ± 0,3
6 x 4	9 LEAVES	50	115	26000	7,6 ± 0,3	7,3 ± 0,3	6550	7,6 ± 0,3	2,2 ± 0,3
6 x 4T	8 LEAVES	60	95	26000	7,6 ± 0,2	7,6 ± 0,2	4695	7,6 ± 0,2	2,2 ± 0,2
6 x 4T	9 LEAVES	55	85	26000	7,6 ± 0,2	7,6 ± 0,2	4695	7,6 ± 0,2	2,2 ± 0,2
6 x 6	8 LEAVES	55	110	26000	7,6 ± 0,3	7,3 ± 0,3	6700	7,6 ± 0,3	2,2 ± 0,3
6 x 6	9 or 10 LEAVES	50	115	26000	7,6 ± 0,3	7,3 ± 0,3	6340	7,6 ± 0,3	2,2 ± 0,3
6 x 6T (66.38T 66.42T)	8 LEAVES	60	95	26000	7,3 ± 0,2	7,3 ± 0,2	4905	7,3 ± 0,2	2,2 ± 0,2
6 x 6T (66.38T 66.42T)	9 or 10 LEAVES	55	85	26000	7,3 ± 0,2	7,3 ± 0,2	4905	7,3 ± 0,2	2,2 ± 0,2
6 x 6T (66.45T 66.52T)	8 LEAVES	60	95	26000	7,6 ± 0,2	7,6 ± 0,2	4905	7,6 ± 0,2	2,2 ± 0,2
6 x 6T (66.45T 66.52T)	9 LEAVES	55	85	26000	7,6 ± 0,2	7,6 ± 0,2	4905	7,6 ± 0,2	2,2 ± 0,2
8 x 4	8 LEAVES	55	100	26000	7,6 ± 0,2	7,3 ± 0,2	6100	7,6 ± 0,2	2,2 ± 0,2
8 x 4	9 LEAVES	50	90	26000	7,6 ± 0,2	7,3 ± 0,2	6100	7,6 ± 0,2	2,2 ± 0,2
8 x 6	8 LEAVES	65	100	26000	7,6 ± 0,3	7,3 ± 0,3	6100	7,6 ± 0,3	2,2 ± 0,3
8 x 6	9 LEAVES	51	90	26000	7,6 ± 0,3	7,3 ± 0,3	6100	7,6 ± 0,3	2,2 ± 0,3

Figure 20



1. Braking control – 2. Rear lens – 3. Tandem axle connecting rod – 4. Lever – 5. Control rod – A. 2-axle vehicles – B. 3-axle and 4-axle vehicles

To adjust the braking control proceed as follows:

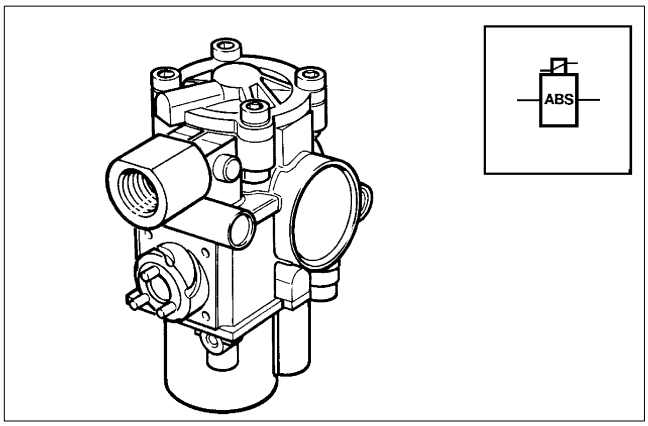
- ❑ Check that the length (L) of the lever (4) matches the value indicated on the plate. If it does not, replace it;
- ❑ connect a gauge before the braking control;
- ❑ connect a gauge after the braking control;
- ❑ connect a gauge to the front brake cylinders pressure socket;
- ❑ fill the tanks to the pressure that triggers the regulator;
- ❑ progressively press the brake pedal until the specified pressure is obtained at the braking control inlet;
- ❑ find the outlet pressure from the braking control and compare it with the value on the plate;
- ❑ modify, if necessary, the regulation by adjusting the length of the control rod (5);
- ❑ check that the incoming pressure to the front axle matches the values on the plate, otherwise check the efficiency of the Duplex distributor;

Never modify the rod adjustment when the circuit is under pressure.
Make the check with a progressive increase in pressure.

- ❑ to have an accurate adjustment it is opportune to artificially create the various intermediate load conditions and find the values;
- ❑ remove the control rods from the axle braking control, lift it for its entire stroke and simulate full load conditions
- ❑ under these conditions find the outlet pressure that is to match the value on the plate, otherwise overhaul the braking control.

Brake anti-lock distributor

Figure 21

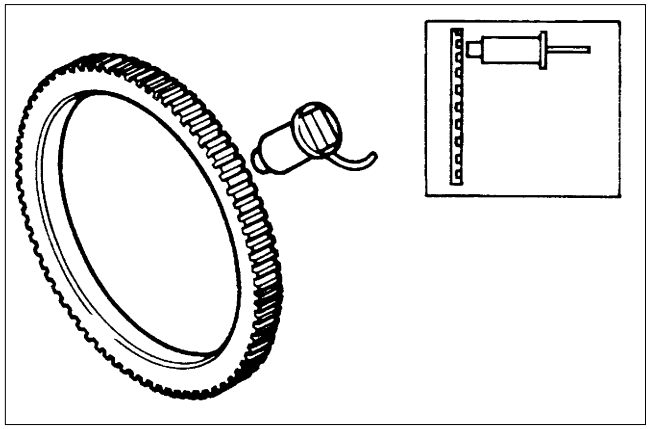


35805

This component modulates the air pressure in the brake circuit. When the electronic control unit detects a wheel with a tendency to lock, the valve intercepts the brake cylinder feed, thus preventing the wheel locking.

Rpm sensors
Phonic wheels

Figure 22



35385

The revolutions sensors and phonic wheels find the revolutions of the respective wheels.
The phonic wheel is housed on the wheel hub and turns at the same speed as the wheel. It generates in the sensors, by induction, alternate voltages having a frequency that is proportional to the rotation speed of the wheel.
These voltage signals are transmitted to the electronic control unit for processing. Each wheel has a sensor and a phonic wheel installed. This enables individual adjustment of the braking pressure for each wheel, thus perfecting the driving stability and braking space.

PIPES AND COUPLINGS

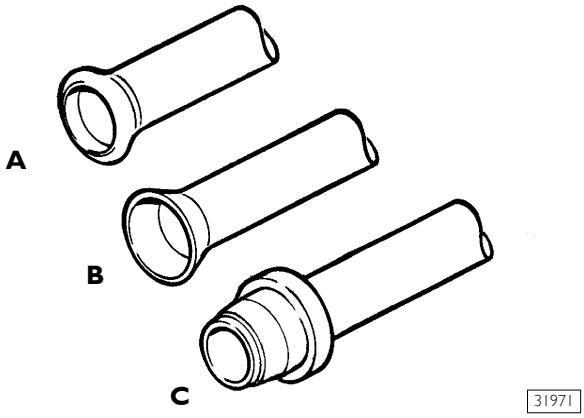
General

The pipes in the braking systems of commercial vehicles are currently of two types :

- ❑ Flexible nylon hose with single or two-ply structure and in the following diameters (Ø 6, 8, 10, 12, 16 mm) supplied as spares by the metre.
- ❑ Rigid metal pipe of the following diameters (Ø 4.75, 6.35, 8, 10, 12 mm). Piping from Ø 4.75 to Ø 10 mm is supplied as spares in straight lengths of 4, 5, 6 m, while those which are over 10 mm diam are supplied as spares ready cut, bent and flared.

End forming on rigid pipes

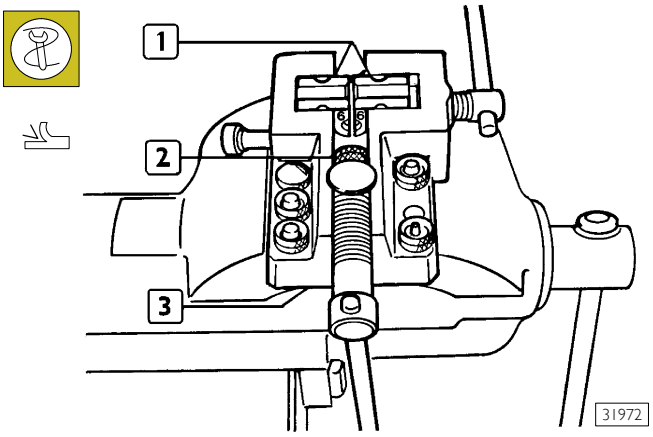
Figure 23



TYPES OF END FORMING ON RIGID PIPES

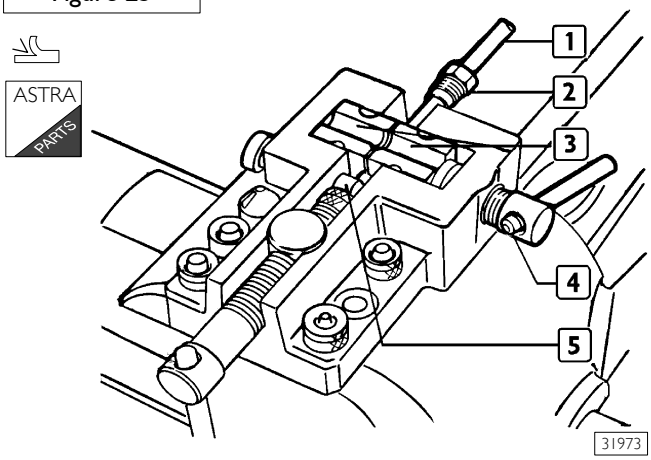
A Type end forming

Figure 24



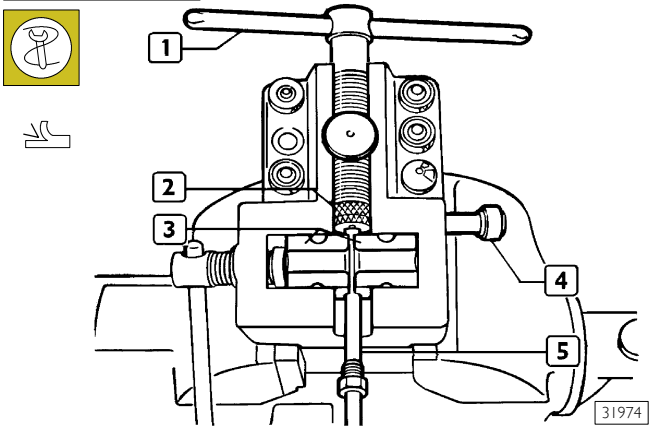
Position on press 99386523 (3) the blocks (1) so that the stamped numbers indicating the diameter of the piping to be worked are facing towards the die (2). The choice of die depends on the diameter of the pipe to be worked. And the diameter for which it may be used is stamped on every die (2).

Figure 25



Deburr pipe (1), insert union fitting (2) onto it and position it between blocks (3) bearing against pin (5). Lock pipe (1) with screw (4).

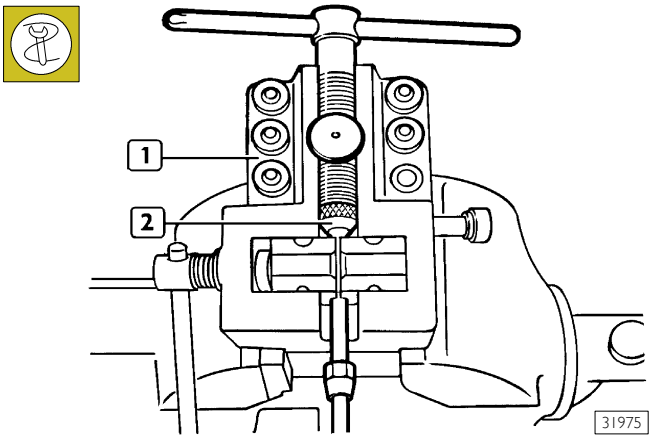
Figure 26



Move pin (4) to neutral position. Screw up screw (1) until die (2) comes up against blocks (3), thus forming the end of pipe (5).

B Type end forming

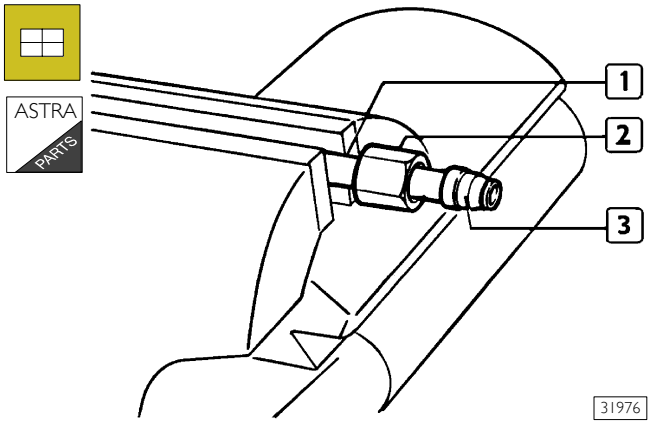
Figure 27



Fit die (2) to press 99386523 (1). For end forming process, follow the directions given above for A type end forming.

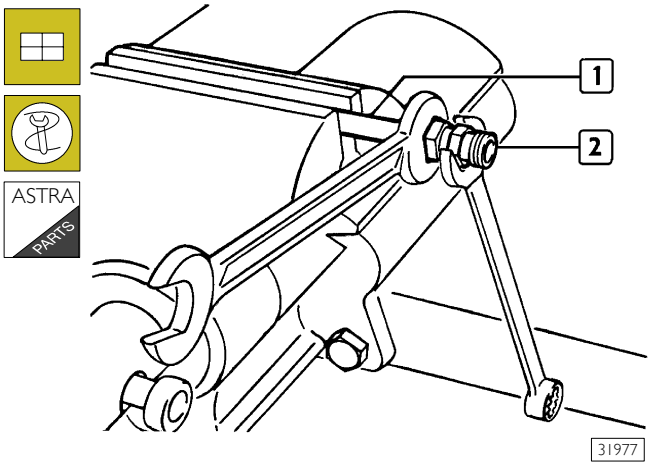
C Type end forming

Figure 28



Install nut (2) and ring (3) onto piping (1).

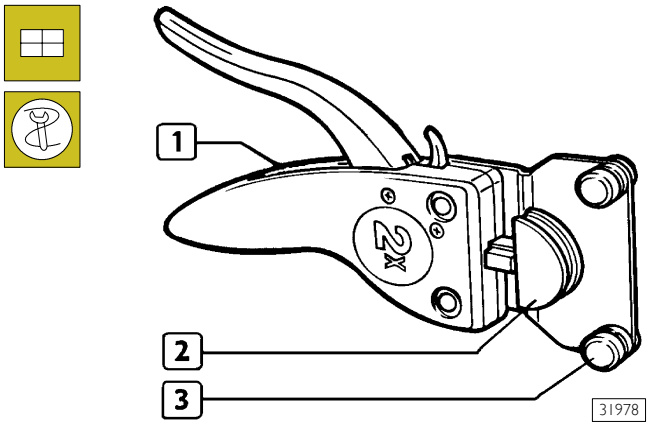
Figure 29



Fit union (2) and tighten so that the olive (3, fig. 6) is locked onto the pipe (1).

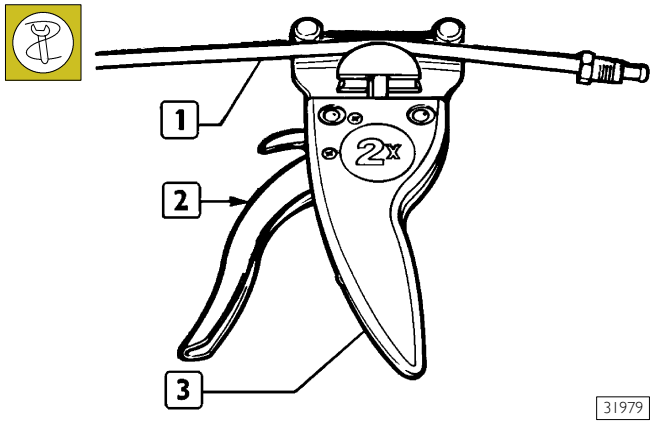
Bending rigid pipes

Figure 30



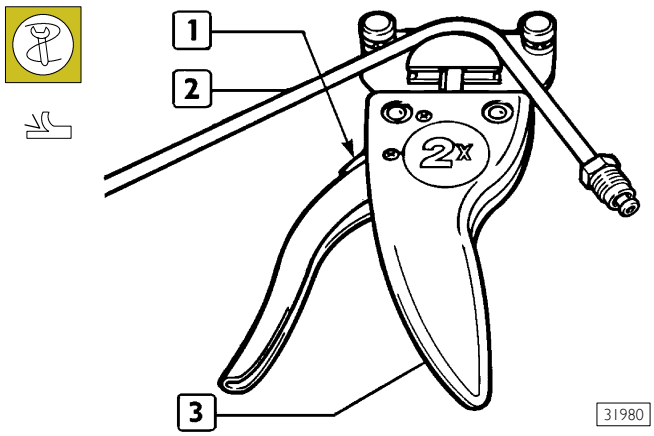
Assemble tool (1) 99386523, choosing parts (2) and (3) according to the diameter of the pipe to be bent.

Figure 31



Position pipe (1) in tool (3) and bend pipe by pressing lever (2).

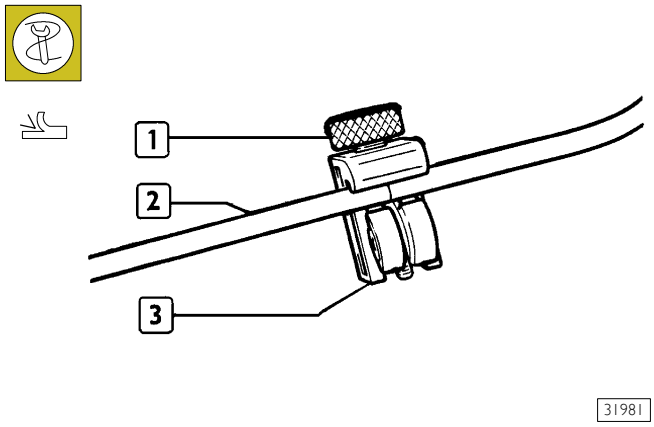
Figure 32



To release pipe (2) from tool (3), press catch (1).

Cutting rigid pipes

Figure 33



Position pipe (2) in tool (3) 99386523 and tighten screw (1). Holding pipe (2) stationary, rotate tool (3) until pipe is completely cut.

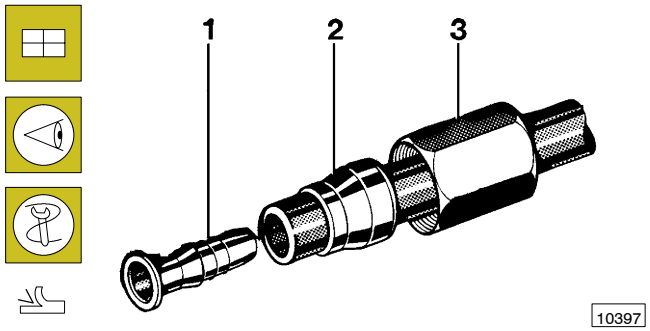
After cutting the pipe, deburr and proceed to form the end as described previously.

When tool (3) is rotated around pipe (2), screw (1) loosens. To cut the pipe completely, it is therefore necessary to tighten the screw (1) as and when it becomes loose.

Replacing flexible hoses with threaded couplings

Carefully follow the instructions below:

Figure 34

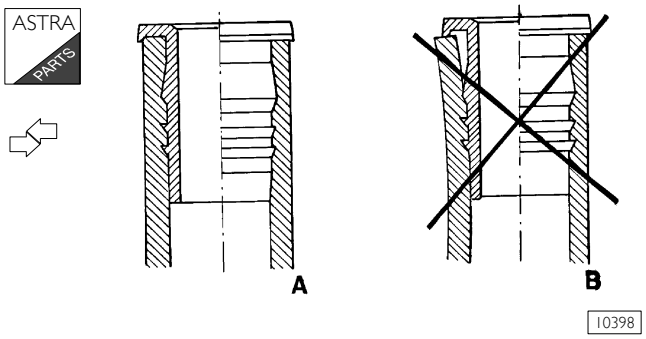


- ❑ Use only approved hose
- ❑ Check the condition of the replacement hose; there must be no cracks, cuts or incisions on it.
- ❑ Cut the pipe to the required length, cutting at 90° to the centreline using appropriate pipe cutting pliers 99387050.

Thread onto the pipe, in the order given:

- ❑ nut (3), compression ring (2) (larger thickness towards the nut (3)) and reinforcing bush (1);
- ❑ bush must be in perfect condition (it must not show any distortion or signs of hammering).

Figure 35



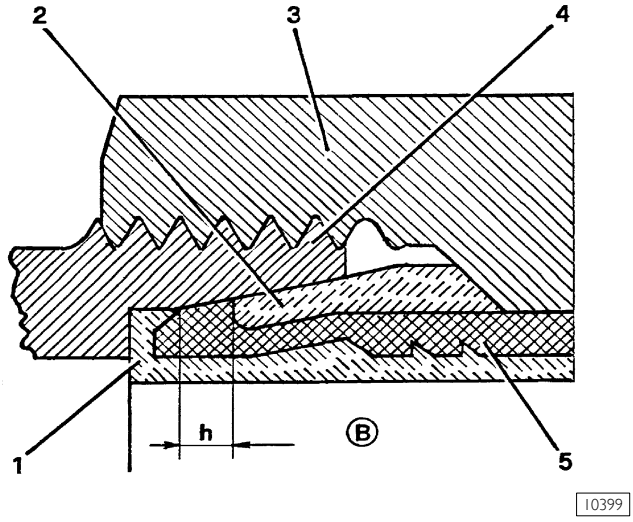
FITTING REINFORCING BUSH
A = CORRECT METHOD OF FITTING
B = INCORRECT METHOD OF FITTING

- ❑ Install reinforcing bush using tool 99372219, ensuring that there is contact between its flange and the end of the hose;
- ❑ make sure that the end of the hose fits into the raked groove in the flange.
- ❑ End-form the seating bush, on fitting to the vehicle or on the work bench, to a union.
- ❑ The pressure exerted and the final distance of the front edge of the compression ring from that of the reinforcing bush must be the value listed in the schedule as given in the table.

If the fittings are badly assembled, do not re-use the hose after extracting the bush and seating ring.

	Pipe mm	Distance "h" between edge of bush and ring mm	Assembly pressure N/mm²
Single layer	6 x 1	from 1 to 1,5	0,040
	8 x 1	from 2 to 2,5	0,050
Double layer	10 x 1,5	from 2 to 2,5	0,050
	12 x 1,6	from 2 to 2,5	0,060
	16 x 2,34	from 3 to 3,5	0,060

Figure 36



1. Reinforcing bush - 2. Compression ring - 3. Nut - 4. Union
5. Hose - h. Distance between edge of bush and edge of ring (see table).

Insert the end of the hose prepared in this way into the union body until reinforcing bush flange bears against seating;

- ❑ To tighten nut onto union, first of all screw in by hand and then complete tightening using a polygon wrench fitted on the torque wrench, to be set according to the specified tightening torque.

When fitting the hose to the vehicle, some important points requiring care should be borne in mind :

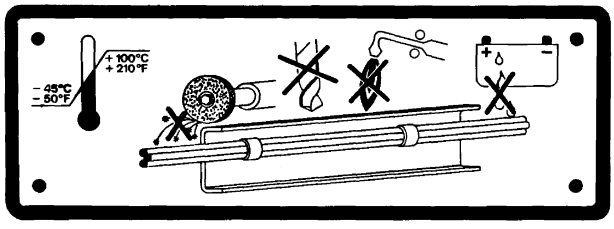
- ❑ Bends must comply with minimum radii, so as to avoid constrictions:

Diameter of pipe mm	Minimum radius of curvature mm
6 x 1	≈ 40
8 x 1	≈ 50
10 x 1,5	≈ 60
12 x 1,6	≈ 75
16 x 2,34	≈ 100

Make sure that the hoses are not in contact with sharp edges or with sharp metal parts or sources of heat, but are at a minimum safety distance of 15 mm from these.

- ❑ When hoses run through chassis members or metal parts, make sure that the holes through which they pass are fitted with rubber grommets and that these are in good condition.
- ❑ Avoid sliding the hose along sharp edges which might cause cuts.
- ❑ Where the hose has to be attached to existing pipework, take account of the additional heat to which it may be subjected (power steering pipework); in this case, the hose must be protected with shields.
- ❑ When the hose has been connected, check that it is not under tension between the attachment points, instead leaving it slightly slack to take up the more substantial variations in temperature, especially for short lengths.
- ❑ Before fitting, thoroughly clean the hoses by blowing compressed air through them to safeguard operation of the system.

Figure 37



13132

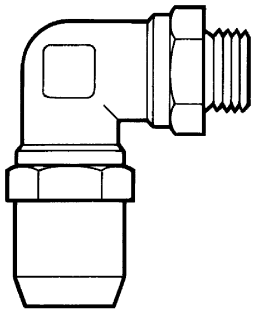
- ❑ Protect the hoses if grinding or welding operations are carried out on the vehicle; a notice is fitted in the cabin indicating the precautions to be observed carefully to avoid damage.

For greater safety and convenience in working, it is advisable to remove the hoses during these operations.

When fitting is finished, check that all seals (unions, couplings etc.) are completely free from leaks.

Replacing flexible hoses with quick-connection couplings

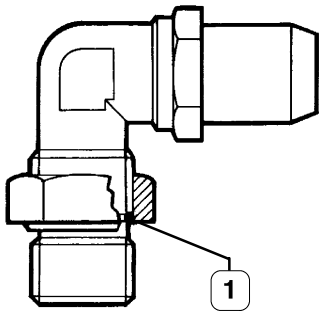
Figure 38



39306

Screw the coupling into the threaded seating provided on the air valve and tighten it to the tightening torque indicated in the table.

Figure 39

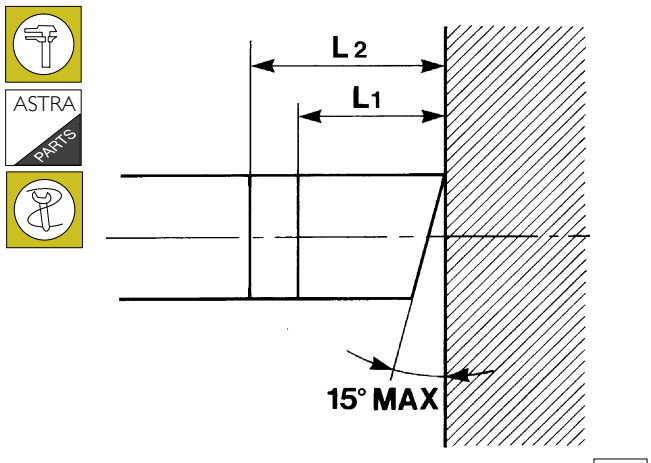


39307

- ❑ Use approved hose only.
- ❑ Check condition of replacement hose; there must be no cracks, cuts or incisions on it.
- ❑ Cut hose to required length, cutting at 90° with a max error of 15° with respect to the centreline using appropriate pipe cutting pliers 99387050.

THREADING	TIGHTENIG TORQUE (Nm ± 10%)
M 10 x 1,0 mm	22
M 12 x 1,5 mm	24
M 14 x 1,5 mm	28
M 16 x 1,5 mm	35
M 22 x 1,5 mm	40

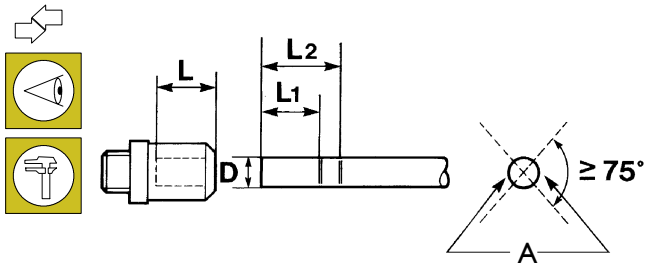
Figure 40



33977

- ❑ Only use approved type-tested hoses;
- ❑ Check the condition of the new hose to ensure it has no cracks, cuts or scores;
- ❑ Cut the hose at 90°, maximum error 15°, with reference to the axis. Use pipe-cutter pliers 99387050 to cut to the required length;

Figure 41



33976

A = Mark to identify end of tube travel

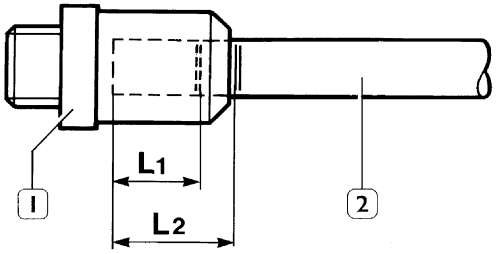
- ❑ Use indelible ink to mark clearly two reference marks on both diametrically opposite faces of the pipe at an angle of ≥ 75°, set at distances L_1 and L_2, to ensure correct fitting in place.

L_1 and L_2 vary according to the diameter of the hose and are to be measured at the longer part of the hose.

D (mm)	$L\ ^{0}_{+0,5}$ (mm)	$L_1\ ^{-0,5}_{+1}$ (mm)	$L_2\ ^{-0,5}_{+1}$ (mm)
6	19,8	17	22
8	20,5	18	23
12	25	22	28
16	27,1	24	30

Rpm sensor phonic wheel

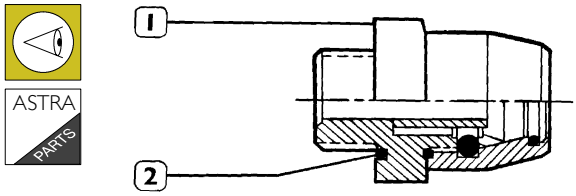
Figure 42



39308

- ❑ Insert the hose (2) by hand into the coupling (1), with a force between 30 and 120 N according to the hose diameter, so that reference mark L_1 is inside the hose whereas L_2 remains visible.

Figure 43



33978

- ❑ When removing couplings (1) from pneumatic components, check the condition of the seal ring (2) and if necessary replace it.

COUPLING THREAD	SEAL DIMENSIONS
M 10 x 1,0	10,1 x 1,6
M 12 x 1,5	11,0 x 2,0
M 14 x 1,5	–
M 16 x 1,5	15,0 x 2,0
M 22 x 1,5	–

Whenever a hose is removed from a quick connection coupling, the coupling itself must be replaced. Spare quick connection couplings are supplied complete.

Quick release and threaded couplings are not interchangeable. This also applies to flexible hoses used with quick release couplings and flexible hoses used with threaded couplings.

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ELECTRICAL SYSTEM

SECTION 17

SECTION 17

Electrical system

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TECHNICAL DATA

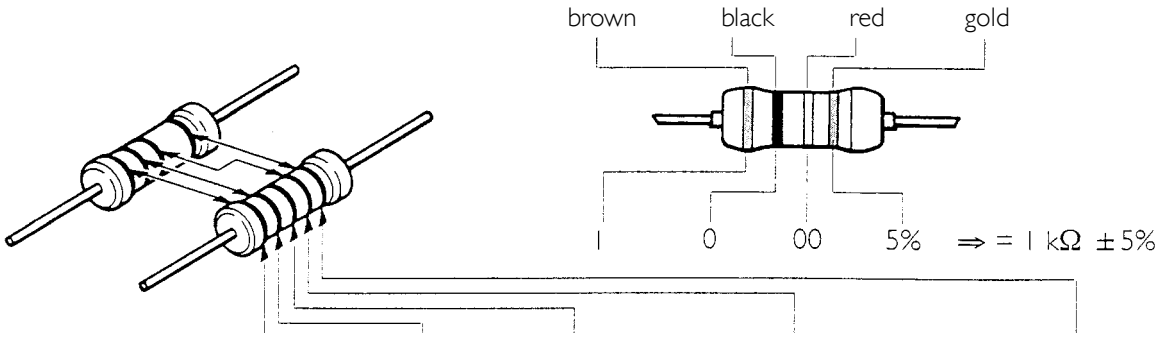
International System Units (S.I.)

Value	Symbol	Unit	Symbol
plane angle	α, β	radian	rad
solid angle	Ω	steradian	sr
LENGTH	L, l	meter	m
area, surface	S, s	square meter	m^2
volume	V	cubic meter	m^3
TIME	t	second	s
angular velocity	ω	radian per second	rad/s
frequency	f	hertz	Hz
spinning frequency	n	$(second)^{-1}$	s^{-1}
velocity	v	meter per second	m/s
acceleration	γ, g	squared meter per second	m/s^2
MASS	M, m	kilogram	kg
volume mass	ρ, μ	kilogram per cubic meter	kg/m^3
force	F	newton	N
moment of a force/torque	M, T	newton-meter	Nm
energy, work	W	joule	J
power	P	watt	W
pressure	p	pascal	Pa, N/m^2
TEMPERATURE (thermodynamic)	Θ, T	kelvin	K
Celsius temperature	θ, t	Celsius degree	°C
temperature range	$\Theta, \Delta\Theta$	kelvin	K
heat quantity	W	joule	J
mass heat capacity	c	joule per kilo per kelvin	J/kg · k
CURRENT INTENSITY	I	ampere	A
quantity of electricity	Q	coulomb	C
electric field	E	volt per meter	V/m
voltage, d.d.p., f.e.m.	U, E	volt	V
capacity	C	farad	F
current density	J	ampere per square meter	A/m^2
resistance	R	ohm	Ω
conductance	G	siemens	S, A/V
resistivity	ρ	ohm-meter	Wm
magnetic excitation	H	ampere per meter	A/m
magnetic field	B	tesla	T
magnetomotive force	F	ampere (turn)	A
magnetic moment	M	squared ampere per meter	Am^2
magnetic flux	Φ, φ	weber	Ωb
inductance	L, M	henry	H
LUMINOUS INTENSITY	I	candle	cd
luminous flux	E	lumen	lm
irradiance	F	lux	lux

Main elements - Resistivity and temperature coefficient

Substance	ρ ($\Omega \cdot m$)	α $(°C)^{-1}$
Conductors		
Aluminium	2.83×10^{-8}	0.0039
Copper	1.69×10^{-8}	0.00393
Gold	2.44×10^{-8}	0.0034
Iron (0 °C)	8.85×10^{-8}	0.0050
Nickel	7.24×10^{-8}	0.006
Silver (0 °C)	1.47×10^{-8}	0.0038
Mercury	95.8×10^{-8}	0.00089
Tungsten	5.51×10^{-8}	0.0045
Costantan (60% Cu, 40% Ni)	44.0×10^{-8}	0.0000
Nichrome	100.0×10^{-8}	0.0004
Semiconductors		
Germanium (pure)	0.450	-0.048
Germanium (5 ppm As)	0.011	
Silicon (pure)	640.0	-0.075
Silicon (100 ppm As)	0.003	
NaCl (saturated solution)	0.044	-0.005
Insulators		
Amber	5.0×10^{14}	
Glass	$10^{10} \div 10^{14}$	
Mica	$10^{11} \div 10^{15}$	
Quartz	7.5×10^{17}	
Wood	$10^{8} \div 10^{11}$	

Resistor colour codes



Colour code	1° ring	2° ring	3° ring	Multiplier	Tolerance
Silver					± 10%
Gold					± 5%
Black		0	0	1	± 20%
Brown	1	1	1	10	± 1%
Red	2	2	2	10^2	± 2%
Orange	3	3	3	10^3	
Yellow	4	4	4	10^4	
Green	5	5	5	10^5	
Blue	6	6	6		
Violet	7	7	7		
Grey	8	8			
White	9	9			

Wires - Composition and characteristics

CU 0.5

CU 1

CU 2.5

CU 4

CU6

Composition and characteristics of low tension copper wires on vehicle electrical system (CUNA standards)														
Section(mm^2)	0.5	1	1.5	2.5	4	6	10	16	25	35	50	70	95	120
Max continuous current (A)	6	11	14	20	28	37	53	75	100	125	160	200	240	280
No. of strands x No. of wires	1x16	1x14	1x21	1x35	1x56	1x84	1x19	1x19	19x14	19x14	19x21	19x30	37x19	37x27
Wire diameter	0.20	0.30	0.30	0.30	0.30	0.30	0.83	1.04	0.35	0.40	0.40	0.40	0.40	0.40
d	0.90	1.30	1.60	2	2.60	3.20	4.80	5	7.30	9.20	10.6	12.6	14.8	16.5
Nominal thickness	0.70	0.70	0.80	0.85	0.95	0.95	1.05	1.85	1.40	1.40	1.60	1.80	2	2
Max diameter	2.40	2.80	3.35	3.80	4.60	5.20	7.10	9.00	10.3	12.2	14.0	16.4	19.0	20.7
Min diameter	2.20	2.60	3.15	3.60	4.40	5.00	6.70	8.60	9.90	11.8	13.6	16.0	18.6	20.3
Theoretical resistance at 20 °C Ω/km	37.5	18.3	12.4	7.53	4.68	3.15	1.76	1.11	0.75	0.53	0.37	0.26	0.19	0.15

GENERAL INSTRUCTIONS
General precautions

NEVER DISCONNECT THE BATTERIES OR OPEN THE KNIFE SWITCH WITH THE EXTERNAL-COMBUSTION ENGINE STARTED.

NEVER START UP THE ENGINE WITHOUT HAVING CONNECTED THE BATTERIES PERMANENTLY.

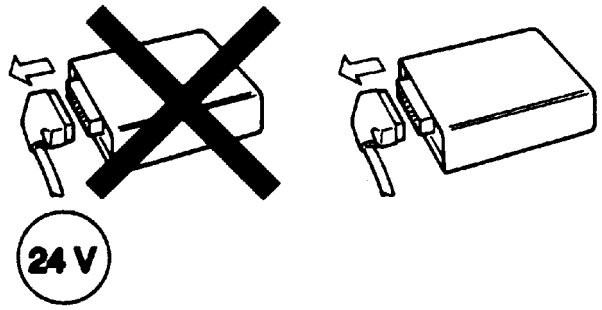
- ❑ Before carrying out any servicing operation on the vehicle, chock the wheels securely to prevent the truck from moving on its own.
- ❑ Starting from the engine compartment should only be performed with the cab securely fixed in its maximum opening position, parking brake on, transmission in neutral, wheels properly chocked.
- ❑ Avoid aiming water/other fluid jets at the rear bulkhead junction block.
- ❑ Do not use quick charging devices to start the engine. Engine starting should be performed only by means of separate batteries or a suitable trolley.
- ❑ While performing electrical welding on the chassis, disconnect connectors from electronic control modules and disconnect the terminals from the battery.
- ❑ In case of fuse change, in order to avoid damages to electric plant of the vehicle, use fuses only of the same power as indicated by the producer.
- ❑ Check for exact battery terminal polarity during start up from auxiliary truck.
- ❑ When disconnecting the batteries from the system, always disconnect first the chassis ground cable of the negative battery terminal.
- ❑ Check system perfect insulation before disconnecting the batteries.
- ❑ Incorrect supply voltage polarisation of the electronic control modules (e.g. incorrect battery polarisation) can cause module breakage.
- ❑ Add a fly-fuse between the negative battery terminal and the chassis ground cable during troubleshooting of a circuit fault (main current switch connected).
- ❑ Disconnect the ground cable from the negative battery terminal before removing electronic components.
- ❑ Electrical measurements on electronic components must be performed using suitable instruments only.
- ❑ Do not power electronic control unit components with vehicle voltage rating.
- ❑ Ensure that electronic device wirings (length, type of wire, location, shielding continuity, if required, grounding, etc.) comply with the ASTRA system and that wirings are suitably reset after overhauling or repair operations.
- ❑ Disconnect the batteries from the system during recharging with external equipment.
- ❑ Disconnect the external battery charger from the civil network before removing its plug-in contacts from the battery terminals.
- ❑ Never connect or disconnect cable connector from electronic control modules with powered supply.
- ❑ Remove the electronic control modules when operations involve temperatures exceeding 80°C (drying oven).
- ❑ During the connection stage, screw connector flap nuts (temperature and pressure sensors, etc.) to the prescribed torque only.
- ❑ Measurements on electronic modules controlling plugs, plug connections and electrical component connections can be only performed on suitable test lines with proper plugs and bushes.
  Never use improper tools such as metallic wires, screwdrivers, clips and equivalent.
  Short circuits can occur and plug connections could be damaged causing successive contact troubles.

ALWAYS DISCONNECT THE BATTERIES AND CONNECTORS FROM ELECTRONIC CONTROL MODULES WHEN PERFORMING ELECTRIC WELDING OPERATIONS ON THE VEHICLE.

Before replacing a fuse, check always the cause of its blowout. Circuit operation can be reset only after having removed the fault.

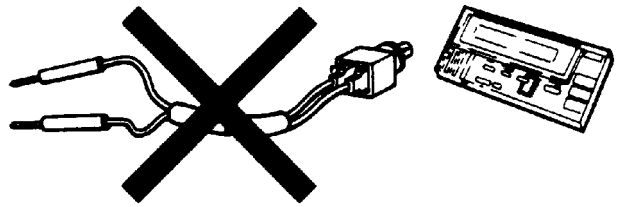
General precautions for electronic components

Figure 1



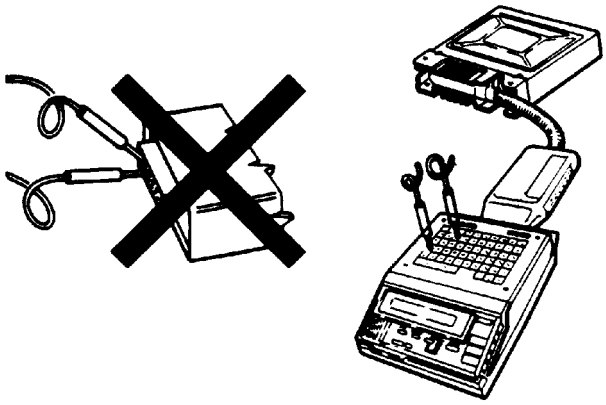
- ❑ Insulate the system before disconnecting the connector from an electronic module.
- ❑ Never cause sparks to check if the circuit is powered.
- ❑ Do not touch connector plugs of electronic modules with your hands.

Figure 2



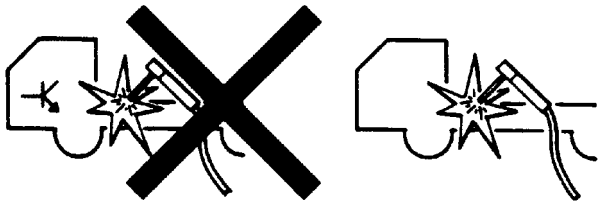
- ❑ Never use a test lamp to check circuit continuity, use suitable testers only.
- ❑ Do not power electronic control unit components with vehicle voltage rating.
- ❑ Ensure that electronic device wirings (length, type of wire, location, shielding continuity, if required, grounding, etc.) comply with the ASTRA system and that wirings are suitably reset after overhauling or repair operations.
- ❑ To avoid damage to electronics on board the vehicle, ensure the wiring pertaining to additional equipment follows a different route.
- ❑ Use ASTRA original spare parts only,

Figure 3



- ❑ Do not fit tester prods into electronic module connector plugs.
- ❑ Measurements shall be performed with multimeter.
- ❑ Do not install additional electric and/or electronic equipment not provided by ASTRA or by the local laws.
- ❑ Do not connect negative components of additional equipment to negative components of electronic modules.

Figure 4



- ❑ When performing electric welding on the vehicle, disconnect electronic modules and/or disconnect the power cable from positive battery terminal and connect it to chassis ground.
- ❑ Remove electronic components and modules for painting baking.

THE CONCEPT OF EARTH AND ELECTROMAGNETIC COMPATIBILITY

The standard system is traditionally a single-pole system. The body, chassis, metal container of eledromechanical components act as equipotential return condudor to the generator, since any point of the metal structure or any unisolated negative terminai is at the same potential or EARTH. This is why the earth has been chosen as the reference for the entire system, conventionally giving it a rating of 0.

For obvious constructive reasons, different earth points scattered over the vehicle according to the location of the components, influence the system in the negative network.

Ideally, all the equipment should be connected to only **one** earth point to warrant a clearly defined earth reference, especially for the electronic devices.

Due to the above-mentioned reasons, the **supply earth** or system earth characterised by strong direct current intensity (> I A for electromechanical components) must be distinguished from the **analogue earth** characterised by wave shapes at determinate frequencies and with very small current intensities (mA, μA) of the electronic/numerical systems.

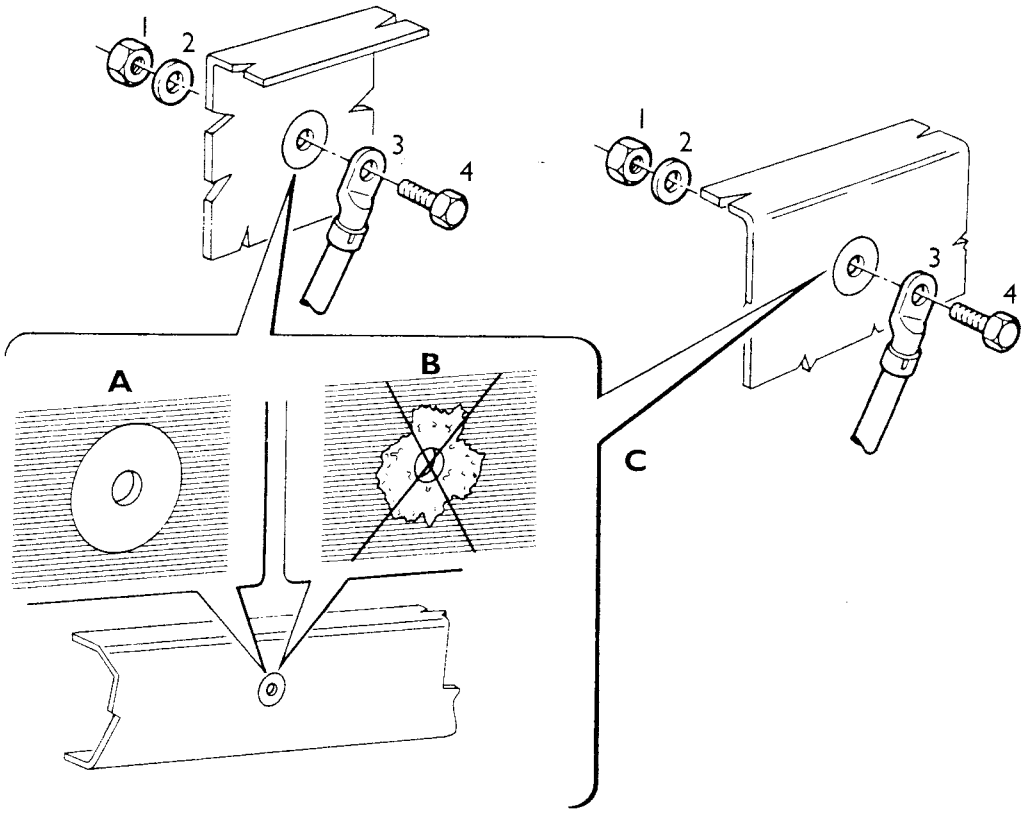
The definition of signal earth or analogue earth depends on the sensitivity of the electronic systems to EMC (electromagnetic compatibility) since parasite signals induce malfunctioning and/or deterioration of the actual systems (as they are emitted by systems on board and/or outside the vehicle).

In order to minimise continuous or transient disturbances or interferences caused by parasite radiations, it is of the **utmost importance** to follow the warnings given on next page, always bearing in mind that the soundness of the reference plan or system earth depends on the excellent conduction features (contact resistance tending to zero) in each of its connecting points.

To sum up we can say that earth intended as equipotential electric conductor, i.e. as potential reference of all the electric/electronic components on board, is subdivided into system earth and analogue earth.

The earth points in this system are estabiished by the manufacturer. They must obviously be free from paint, oxidation, traces of grease or dust etc. Particular attention should be paid to the efficiency of battery and starter motor earth points.

Figure 5



EARTH POINTS AND CONTACT EFFICIENCY

A. Efficient earth point - B. Inefficient earth point - C. Fastening sequence
1. Nut - 2. Washer - 3. Wire terminal - 4. Screw

Practical hints

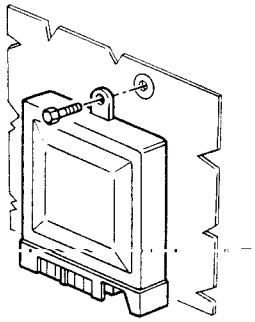
Connection between a component and an earthing point must be as short as possible. Conductors converging in an earthing point (cab and/or chassis) must be star-connected between themselves accurately avoiding overlappings in order to minimise contact resistance (Fig. 6, ref. B).

As regards eledronic components, the following instructions must be strictly observed.

- ❑ The electronic control modules/units fitted with a metal casing are to be connected to the system earth by means of a screw or bolt (Fig. 6, ref. A).
- ❑ Conductors related to analogue earth must have optimum isolation characteristics both between themselves and as regards the system earth.
- ❑ Negative conductors isolated from control units must be connected to a system earth point (set be the manufacturer) and to the battery negative terminal. Avoid serial or chain connections (Fig. 6, ref. B).
- ❑ Each end of the braided wire must make electric contact with the system components. Only one of the braided wire ends is connected to the system earth. The unbraided section (Fig. 6, d dimension in ref. C) (cable connectors) must be as short as possible.
- ❑ Cable looms must be parallel to the reference plane, that is to say attached to the chassis/cab structure (Fig. 6, ref. D).
- ❑ Bodybuilders installing auxiliary systems must take great care when performing connections to the system earth. The new wires must not run alongside the wiring system already installed on the vehicle.

Figure 6

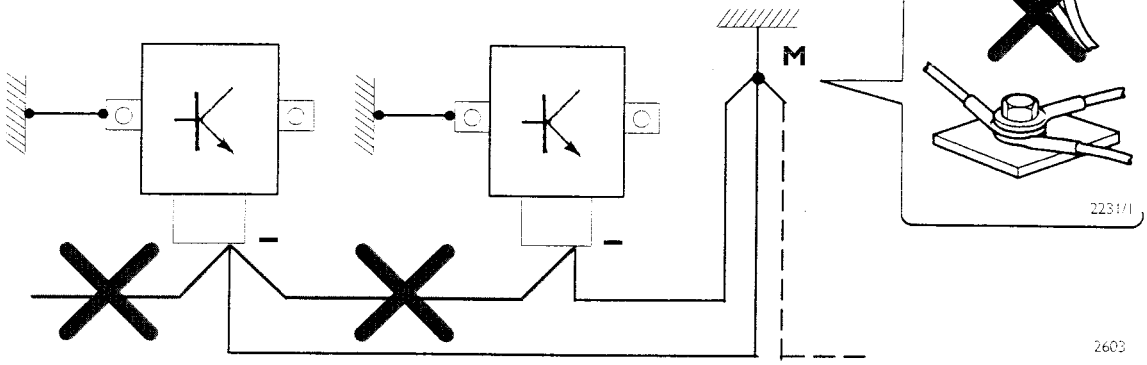
A



2602

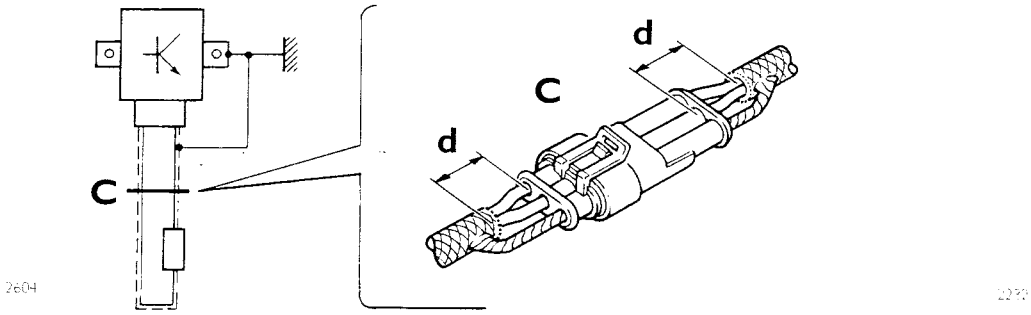
FASTENING CONTROL UNIT BY MEANS OF A SCREW

B



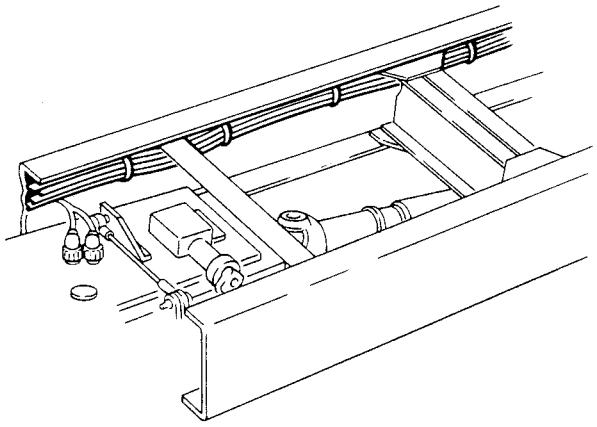
STAR CONNECTION OF NEGATIVE CABLES TO **M** SYSTEM EARTH

C



SHIELDING OF THE CABLE OF AN ELECTRONIC COMPONENT BY MEANS OF A BRAIDED WIRE - C. CONNECTOR - d. GAP → 0

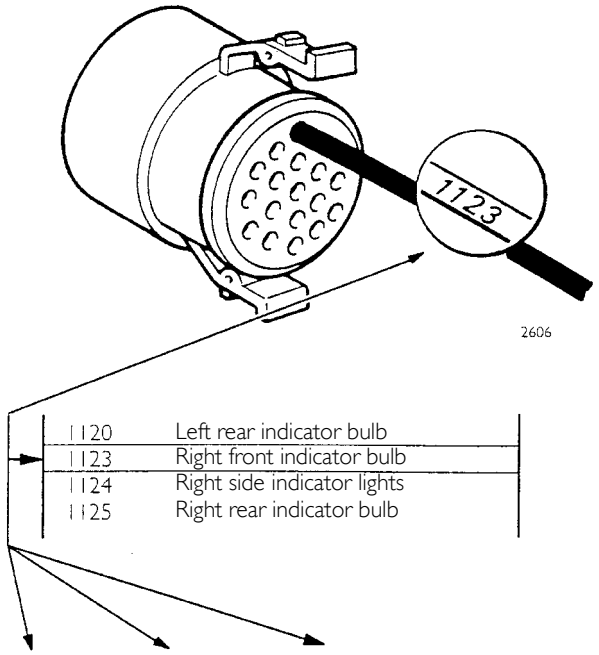
D



2605

CABLE LOOMS ASSEMBLED ALONG CHASSIS SIDE MEMBERS

CABLE COLOUR CODES



CODE	COLOUR	BASIC FUNCTION
1111	Light blue	Optical and audible signals
2222	White	Illumination by headlights
3333	Yellow	Parking lights/side marker lamps
4444	Grey	Internal lighting

To enable its practical application, the wiring system has been split into ten main funcions (associated with ten cable colours), each of them including more specific functions. Each function is identified by a four-figure code number.

Obviously, each function includes more specific sub-functions.

The first number indicates the basic function of the cable and identifies always the basic colour of the cable (the matching of number and colour is indicated in the table on the side).

The other numbers identify the specific function of the cable:

Summing up, we can say that:

- **a number consisting of four identical figures indicates a main function and a single-colour cable;**
- **a number consistin of four partially or totally different figures indicates a specific function.**

IDENTIFICATION OF THE ELECTRIC FUNCTION BY THE CABLE COLOUR CODE

No.	Code	Colour	Function
1	1111	Light blue	Optical and audible signals
2	2222	White	Illumination by headlights
3	3333	Yellow	Parking lights/side marker lights
4	4444	Grey	Internal lighting
5	5555	Orange	Optical signals, engine operation and measuring instruments
6	6666	Violet	Optical signals
7	7777	Red	Main supply and pertaining accessories not excluded by the ignition switch
8	8888	Green	Secondary supply and pertaining accessories not excluded by the ignition switch
9	9999	Pink	Electrically-operated mechanical components
10	0000	Brown	Earth

4 - DIGIT CABLE COLOUR CODES

0300 6-diode self-rectifying alternator
0000 General earth
0001 Radio set insulated earth
0002 Hazard lights earth
0003 Earth of ceiling lamp switch on device (door post switch)
0004 UNIC project: parking lights insulated earth (dangerous cargo vehicles)
0005 Earth of trailer brake/exhaust brake interlock relay
0006 Earth of rheostat connected optical indicators
0007 Earth of stop rerequest optical indicator switch off relay
0008 Earth of starter motor relay
0009 Earth of windshield wiper unit fixed stop
0010 Earth of ceiling lamp switch on device (switch/lamp)
0011 Earth of rear door open optical indicator
0012 Earth of main current relay
0013 Earth of exhaust brake enablement relay
0014 Earth of ventilation motors operation relay
0015 Earth of auxiliary heater water recirculating pump motor
0016 Earth of relay for windshield heater/defroster operation (water auxiliary heater)
0017 Earth of front door open optical indicator
0018 Hydraulic braking system signal
0019 Earth of MS6 control unit terminal 8
0020 Earth of heater mirror relay excitation device (relay control unit)
0021 Insulated earth of MS6 control unit terminal 25
0022 Auxiliary heater insulated earth
0023 Earth of flasher light optical indicators
0024 Earth of optical indicators connected to lamp test pushbutton
0025 Earth of emergency optical indicator (central safety unit)
0027 Terminal 85 of Retarder/ABS operation relay
0028 KICKDOWN signal
0030 Earth supply for engine rpm diagnosis sensor no. 1 (n=1/1) and engine rpm electronic sensor
0031 Earth supply for engine rpm diagnosis sensor no. 2 (n=1/1)
0032 Earth supply for engine rpm diagnosis sensor (n=1/2 injection pump)
0033 Hydraulic brake solenoid valve control
0034 Hydraulic brake reducing solenoid valve control
0035 Thermometric switch controlling relais for gas oil heating
0036 Earth of centre door open relay
0037 Earth of belt warning lamp excitation relay
0038 Earth of key rotation inhibiting solenoid valve
0040 Cross differential lock switch off control
0041 Cross differential lock switch on control
0043 Insulated earth on exhaust brake control circuit
0044 Earth of belt control warning lamp
0045 Insulated earth for exhaust brake "R2" resistor

0048 ASR cut off
0049 ABS cut off
0050 General earth, analogue signal
0051 ABS n° 1 control relay
0052 ABS n° 2 control relay
0055 Insulated earth of rear axle switch
0058 Insulated negative for electronic tachograph sender unit
0059 Speed limiter solenoid valve turn off signal (transmission in neutral)
0060 Earth cable after Z diode for dashboard warning lights dimmer (Military Vehicles)
0061 Earth cable for warning lamp supply (Military Vehicles) (warning lamp dimming via 7 diode)
0066 Earth of tachograph clock
0067 Earth of engine operation relay (automatic clutch)
0068 Earth of starting enablement relay from automatic clutch control unit
0069 Earth of reversing lights relay from automatic clutch control unit
0070 Earth of automatic clutch warning lamp supply relay
0071 Earth of automatic clutch control unit buzzer
0072 Earth of automatic clutch position sensor
0073 Earth of accelerator pedal sensor (automatic clutch)
0074 Earth of transmission lever position sensor (automatic clutch)
0076 Electrical battery disconnector relay self-excitation coil return
0078 Alternator D+ after power diode
0081 Negative to terminal 30 of exhaust brake control relay (service brake)
0082 Negative to terminal 30 of exhaust brake control relay (accelerator pedal)
0084 Automatic clutch actuator solenoid valve (earth)
0085 Earth of automatic clutch control unit from door pushbuttons
0090 Earth from sensor to "EGR " control unit
0092 Earth of starting safety unit (cab tilted up or engine compartment door open) (BUS)
0093 Earth of starting safety relay
0094 Earth of preheating operation enablement relay
0095 Earth of remote rev-up enablement relay (cab tilted)
0096 Earth of cab lock optical indicator after the diode
0097 Earth of electronic horn
0098 Automatic chassis lubrication system control after the pushbutton
0100 Earth of semiautomatic transmission display
0101 Earth of speed sensor (input) (semiautomatic transmission)
0102 Earth of speed sensor braided wire (input) (semiautomatic transmission)
0103 Earth of speed sensor braided wire (output) (semiautomatic transmission)
0104 Earth of speed sensor (output) (semiautomatic transmission)
0105 Earth of display braided wire (semiautomatic transmission)
0106 Earth of accelerator pedal position sensor (semiautomatic transmission)
0107 Earth of semiautomatic transmission diagnosis equipment
0110 Earth of transmission solenoid valve unit (semiautomatic transmission)
0111 Earth of splitter gears solenoid valve unit (semiautomatic transmission)
0112 Earth of transmission brake solenoid valve (semiautomatic transmission)

0114	Earth of solenoid valve for keeping clutch released (semiautomatic transmission)
0115	Earth of engaged gear speed unit sensor (semiautomatic transmission)
0116	Earth engaged gear sensor (semiautomatic transmission)
0119	Exhaust brake on signal to semiautomatic transmission gear selector
0121	Earth of injection pump actuator power increasing (semiautomatic transmission)
0131	Rear power take-off control signal (semiautomatic transmission)
0132	Side power take-off control signal (semiautomatic transmission)
0133	Brake pedal depressed signal to semiautomatic transmission gear selector
0135	Insulated earth for exhaust brake on warning lamp
0140	EDC needle lift sensor return
0143	Driver's door open signal to semiatomatic transmission gear selector
0150	EDC control unit component return connection
0151	Engine stop supply (EDC)
0155	Earth of EDC MS6 main relay
0156	Fault diagnosis request pushbutton (EDC)
0157	Earth from accelerator pedal to MS6 control unit
0159	Accelerator pedal idling switch (EDC)
0160	Signal from clutch switch (EDC)
0165	Earth of supercharging pressure sensor (EDC)
0170	Earth of valve gear cam rpm sensor (EDC)
0175	Earth of fuel temperature sensor (EDC)
0309	Hydraulic retarder temperature sensor earth signal
0310	Hydraulic retarder solenoid valve return signal
0315	Hydraulic retarder cutoff with ABS on
0350	Insulated earth from relay to Martin horn compressor (Fire-Fighting vehicles)
0351	Insulated earth from switch to urban/suburban centre electronic alarm signal (Fire Fighting vehicles)
0400	Earth of ECAS chassis level control sensors
0446	Enablement of hydraulic pump turn on relay with pressure below 30 bar during axle lower stage
0450	Supply from hydraulic pump thermal switch (axle raising)
0503	Thermal switch earth supply for cab interior temperature thermostat with water temperature over 50 °C (auxiliary heater)
0504	Fan relay earth control (1st speed) via adjustable thermal switch for cab interior temperature thermostat (auxiliary heater)
0550	Earth of potentiomenter and sensor servomotors (AGND) (air-conditioning system)
0555	Fan earth (air-conditioning system)
0562	Earth of floor area air delivery servomotor (-FOOT) (air-conditioning system)
0564	Earth of windshield defrosting air delivery servomotor (-DEF) (air-conditioning system)
0566	Earth of air intake/recirculation servomotor (-RYC) (air-conditioning system)
0568	Earth of air mixing servomotor (-MIX) (air-conditioning system)
0610	Earth (n° 1) of ceiling lamp operation from switch
0611	Earth (n° 2) of ceiling lamp operation from switch
1100	Connection between IVECO CONTROL control units (2nd/3rd level)
1101	Supply of semiautomatic transmission failure bell
1103	From turn signal switch to Rh control unit
1104	Supply of Hostess bell

1105 Supply of stop request
1109 From turn signal switch to Lh control unit
1110 Supply of flasher lights reversing switch
1111 Supply of turn signal flasher lights (common circuits)
1112 Optical indicator, tractor turn signal flasher lights
1113 Supply of hazard lights relay (terminal 30)
1114 Optical indicator, hazard flasher lights
1115 Supply of rotary beacon
1116 Horn supply
1117 Connection between cab control unit and stop signal switch
1118 Optical indicator, trailer turn signal flasher lights
1119 Supply of electrical/air horns
1120 Tail lh turn signal light
1123 Front rh turn signal light
1124 Rh turn signal side repeater - Not controlled
1125 Tail rh turn signal light
1126 Lh turn signal side repeater - Not controlled
1129 Front lh turn signal light
1133 Horn, road, electropneumatic: from switch to horn
1139 Supply of stop request/Hostess bell enablement switch
1144 Layshaft max rpm buzzer (ES)
1146 Excitation of hazard/turn signal lights switching relay
1147 Hazard lights relay
1150 IVECO CONTROL: Tail parking light/STOP/rear fog lights (tractor lh-side)
1151 IVECO CONTROL: Front lh parking light/front rh maker light (tractor)
1152 IVECO CONTROL: Tail parking light/ STOP/rear fog lights (tractor rh-side)
1153 IVECO CONTROL: Number plate light
1154 IVECO CONTROL: Front rh parking light/front lh maker light (tractor)
1155 IVECO CONTROL: Tractor alarm
1156 IVECO CONTROL: Trailer alarm
1163 Safety horn
1167 Supply from ABS infomodul AK position (12V trailer socket ABS infomodul)
1168 Supply of trailer 12V stop light before the diode (ABS infomodul)
1169 Supply of trailer stop light before the diode (12V trailer socket ABS infomodul)
1170 From flasher light to control unit (front/rear lh circuits)
1171 Stop lights cable after BO light switch (lh terminal 54) (Military vehicles)
1172 Tail rh stop signal
1173 ABS/INFO/Module stop lights / IVECO CONTROL stop lights
1175 Supply of stop lights signal
1176 Stop lights relay control
1177 Tail lh stop signal
1178 From flasher light to control unit (Front/rear rh circuits)
1179 Trailer stop lights
1180 Trailer rear lh turn signal light

1183	Loudspeaker rh channel (-)
1184	Loudspeaker rh channel (+)
1185	Trailer rear rh turn signal light
1186	Loudspeaker lh channel (-)
1188	Loudspeaker lh channel (+)
1193	Diagnosis L line (retarder control unit)
1194	Diagnosis L line (air suspension control unit)
1195	Diagnosis L line (auxiliary heater control unit)
1196	Diagnosis L line (air-conditioning system control unit)
1197	Diagnosis L line (automatic transmission control unit)
1198	Diagnosis L line (MS6 control unit)
1199	Diagnosis L line (ABS/speed limiter control unit)
1351	Front lh rotary beacon (Fire-Fighting vehicles)
1352	Front rh rotary beacon (Fire-Fighting vehicles)
1355	Low-tone horn (Fire-Fighting vehicles)
1356	High-tone horn (Fire-Fighting vehicles)
1358	Auxiliary turn signal light on superstructure rear lh-side (Fire-Fighting vehicles)
1359	Auxiliary turn signal light on superstructure rear rh-side (Fire-Fighting vehicles)
1361	Rear lh rotary beacon (Fire-Fighting vehicles)
1362	Rear rh rotary beacon (Fire-Fighting vehicles)
2200	Supply of lh/rh high beam headlights (from switch to fuses)
2201	Supply of lh/rh low beam headlights (from switch to fuses)
2203	Supply of flasher light (from switch to fuses)
2204	Flasher light control
2219	Supply of lh high beam headlight
2220	Dual reversing switch
2221	Supply of rh high beam headlight
2222	—
2223	Supply of rh low beam headlight
2224	Supply of loading lamp
2226	Supply of reversing light
2227	Supply of reversing light (control unit - headlight)
2228	Supply of fog lamps
2229	Supply of auxiliary driving headlights
2231	Supply of rh low beam headlight
2235	Supply of exterior lighting switch
2237	Supply of high/low beam headlights: from exterior lighting switch to control unit
2239	Supply of high/low beam headlights: from control unit to headlight switch
2246	Supply of BO lights
2268	Supply of reversing light switch
2269	Supply of auxiliary driving light switch
2280	Rear fog light relay control
2281	Supply of rear fog lamp before the fuse
2283	Supply of rear fog lamp (after the fuse or general)

2284	Supply of rear fog lamp with fog lights on
2285	Optical indicator, high beam lights
2286	Supply of tractor rear fog light (after IVECO Control)
2287	Optical indicator, rear fog lights
2288	Optical indicator, rear fog lights (only as a connection after the diode, if fitted)
2289	Fog lmp realy control
2293	Diagnosis "K" line (retarder control unit)
2294	Diagnosis "K" line (air suspension control unit)
2295	Diagnosis "K" line (auxiliary heater control unit)
2296	Diagnosis "K" line (air-conditioning system control unit)
2297	Diagnosis "K" line (automatic transmission control unit)
2298	Diagnosis "K" line ("MS6" control unit)
2299	Diagnosis "K" line (ABS/speed limiter control unit)
2351	Work lamp after the fuse (Fire-Fighting vehicles)
3300	General lh supply for IVECO Control control unit after the fuse
3301	General rh supply for IVECO Control control unit after the fuse
3302	Excitation of rear parking fog light relays / Fog lights switch on device
3304	Supply of front lh parking/marker light after IVECO Control control unit
3305	Supply of rear lh parking light after IVECO Control control unit
3306	Supply of rear lh trailer parking light after IVECO Control control unit
3307	Supply of number plate light after IVECO Control control unit
3308	Supply of rear lh/rh marker lights after IVECO Control control unit
3314	Supply of front rh parking/marker light after IVECO Control control unit
3315	Supply of rear rh parking light after IVECO Control control unit
3316	Supply of rear rh trailer parking light after IVECO Control control unit
3330	Front rh parking, rear lh, trailer rh lights. Front lh marker light (Germany and Italy). Rh marker light (France and Sweden). Rh number plate light
3331	UNIC project: Rh marker light, Side lh gabarit light (France). Rear lh gabarit light (tractor France). Rear rh marker and parking light. Number plate light (trailer)
3332	UNIC project: Lh marker light, Side rh gabarit light (France). Rear lh gabarit light (tractor France). Rear lh marker and parking light. Number plate light (trailer)
3333	Parking lights (common circuits)
3334	Front rh and rear lh parking lights. Rh number plate light. Rh marker light (*)
3335	Front lh and rear rh parking lights. Lh number plate light. Lh marker light. Trailer insulated lights (socket 4 on trailer auxiliary coupling joint) (*)
3337	Number plate box light
3338	Front lh parking , rh rear, lh trailer light. Front rh marker light (Germany and Italy). Lh marker light (France and Sweden). Lh number plate lights
3339	Front lh parking , rh rear, lh trailer light. Front rh marker light (Germany and Italy). Lh marker light (France and Sweden). Lh number plate lights
3347	Tail BO parking light
3348	BO stop lights
3349	Auxiliary tail BO headlight (NATO vehicles)
3350	Supply to terminals 58 of fuse box from relay (Fire-fighting vehicles)
3354	Excitation of terminal 58 relays (Fire-fighting vehicles)
3377	Trunk or luggage compartment light (exceptional use)

3380	General supply for parking lights (control unit - switch)
3390	General supply for parkign and marker lights
3391	UNIC project: Common supply for parking lights (*)
3397	EOL data entering line (automatic transmission control unit)
4101	Supply of display lighting (semiautomatic transmission)
4400	Supply of interior lighting switch no. 1 (bus)
4401	Supply of interior lighting switch no. 2 (bus)
4402	Switch no. 1: 1st lamp series (bus)
4403	Switch no. 1: 2nd lamp series (bus)
4405	Switch no. 2: 1st lamp series (bus)
4406	Switch no. 2: 2nd lamp series (bus)
4407	Engine compartment lighting
4408	Front door steps lighting
4409	Rear door steps lighting
4411	Optical indicator, general lighting on
4413	Centre door steps lighting
4418	Trucks: ceiling lamp illumination via separate switch no.
4420	Supply of ashtray light
4421	Supply of blue lights and driver's light switches
4422	Supply of blue lights (passengers)
4423	Supply of driver's light
4440	Supply of reading lamp (passengers)
4441	Trucks: ceiling lamp illumination via separate switch no. 1
4442	Supply of dashboard symbol lighting
4443	Supply of cigar lighter light
4444	Instrument panel lighting after the rheostat (or switch)
4445	Supply of door steps lighting
4447	Under hood compartment lighting
4448	Tool compartment lighting
4449	Trunk or luggage compartment lighting
5102	Speed sensor signal (input) (semiautomatic transmission)
5103	Speed sensor signal (output) (semiautomatic transmission)
5104	Supply of speed sensor signal (output) (semiautomatic transmission)
5106	Supply of accelerator pedal position sensor (semiautomatic transmission)
5107	Signal for accelerator pedal position sensor (semiautomatic transmission)
5109	Signal for accelerator pedal idling switch (semiautomatic transmission)
5110	Supply for accelerator pedal idling switch (semiautomatic transmission)
5111	Supply of "KickDown" switch (semiautomatic transmission)
5112	Signal for "KickDown" switch (semiautomatic transmission)
5113	Signal from speed sensor amplifier (semiautomatic transmission)
5115	Signal for engaged gear speed group (semiautomatic transmission)
5116	Signal for engaged gear sensor (semiautomatic transmission)
5118	TRISTATE signal (automatic transmission)
5150	Alternator "W" contact (EDC)

5151 Air temperature sensor (EDC)
5152 Supercharging pressure sensor signal (EDC)
5153 Supply of supercharging pressure sensor signal (EDC)
5154 Water temperature sensor (EDC)
5155 EDC speed pulse (tachograph B7)
5157 Accelerator pedal sensor signal (EDC)
5158 Supply of accelerator pedal sensor (EDC)
5160 Enablement to EDC control unit programming
5161 Accelerator pedal position control (EDC)
5309 Supply of hydraulic retarder temperature sensor
5410 Signal for chassis levelling control (ECAS front axle system)
5421 Signal for Rh chassis levelling control (ECAS rear axle system)
5422 Signal for Lh chassis levelling control (ECAS rear axle system)
5441 Signal for Rh pressure sensor (ECAS lift axle system)
5442 Signal for Lh pressure sensor (ECAS lift axle system)
5443 Signal for Rh pressure sensor (ECAS axle system)
5444 Signal for Lh pressure sensor (ECAS axle system)
5500 Injection pump potentiometer (EGR)
5501 Optical indicator, crankcase high temperature
5503 Optical indicator, oil min pressure
5504 Optical indicator, oil max temperature
5505 Engine oil level sensor
5506 Engine oil level sensor
5507 Oil pressure sender unit
5508 Supply positive for engine oil pressure sender unit
5510 Adaptor to repeater tachometer signal
5511 Electronic tachometer sender unit - supply
5512 Electronic rev counter sender unit - supply
5513 Electronic tachometer sender unit - signal or supply of tachometer signal
5514 Electronic tachograph sender unit - supply
5516 Electronic tachograph sender unit (reversed signal)
5517 Electronic tachograph sender unit - speed signal
5518 Electronic tachograph sender unit - distance covered signal
5519 Electronic rev counter sender unit (signal) and signal from speedometer switch (mechanical rev counter)
5520 Optical indicator, min coolant level
5521 Warning lamp, windshield tank fluid level
5523 Crankcase temperature thermometer sender unit
5525 Warning lamp, power steering fluid
5527 Min coolant level sender unit
5528 Optical indicator, max water temperature
5530 Warning lamp, water in prefilter
5532 External temperature sensor
5535 Warning lamp, EDC system failure
5540 Speed pulse from tachograph

5541 Speed pulse from signal repeater
5542 Speed pulse from signal repeater to diagnostic socket
5550 Oil temperature sender unit
5551 Engine overspeed indicator (optical and sound signal)
5552 Water temperature sender unit
5553 Optical indicator, preheating on
5555 Optical indicator, min fuel level
5556 Warning lamp, engine oil level
5557 Fuel level indicator (single-pole device)
5558 Signal from control unit to engine oil level indicator
5559 Transmission oil temperature sender unit
5561 Air pressure sender unit (rear brakes)
5562 Air pressure sender unit (front brakes)
5568 Air pressure sender unit (emergency brake)
5570 Front lh wheel sensor (ABS system)
5571 Front rh wheel sensor (ABS system)
5572 Rear lh wheel sensor (ABS system)
5573 Rear rh wheel sensor (ABS system)
5577 Pre/after-heating control sensor
5580 EGR absolute barometric pressure sensor
5581 Supply from EGR control unit
5584 Signal cable for engine rpm diagnosis no. 1 sensor (n=1/1) and engine rpm electronic sensor
5585 Signal cable for engine rpm diagnosis no. 2 sensor (n=1/1)
5586 Signal cable for engine rpm diagnosis sensor (n=1/2 on injection pump)
5588 Voltage adjusted according to engine oil level indicator
5590 Supply of fuel pressure sensor (EDC)
5591 Signal for fuel pressure sensor (EDC)
5592 Fuel temperature signal (EDC)
5595 EGR control unit diagnosis
5598 Automatic chassis lubrication system sensor
5600 Signal, automatic clutch accumulator fluid low pressure sensor
5601 Signal, automatic clutch accumulator fluid high pressure sensor
5602 Signal from automatic clutch position sensor
5603 Signal from automatic clutch transmission position sensor (forward position)
5604 Signal from automatic clutch transmission position sensor (backward position)
5605 Signal from automatic clutch transmission position sensor (common)
5606 Signal from accelerator pedal sensor (automatic clutch)
5607 Signal from gearshift lever position sensor (automatic clutch) (position X)
5608 Signal from gearshift lever position sensor (automatic clutch) (position Y)
5609 Signal from gearshift lever position sensor (automatic clutch) (position NA)
5610 Signal from hood position sensor (automatic clutch) (common)
5611 Signal from hood position sensor (automatic clutch) (position NC)
5612 Cruise Control signal from automatic clutch control unit
5613 Signal from EDC accelerator pedal (automatic clutch control unit)

5614	Engine rpm signal from EDC (automatic clutch control unit)
5615	Signal from engine rpm sensor (automatic clutch control unit)
6000	Warning lamp, electronic accelerator
6001	Warning lamp, chassis lowering system
6002	Lamp test
6003	Warning lamp, door II (centre) open before diode
6005	ABS on warning lamp
6007	Warning lamp, electronic suspension levelling unit
6008	Warning lamp, air suspension failure
6011	Warning lamp, rear axle air suspension pressure
6012	Warning lamp, front brake shoe wear before diode
6013	Warning lamp, rear brake shoe wear before diode
6014	Intermittent warning lamp, stop request
6022	Warning lamp, front brake wear (control unit warning device)
6023	Warning lamp, rear brake wear (control unit warning device)
6100	Supply of display (semiautomatic transmission)
6101	Display "Data" line (semiautomatic transmission)
6102	Display "Clock" line (semiautomatic transmission)
6103	Warning lamp, air pressure signal (semiautomatic transmission)
6104	"TX" diagnosis line (semiautomatic transmission)
6105	"RX" diagnosis line (semiautomatic transmission)
6106	Data diagnosis line (semiautomatic transmission)
6107	Supply of diagnostic equipment (semiautomatic transmission)
6108	ISO-CAN H connection (semiautomatic transmission control unit)
6109	ISO-CAN L connection (semiautomatic transmission control unit)
6118	LIMP-HOME signal (semiautomatic transmission)
6131	Return signal, rear power take-off (semiautomatic transmission)
6132	Return signal, side power take-off (semiautomatic transmission)
6301	Warning lamp, hydraulic retarder on
6350	Warning lamp, tool compartment door open (Fire-Fighting vehicles)
6351	Warning lamp, front lh rotary beacon (Fire-Fighting vehicles)
6352	Warning lamp, front rh rotary beacon (Fire-Fighting vehicles)
6353	Warning lamp prearrangement (Fire-Fighting vehicles)
6354	Warning lamp prearrangement (Fire-Fighting vehicles)
6355	Warning lamp, power take-off on (Fire-Fighting vehicles)
6356	Warning lamp, extended work projector telescopic support or protruding stabilizer struts (Fire-Fighting vehicles)
6357	Warning lamp, water pump on (Fire-Fighting vehicles)
6358	Warning lamp, 220V alternator on (Fire-Fighting vehicles)
6359	Warning lamp, winch on (Fire-Fighting vehicles)
6361	Warning lamp, rear lh rotary beacon (Fire-Fighting vehicles)
6362	Warning lamp, rear lh rotary beacon (Fire-Fighting vehicles)
6401	Warning lamp, low air pressure (air suspension system)
6402	CLOCK line, ECAS suspension system button strip
6403	DATA line, ECAS suspension system button strip

6440 Warning lamp, axle up
6460 Warning lamp, assistance to starting on
6490 Warning lamp, 3rd steering axle in operation
6499 Warning lamp, 3rd steering axle system locked
6500 Warning lamp supply, auxiliary heater failure
6600 Optical indicator, front door open
6601 Optical indicator, transmission drive on
6602 Warning lamp, all-wheel drive on
6603 Optical indicator, transfer case differential lock
6604 Optical indicator, TELMA retarder
6605 Optical indicator supply, auxiliary heater on
6607 Optical indicator, tilted body
6608 Optical indicator, rotary beacon
6609 Warning lamp, door 1 (front) open before diode
6611 Optical indicator, clutch wear
6612 Connection between relays, stop request optical indicator on/off
6613 Optical indicator, brake system failure (general)
6614 Optical indicator, air/water/oil repeater
6615 Optical indicator, refrigerator on
6616 Warning lamp, heated windshield
6617 Optical indicator, heating on (KHD motor)
6618 Optical indicator, oil filter restriction (engine compartment ventilation hydraulic circuit)
6619 Optical indicator, thermal glass, front headlight cluster
6620 Control unit, cross differential lock (terminal 4)
6621 Control unit, cross differential lock (terminal 2)
6622 Optical indicator, forced ventilation
6623 Optical indicator, brake linig pre-wear condition
6624 Optical indicator, rear door open
6627 Optical indicator, exhaust brake on
6628 Warning lamp, automatic snow chains on
6629 Optical indicator, stop request
6633 Optical indicator, interior heating
6634 Optical indicator, interior heating motors
6635 Optical indicator, engine compartment ventilation failure
6637 Optical indicator, alternator charge (before diode)
6640 Warning lamp, automatic clutch system failure
6644 Optical indicator, auxiliary alternator charge
6645 Warning lamp, reading lights
6647 Warning lamp supply, centre door open signal
6651 Warning lamp, rear axle brake fluid level
6652 Optical indicator, heated rearview mirror
6655 Optical indicator, auxiliary heater
6657 Warning lamp, FREON compressor on
6658 Optical indicator, stop brake

6659 Warning lamp, cross differential lock (front)
6660 Optical indicator, cross differential lock
6661 Optical indicator, brake fluid min level
6662 Optical indicator, hand brake
6663 Optical indicator, air cleaner restriction
6664 Optical indicator, front axle brake lining wear
6665 Warning lamp, front axle air suspension pressure
6666 Optical indicator, cab unlatched
6667 Optical indicator, general/rear axle brake lining wear
6668 Optical indicator, coupling joint hitched up
6669 Buzzer, engine sound alarm signal
6670 Warning lamp, tractor ABS/CEF failure
6671 Warning lamp, trailer ABS failure
6672 Warning lamp, ASR/speed limiter failure
6675 Warning lamp, trailer ABS disconnected
6677 Optical indicator, ICP (hydraulic brake system malfunction)
6679 Warning lamp, FREON compressor off
6680 Optical indicator, rear brake system min air pressure
6681 Warning lamp, stop request before diode
6682 Optical indicator, parking brake system min air pressure
6683 Optical indicator, air suspension min air pressure
6684 Optical indicator, front brake system min air pressure
6685 Warning lamp, transfer case, neutral position
6687 Warning lamp, chassis raising system
6688 Warning lamp supply, splitter gear engaged
6689 Optical indicator, trailer brake system min air pressure
6693 Optical indicator, converter oil pressure
6694 Optical indicator, vehicle front raising system
6695 Optical indicator, vehicle rear raising system
6698 Warning lamp, automtic chassis lubrication system failure
6699 Warning lamp supply, high transmission oil temperature
7000 Relay excitation, front/rear interior heating motors (1st/2nd speed)
7001 Relay excitation, front/rear interior heating motors (internal speed)
7002 Supply of front/rear interior heating motors (1st/2nd speed after relay)
7003 Supply of front/rear interior heating motors (internal speed after relay)
7004 Supply of auxiliary heating system (partially open)
7005 Supply of auxiliary heating system (fully open)
7009 Supply of relay for battery charging warning lamp
7010 Supply of hatch opening control
7011 Supply of hatch closing control
7017 Supply of EDC through end-of-line programming control switch
7050 Signal switch, transmission in neutral
7073 Supply of relay for electrical battery disconnector after diode
7076 Self-excitation supply, electrical battery disconnector relay coil

7150 Supply of EDC/MS6 system from main relay
7152 Supply of preheating switch on relay
7155 Supply of MS6 system from main relay
7350 Supply of rotary beacon relay/alarm switch (Fire-Fighting vehicles)
7351 Supply of amperometric relay from control relay for switching on front rotary beacon (Fire-Fighting vehicles)
7352 Supply of front rotary beacon relay/supply of rear rotary beacon switch from alarm switch (Fire-Fighting vehicles)
7355 Supply of Fiamm/Martin horn relay (Fire-Fighting vehicles)
7356 Supply of Fiamm/Martin horn relay (Fire-Fighting vehicles)
7357 Supply of radioreceiver set switch from fuse (Fire-Fighting vehicles)
7358 Supply of radioreceiver set from switch (Fire-Fighting vehicles)
7359 Supply of outlet from fuse (Fire-Fighting vehicles)
7361 Supply of rear rotary beacon amperometric relay from control relay (Fire-Fighting vehicles)
7362 Supply of rear rotary beacon amperometric relay from alarm relay (Fire-Fighting vehicles)
7440 Supply of lift axle system after the fuse
7502 Supply of cab and/or engine heating switches (auxiliary heater)
7503 Cab heating control after diode
7504 Supply of fan relay (1st speed)
7505 Supply of fan relay (2nd speed)
7506 Auxiliary heater control with microswitch connection on heating cock control lever
7507 Cab heating control
7508 Auxiliary heating control after engine heating switch
7509 Auxiliary heating control after cab heating switch
7510 Supply of auxiliary heater control signal
7511 Supply of electronic pulse generator for auxiliary heater incandescence plug
7515 Supply of auxiliary heater thermal sensor
7516 Supply of auxiliary heater flame sensor
7519 Supply of auxilairy heater failure warning lamp after diodes
7520 Supply of cab interior temperature sensor
7550 Supply of air-conditioning switching system
7551 Supply of air-conditioning system fan
7552 Supply of TOP FLAP door opening relay
7553 Supply of TOP FLAP door closing relay
7554 Supply of fan governor control unit (TGMV) (air-conditioning system)
7555 Supply of fan governor control unit (GMV) (air-conditioning system)
7556 Battery isolating switch relay control (air-conditioning system)
7560 Supply of servomotor potentiometer (VPOT) (air-conditioning system)
7561 Servomotor potentiometer signal for air delivery to floor area (PFOOT) (air-conditioning system)
7562 Supply of servomotor for air delivery to floor area (+FOOT) (air-conditioning system)
7563 Servomotor potentiometer signal for air delivery to windshield deforsting unit (PDEF) (air-conditioning system)
7564 Supply of servomotor for air delivery to windshield defrosting unit (+DEF) (air-conditioning system)
7565 Servomotor potentiometer signal for air recirculation/external air intake (PRYC) (air-conditioning system)
7566 Supply of servomotor for air recirculation/external air intake (+RYC) (air-conditioning system)

7567	"Air mixing" servomotor potentiometer signal (air-conditioning system)
7568	Supply of "air mixing" (+ MIX) servomotor (air-conditioning system)
7571	Water temperature sensor signal (TAS) (air-conditioning system)
7572	Water temperature sensor signal (TEVAP) (air-conditioning system)
7573	External temperature sensor signal (TEXT) (air-conditioning system)
7574	Sun radiation sensor signal (SUNLOAD) (air-conditioning system)
7590	Supply of ventilation system (air-conditioning system)
7591	Supply fan ON position with air-conditioning system turned on
7600	Supply of automatic clutch system
7601	Supply of automatic clutch motor
7700	Connection for C1 auxiliary heater control unit and air-conditioning system switch (supply of water temperature adjusting device)
7701	Supply for rotary beacon amperometric relay
7702	Relay excitation for auxiliary heater compensation tank filling motor
7703	12V positive after diod (radio supply)
7704	Radio amplifier supply
7705	Supply of auxiliary heater ignition plug
7706	Supply of interior heating motors (front)
7707	Supply before ABS fuse
7708	Auxiliary heater supply
7709	Supply of interior heating motors (rear)
7710	Supply of ABS control unit after relay no. 1
7711	Suuply of windshield defrosting and heating motor
7715	Stop request signal resetting control
7720	Supply of ABS control unit after relay no. 2
7721	Cigar lighter supply
7722	Supply of cab heating air blower motor (auxiliary heater)
7724	Supply of ignition key (positive after fuse)
7725	Positive cable for connection of timer clock terminal to control relay
7726	Connection cable for air-conditioning system switch off relay (auxiliary heater on)
7728	Flasher light supply
7729	Assisted cab tilting relay control
7730	Cab tilting hydraulic pump supply (assited cab tilting system)
7731	Excitation positive before the ignition key
7733	Supply of fuel heater
7734	Supply of fuel heating before the fuse
7735	Suply of refrigerator motor
7736	Supply of air temperature thermostat (auxiliary heater)
7741	Supply of steering column antitheft coil
7744	Supply of engine compartment ventilation switch on control
7745	Supply of engine ventilation motor
7746	Supply of retarder relay through switch
7750	Supply from V4 branch point to EDC control switch relay
7751	Supply of remote engine rev up device after relay NO contact
7752	Supply of EDC control after relay NC contact

7753	Supply of heated fuel settler prefilter
7755	Supply of retarder relay terminal r (after the diode)
7756	Charge signal relay excitation (separate regulator alternator)
7759	Positive cable after air-conditioning system switch to timer clock
7766	Supply of comburent air pump and ignition coil motor (auxiliary heater)
7768	Tachograph continuous supply
7770	Positive after drop-out resistance or 12V positive before the diode (radio supply)
7771	Positive before amperometer
7772	Positive after fuse
7773	Generator/alternator excitation
7774	Horn supply (from switches to fuse)
7775	Auxiliary heater supply via switch
7776	Battery switch separate supply (dangerous cargo vehicles)
7777	Battery direct positive (unprotected)
7778	Optical indicator, generator/alternator charge
7779	Indicator, auxiliary heater switch off relay via control units
7780	Alternator D+ after diode
7781	Optical indicator supply, timer, electronic control unit, preheating/water temperature thermostats (auxiliary heater) (BUS temperature 65/70 °C)
7783	Supply of auxiliary fuel pump and fuel control solenoid valve (auxiliary heater)
7784	Supply of 80/85 °C water temperature thermostat (auxiliary heater)
7785	Supply of water circulation pump motor (auxiliary heater)
7786	Independent heating water pump enablement device
7788	Supply of preheating thermostat (auxiliary heater)
7789	Optical indicator, alternator charge (separate regulator alternator)
7790	Trailer socket supply after fuse (TMP USERS)
7791	GCR control electronic supply combined with emergency cutoff after fuse
7792	Fuel delivery booster solenoid before the fuse
7793	General supply, interior heating motors (front/rear) before relay
7794	Fuel delivery booster solenoid before the fuse
7798	Supply of automatic chassis lubrication system after fuse
7799	Supply of 1st/2nd speed/full speed relay excitation before control switch
8000	Supply of optical indicator test circuit
8001	Supply of interior aeration motor (centre) - Air expulsion
8002	No. 1 connection between side rh power window switches
8003	No. 1 connection between side lh power window switches
8004	Supply of electric heater switch (switch relay)
8005	Supply of engine preheating resistor signal
8006	Supply of front headlight cluster glass heating
8007	Supply of interior heating motors and forced ventilation switches
8008	Electrofan supply (4th speed)
8009	Supply of air-conditioning system relay
8010	Supply of speed limiting device without the fuse
8011	Supply of switch for internal aeration motors
8012	Supply of stop request optical indicator switch off relay

8013 Supply of fuel boost electromagnet
8014 Supply of chassis raising system
8015 Supply of chassis lowering system
8016 Brake wear cable (rear sensors)
8019 Supply of evaporator motors switch on relays
8020 Supply of windshield heating
8022 Supply of evaporator motors
8023 Supply of forced ventilation system relays
8024 Flasher light relay control
8025 Terminal 15 dilayed switch off relay, battery disconnector cutoff (GCR)
8026 Reversing light relay excitation cable
8027 Automatic light relay excitation cable
8028 Jumper on speed limiter control unit for unlimited engine rpm function
8029 Relay excitation cable (starting with transmission in neutral)
8030 Gear uncoupling relay excitation (speed limiting device)
8031 Supply for driver's seat heating
8032 Supply for co-driver's seat heating
8033 Supply of relay for TELMA retarder relay (stage 3)
8034 Reverse gear enablement cable (automatic transmission)
8035 Relay excitation for holding GCR alive
8037 Supply from ignition switch terminal 50 for inhibiting vehicle starting with engine running
8044 Supply of TELMA retarder relay, stage 4
8045 GCR relay excitation via ignition switch
8046 Time relay excitation (heated windshield)
8047 Control of vehicle running signal relay (hydraulic braking system)
8048 Cruise Control switch off relay with retarder on
8050 Transmission in neutral signal switch
8051 Supply of "MS6" control unit +15 after the relay
8059 Supply of speed limiter solenoid valve switch off relay (during gear shifting)
8060 Positive cable after Z diode for instrument light/pilot light dimmer (Military vehicles)
8061 Positive cable for warning lamp supply (dimmed light switching enabled via Z diode) (Military vehicles)
8062 Supply of instrument lights (dimmed light switching enabled via Z diode) (Military vehicles)
8087 Supply of miscellaneous components after relay
8101 Supply of semiautomatic transmission after fuse
8102 Neutral switch supply after fuse (semiautomatic transmission)
8103 Supply of semiautomatic transmission after fuse
8104 Neutral switch signal (starting inhibting device semiautomatic transmission)
8105 Neutral switch supply (starting inhibting device semiautomatic transmission)
8106 Neutral switch signal (starting inhibting device after diode unit)
8107 Supply of air low pressure switch (semiautomatic transmission)
8108 Gear increase signal from semiautomatic transmission gearshift lever
8109 Gear decrease signal from semiautomatic transmission gearshift lever
8110 Supply of gear selector switch (semiautomatic transmission)
8111 Reverse gear engagement signal from gear selector device (semiautomatic transmission)

8112 Supply of clutch position switch (semiautomatic transmission)
8113 Clutch position switch signal (semiautomatic transmission)
8114 Retarder signal (semiautomatic transmission)
8115 Connection from speed group switch to engaged gear switch (semiautomatic transmission)
8116 Engaged gear signal (semiautomatic transmission)
8118 Engaged speed group signal (semiautomatic transmission)
8119 LIMP HOME supply (semiautomatic transmission)
8120 Signal from exhaust brake switch (semiautomatic transmission)
8123 Neutral position signal from direction preselector (semiautomatic transmission)
8124 Neutral position signal from direction preselector to semiautomatic transmission gear selector
8125 Forward gear signal from automatic transmission direction preselector
8131 Supply of rear power take-off relay (semiautomatic transmission)
8132 Supply of side power take-off relay (semiautomatic transmission)
8141 Signal to ABS system (PBM/PWM) (semiautomatic transmission)
8142 Signal to ABS system (MPS/MUX) (semiautomatic transmission)
8149 Supply of reverse gear relay (semiautomatic transmission)
8150 EDC supply
8151 EDC control unit interface signal to other electronic systems (PBM)
8152 EDC control unit interface signal to other electronic systems (MPS)
8153 Signal from primary stop light switch (EDC)
8154 Signal from Cruise Control cutoff switch (EDC)
8155 Signal from Cruise Control operation switch (EDC)
8156 Signal from Cruise Control speed reducing switch (EDC)
8157 Signal from Cruise Control speed increasing switch (EDC)
8158 Signal from secondary stop light switch (EDC)
8159 Signal from exhaust brake switch (EDC)
8161 EDC supply after Cruise Control cutoff relay
8162 Engine rpm increase switch with air-conditioning on (EDC)
8163 Connection to 3-lever pressure switch (air-conditioning system)
8164 EDC supply after engine stopping relay
8170 Supply of MS6 control unit +15 from interconnection unit to relay
8300 Supply of hydraulic retarder system
8350 Supply from control relay to terminal 15 of fuse box (Fire-Fighting vehicles)
8351 Sound alarm instrument after fuse (Fire-Fighting vehicles)
8352 Control of sound alarm instrument (Fire-Fighting vehicles)
8353 Dual tone horn control (Fire-Fighting vehicles)
8354 Excitation of Martin horn relay (Fire-Fighting vehicles)
8355 Supply of terminal 15 of users after fuses (Fire-Fighting vehicles)
8356 Excitation of relay, terminal 15 (Fire-Fighting vehicles)
8357 Supply of power take-off switch hour counter (Fire-Fighting vehicles)
8358 Supply of MS6 control unit, terminal 20, before clutch switch
8360 Solenoid valve (+15) supply (VGT turbine air pipe lock)
8361 Frequency converter (+15) supply (VGT turbine)
8362 Supply of "MS6" control unit (terminal 31) before brake pedal switch

8402 Supply of electronic suspension levelling system (non-travelling condition)
8410 Control of front axle electronic suspension levelling system (travelling condition)
8411 Excitation of front axle self-levelling electronic suspension system (travelling condition)
8420 Control of rear axle electronic suspension levelling system (travelling condition)
8421 Excitation of rear axle self-levelling electronic suspension system (travelling condition)
8422 Supply of chassis rear lowering system
8423 Control of rear axle stroke stop relay
8439 Supply of axle lifting relay (speed < 2 km/h)
8440 Supply of axle lifting systen after fuse
8441 Supply of axle lifting system after pushbutton
8442 Supply of axle lowering system after pushbutton
8443 Supply of 11 ton axle lifting system pressure switch
8444 Supply of axle lifting system after tachometer switch
8445 Supply of axle lifting/lowering switch
8446 Supply of axle lowering relay
8447 Supply of axle lifting relay
8448 Supply of axle lifting/lowering relay
8449 Axle lifting supply after relay
8450 Supply of hydraulic pump relay (lift axle sytem)
8451 Hydraulic pump cutoff signal from pressure switch (lift axle sytem)
8452 Supply of hydraulic pump system (lift axle sytem)
8453 Signal after 11 ton pressure switch (lift axle sytem)
8454 Signal after 11 ton pressure switch after diode (lift axle sytem)
8455 Supply after time relay with less than 11 tons
8456 Supply of axle lowering relay from chassis levelling system during lowering stroke
8457 Supply of air solenoid valve reversal relay during axle lowering stroke
8460 Supply of starting assistance device after pushbutton
8461 Supply of starting assistance function after time relay
8462 Starting assistance relay enablement with less than 13 tons
8463 Supply of starting assistance relay
8464 Starting assistance cutoff device
8465 Starting assistance relay cutoff device
8466 Supply of starting assistance deviceat a speed of ≥ 25 km/h
8468 Starting assistance cutoff at a speed of ≥ 25 km/h
8469 Starting assistance relay self-excitation
8490 Supply of 3rd steering axle system
8491 Signal from front axle straight driving position switch
8492 Signal from rear axle straight driving position switch
8493 3rd steering axle signal relay automatic supply
8494 Supply of 3rd steering axle relay after tachometer switch
8495 3rd steering axle hydraulic control (axle down)
8496 Supply of hydraulically-controlled 3rd steering axle relay in straight-ahead driving position (straight wheels)
8497 Hydraulically-controlled 3rd steering axle control (steered front axle condition)
8501 Ignition key-controlled supply after relay (independent heating)

8591	Supply from mean pressure switch for fan number of revolutions control (air conditioning)
8600	Supply of automatic clutch system
8601	Relay/buzzer supply from automatic clutch control unit
8602	Supply of automatic clutch position sensor
8603	Supply of accelerator pedal position sensor (automatic clutch)
8604	Supply of gear shift lever position sensor (automatic clutch)
8700	Instrument operation enablement (alternator output)
8710	+15 supply prearrangement (external bodybuilders (max = 10 A)
8800	Exhaust brake solenoid valve enablement switch
8801	Supply of de-aeration door opening relay (windshield defrosting external air inlet door open)
8802	Excitation of ignition key-assisted services relay
8803	Supply cable for miscellaneous services after BO light switch (terminal 49)
8804	Supply of draft tube ventilation motors
8805	Supply of permanent tube ventilation motors
8806	Supply of main lh rearview mirror aiming motor
8807	Supply before the fuse (ABS)
8808	Supply of main lh rearview mirror aiming motor (vertical direction)
8809	Supply of main lh rearview mirror aiming motor (endwise direction)
8810	Levelling system supply after fuse
8811	Supply of draft tube ventilation motor switch on relay
8812	Electronic suspension levelling control (travelling condition)
8813	Windshield wiper unit (8-function switch)
8814	Brake wear (return from interconnecting box to cab control unit and sensor connection)
8815	Supply of GCR relay
8816	Supply of trailer ABS from infomodule
8817	Supply of infomodule RK line (ABS)
8818	Supply of infomodule RK line (ABS)
8819	Heated mirror relay excitation
8820	Supply of headlamp wiping unit from relay
8821	Supply of headlamp wiping unit from electric pump
8822	Windshield wiper unit intermittent supply
8823	Supply of headlamp wiping unit
8824	Supply of permanent tube ventilation motor turn on relay
8825	Supply of forced ventilation switch off relay (high speed)
8826	Headlamp wiping unit: connection between motors
8827	Supply of brake oil pump relay
8828	Supply of brake oil pump
8829	Control of heated mirror and/or mirror aiming after fuse
8830	Supply of heated rearview mirrors
8831	Supply (15) of water in prefilter signal
8832	Excitation of fuel heating relay
8833	Supply of relays for front interior heating motors or relais for supply of water circulation pump motor and water/oil exchanger solenoid valve
8834	Relay supply for rear interior heating motors
8835	Supply of front interior aeration/air intake motor

8836 Supply of parking rearview mirror aiming motor (driver's opposite side)
8837 Fuel heating relay temperature switch
8838 Supply of parking rearview mirror aiming motor (vertical direction driver's opposite side)
8839 Supply of parking rearview mirror aiming motor (endwise direction driver's opposite side)
8841 Supply of wide-angle rearview mirror aiming motor (driver's side)
8842 Supply of wide-angle rearview mirror aiming motor (vertical direction driver's side)
8843 Supply of wide-angle rearview mirror aiming motor (endwise direction driver's side)
8844 Supply of front interior aeration/air ejection motor
8845 Supply of centre interior aeration/air intake motor
8847 Supply of ABS/speed limiting device after fuse
8848 Supply of injection pump ignition timer (KB)
8849 Supply of contact key-assisted services and cutoff of various components during starting stage
8850 Relay excitation for cutoff of various components during starting stage
8851 Supply of wide-angle rearview mirror aiming motor (driver's opposite side)
8852 Supply of wide-angle rearview mirror aiming motor (vertical direction driver's opposite side)
8853 Supply of wide-angle rearview mirror aiming motor (endwise direction driver's opposite side)
8855 Supply of rear interior aeration/air intake motor
8856 Supply of rear interior aeration/air ejection motor
8857 Supply of main rh rearview mirror aiming motor
8858 Supply of main rh rearview mirror aiming motor (vertical direction)
8859 Supply of main rh rearview mirror aiming motor (endwise direction)
8860 Supply of KHD motor motor preheating
8861 Supply of side power window control
8862 Connection no. 2 between side rh power window switches
8863 Supply of side power window motor
8864 Supply of trim adjuster motor
8865 Return cable from side power window motor
8866 Positive from TELMA retarder
8867 Connection no. 2 between side lh power window switches
8869 Supply of key antirotation electromagnet
8870 Start preheating supply after fuse
8871 Supply of vehicle operation testing instruments after fuse
8872 Flasher light centre supply after fuse
8873 Windshield wipers fixed stop
8874 Supply of hydraulic prebrake solenoid valves after fuse
8875 Start preheating supply before fuse
8876 Supply of engine operation testing instruments after fuse
8877 Connection for windshield wipers intermittent operation and switch
8878 Supply of ERG control unit
8879 Supply of servoassisted components after fuse
8880 Supply of windshield wiper unit motor - separate fuse
8881 Supply of windshield wiper unit motor - high speed
8882 Supply of windshield wiper unit motor - low speed
8883 Supply of air-conditioning system motor - high speed

8884	Supply of air-conditioning system motor - low speed
8885	Supply of heating relay
8886	Supply of windshield washer pump
8887	Supply of general services before fuse
8888	Starter motor electromagnet or relay
8889	Supply of trailer brake control relay
8890	Supply of trailer prebrake solenoid valve
8891	Supply of windshield defroster and heater switch (fuse + switch or fuse + relay)
8892	Under cab engine starting
8893	Relay excitation for water recirculating pump during auxiliary heter starting stage
8894	Supply of TELMA retarder foot/hand control selecting switch
8895	Travelling signal relay control (hydraulic braking system)
8898	Supply of automatic chassis lubrication system after fuse
8899	Supply of 12V/24V radio set
9000	Supply of center door opening solenoid valve
9002	Supply of spring cylinder emergency release solenoid valve
9003	Gear selector relay excitation
9004	Gear selector relay supply
9005	Connection line between non-series connected exhaust switch and brake pedal switch
9006	Connection line between safety switch and rear door reopening pressure pushbutton
9007	Automatic transmission control
9008	Automatic transmission supply
9010	Door no. 2 (centre) relay control
9011	Connection from terminal 30 of electronic accelerator control unit to terminal 3 of accelerator pedal sender unit and actuator terminal 1
9012	Connection from terminal 21 of electronic accelerator control unit to terminal 6 of accelerator pedal sender unit
9014	Connection from terminal 15 of electronic accelerator control unit to terminal 2 of accelerator pedal sender unit
9015	Connection from terminal 17 of electronic accelerator control unit to terminal 4 of accelerator pedal sender unit and actuator terminal 4
9016	Connection from terminal 16 of electronic accelerator control unit to actuator terminal 3
9017	Connection from terminal 11 of electronic accelerator control unit to terminal 5 of accelerator pedal sender unit and actuator terminal 5
9018	Connection from terminal 22 of electronic accelerator control unit to actuator terminal 2
9022	Connection from terminal 1 of electronic accelerator control unit to actuator terminal 2 (engine)
9023	Connection from terminal 10 of electronic accelerator control unit to actuator terminal 1 (engine)
9027	Transfer case valve supply line after door 1 pushbutton
9028	Transfer case valve supply line after door 2 pushbutton
9031	Service brake solenoid valve supply
9040	Front axle levelling solenoid valve 1 control
9050	Rear axle levelling solenoid valve 1 control
9058	Pre-resistor supply for speed limiter proportional solenoid valves
9060	Dump solenoid valve supply for speed limiter gear uncoupling
9061	Modulating solenoid valve supply (MV1) (speed limiting device)
9062	Modulating solenoid valve supply (MV2) (speed limiting device)

9101	Supply of transmission solenoid valve unit (no. 1) (semiautomatic transmission)
9102	Supply of transmission solenoid valve unit (no. 2) (semiautomatic transmission)
9103	Supply of transmission solenoid valve unit (no. 3) (semiautomatic transmission)
9104	Supply of transmission solenoid valve unit (no. 4) (semiautomatic transmission)
9105	Supply of transmission solenoid valve unit (no. 5) (semiautomatic transmission)
9106	Supply of transmission solenoid valve unit (no. 6) (semiautomatic transmission)
9108	Supply of transmission solenoid valve unit (no. 8) (semiautomatic transmission)
9109	Supply of "A" splitter gear solenoid valve unit (semiautomatic transmission)
9110	Supply of "B" splitter gear solenoid valve unit (semiautomatic transmission)
9112	Supply of transmission brake solenoid valve (semiautomatic transmission)
9113	Supply of transmission solenoid valve unit (no. 13) (semiautomatic transmission)
9114	Supply of clutch release holding solenoid valve (semiautomatic transmission)
9115	Exhaust brake disengagement signal (semiautomatic transmission)
9116	Supply of clutch signal solenoid valve (semiautomatic transmission)
9117	Engine negative on injection pump actuator (semiautomatic transmission)
9118	Engine positive on injection pump actuator (semiautomatic transmission)
9119	Limit switch signal on injection pump actuator (semiautomatic transmission)
9120	Supply of limit switch signal on injection pump actuator (semiautomatic transmission)
9121	Boost supply on injection pump actuator (semiautomatic transmission)
9122	Boost signal on injection pump actuator (semiautomatic transmission)
9131	Supply of power take-off solenoid valve (semiautomatic transmission)
9132	Supply of side power take-off solenoid valve (semiautomatic transmission)
9150	EDC pump rod position sensor (terminal 1)
9151	EDC injection pump rod stroke signal
9152	Engine rpm sender unit (EDC)
9153	EDC pump rod position sensor (terminal 5)
9154	Common EDC pump rod position sensor
9155	Emergency engine stopping solenoid valve (EDC)
9156	Injection pump fuel delivery actuator (EDC)
9157	Injection pump advance check electromagnet (EDC)
9158	Injector internal needle lift sensor (EDC)
9165	MS4/MS6 brake signal (engine rev up from ground enablement)
9301	Position 1 control (hydraulic retarder)
9302	Position 2 control (hydraulic retarder)
9303	Position 3 control (hydraulic retarder)
9304	Position 4 control (hydraulic retarder)
9305	Position 5 control (hydraulic retarder)
9306	Position 6 control (hydraulic retarder)
9307	Supply from lever switch pushbutton (hydraulic retarder)
9308	Supply of lever switch pushbutton (hydraulic retarder)
9310	Supply of hydraulic retarder operation solenoid valve
9311	Supply of oil accumulator solenoid valve (hydraulic retarder)
9402	Supply of chassis levelling solenoid valves II (travelling condition)
9410	Supply of chassis front lowering I/II solenoid valves

9413	Supply of front axle ECAS solenoid valve
9420	Supply of chassis rear lowering I/II solenoid valves
9422	Solenoid valve II control (rear axle chassis levelling control - travelling condition)
9423	Supply of rear axle ECAS solenoid valve unit
9424	Supply of rear axle ECAS solenoid valve unit (rh valve)
9425	Supply of rear axle ECAS solenoid valve unit (lh valve)
9440	Supply of lift axle lowering solenoid valve
9441	Supply of cantilever lifting solenoid valve
9442	Supply of cantilever lowering solenoid valve
9443	Supply of axle lifting solenoid valve (air discharge from springs)
9444	Supply from solenoid valve relay for operation of air pressure-controlled valves
9445	Supply of solenoid valve for operation of air pressure-controlled valves
9446	Supply of ECAS rear axle solenoid valve unit (air discharge from rh rear air spring)
9447	Supply of ECAS rear axle solenoid valve unit (air discharge from lh rear air spring)
9460	Supply of solenoid valve for starting assistance cutoff over 13 tons
9490	Supply of 3rd steering axle solenoid valve unit
9498	Hydraulic steering axle operation control (front axle steered and speed > 45 km/h)
9499	Supply pf 3rd steering axle lock solenoid valve
9506	Solenoid valve supply for stopping engine circuit water circulation with auxiliry heater on
9507	Solenoid valve supply for switching from engine circuit water circulation to auxiliary cab heating
9551	Time valve (1) supply (air-conditioning system)
9552	Time valve (2) supply (air-conditioning system)
9570	TOP-FLAP motor supply from relay (air-conditioning system)
9571	TOP-FLAP motor supply from microswitch (manually-controlled air-conditioning system)
9590	Electrofan supply (air-conditioning system)
9591	Fan motor low speed control (air-conditioning system)
9601	Supply of automatic clutch motor after relay
9602	Automatic clutch actuator solenoid valve (supply)
9900	Front doors opening solenoid valve supply
9902	Rear doors opening solenoid valve supply
9903	Engine stopping control
9905	"MS6" control unit supply (+15) on/off relay coil control
9906	Engine stopping control from Main Current Switch
9907	Starting enablement switch
9910	TELMA retarder supply: 2nd position
9911	Supply of TELMA control switch
9912	TELMA retarder supply: 4th position
9913	TELMA retarder supply: 1st position
9914	Supply of permanent ventilation duct door solenoid valve
9915	Supply of auxiliary retarder cutoff with ABS on
9916	TELMA retarder supply: 3rd position
9917	EDC supply cutoff
9918	Supply of front rh wheel "AV" solenoid valve (ABS system)
9920	Supply of front rh wheel "EV" solenoid valve (ABS system)

9921	Supply of front lh wheel "EV" solenoid valve (ABS system)
9922	Supply of water/oil heat exchanger solenoid valve
9923	3rd axle lifting control
9924	Injector supply (EDC)
9925	Pressure regulator (EDC)
9926	Supply of permanent aeration duct 1/3 door opening solenoid valve
9928	Supply of rear rh wheel "AV" solenoid valve (ABS system)
9929	Supply of rear lh wheel "AV" solenoid valve (ABS system)
9930	Supply of rear rh wheel "EV" solenoid valve (ABS system)
9931	Supply of rear lh wheel "EV" solenoid valve (ABS system)
9932	Valve gear cam rpm sensor (EDC)
9933	Supply of electromagnetic clutch control relay
9934	Headlight aiming control device
9935	Headlight aiming control device (position C)
9936	Headlight aiming control device (position B)
9937	Headlight aiming control device (position A)
9938	1st supply, outside air intake door actuator and relevant warning lamp
9940	TELMA retarder relay box control: 2nd position
9942	TELMA retarder relay box control: 4th position
9943	TELMA retarder relay box control: 1st position
9944	Connection, electronic accelerator control unit terminal 18 to retarder control unit terminal 3
9946	TELMA retarder relay box control: 3rd position
9948	2nd supply, outside air intake door actuator and relevant warning lamp
9950	Trailer brake control solenoid valve (Germany) (trailer 7th current outlet pole)
9951	Differential lock solenoid valve supply
9952	Solenoid valve 1 supply, front axle levelling control
9953	Solenoid valve 2 supply, front axle levelling control
9954	Drive control solenoid valve supply
9955	Connection, electronic accelerator control unit terminal 26 to ABS/ASR control unit terminal 14
9956	Connection, electronic accelerator control unit terminal 27 to ABS/ASR control unit terminal 12
9957	Connection, electronic accelerator control unit terminal 28 to ABS/ASR control unit terminal 30
9958	Two-speed AR rear axle relay control
9959	Gas recirculation solenoid valve control (EGR)
9960	Engine rpm reducing solenoid valve (ASR or speed limiting device)
9961	ASR rh side solenoid valve
9962	ASR lh side solenoid valve
9963	Hydraulic converter on
9966	Supply of engine stopping and/or exhaust brake solenoid valve
9967	Supply of exhaust brake cutoff solenoid valve (ABS)
9968	Speed limiting device
9970	Speed limiting device (supply +15)
9971	Supply of solenoid valve for preventing jumps between speeds
9972	Supply of fuel delivery solenoid valve
9973	Supply of splitter control solenoid valve (normal gears)

9974 Supply of solenoid valve for preventing line jumps on the same level (ZF transmission)
9976 Pressure switch to be operated while shifting from normal to splitter gears
9977 Supply of hydraulic prebrake solenoid valve
9978 Supply of solenoid valve for adjusting fuel delivery according to altitude
9980 Vehicle air suspension system control (front)
9981 Vehicle air suspension system control (rear)
9982 Supply of rear axle levelling control solenoid valve no. 1
9983 Supply of front axle levelling control solenoid valve no. 2
9985 Tachograph - speed limiter realy
9988 Supply of accelerator lock solenoid valve
9990 Solenoid valve control, de-aeration duct door
9991 Vehicle speed induction sensor
9992 Supply of transmission splitter unit control
9993 Electromagnetic clutch supply (air-conditioning system)
9994 Solenoid valve control, draft tube door
9996 Pulse control (2-speed rear axle)
9997 Supply of splitter unit solenoid valve (splitter gears)
9999 —

(*) Dangerous cargo vehicles

4-DIGIT COMPONENT CODES

X3	On-board wiring junction block, automatic transmission
X4	On-board wiring junction block, automatic transmission
0012	Coupling
0013	6-way coupling, air-conditioning system
0015	Ashtray light
0047	Warning lamp, emergency gear engagement
0300	6-diode self-rectifying alternator
0301	9-diode self-rectifying alternator
0302	Self-rectifying alternator with voltage regulator
0600	Electronic voltage regulator for 6-diode alternator
0601	Electronic voltage regulator for 9-diode alternator
0602	Electronic voltage regulator integral to the alternator
0630	Voltage regulator overvoltage protection device
0800	Starter motor
0830	Device for inhibiting vehicle starting with engine running and starting repetition
1200	Motor for windscreen defrosting heater
1201	Motor for internal aerators
1202	Motor for engine compartment ventilation
1203	Motor for forced ventilation
1204	Motor for rh power window
1205	Motor for refrigerator
1206	Motor for internal heater
1207	Motor for ventilation of permanent duct
1208	Motor for ventilation of draft duct
1209	Motor for vehicle front internal heating
1210	Motor for vehicle rear internal heating
1211	Motor for air-conditioner evaporator
1212	Motor for air-conditioner capacitor
1213	Motor for driver's place ventilation
1214	Motor for driver's place heating
1215	Motor for driver's place defrosting/heating
1216	Motor for lh power window
1217	Motor for external air intake door/windscreen defrosting recirculation/driver's heating
1218	Motor for adjustable rearview mirrors
1219	Motor for ventilation of transmission oil radiator
1220	Motor for water circulation pump
1221	Swing door motor
1222	Motor for braking circuit oil pump
1223	Motor for front drive axle differential lock
1224	Motor for windscreen power blind
1225	Motor for headlight alignment control actuator
1226	Motor for added axle hydraulic pump

1227	Motor for cab tilting hydraulic pump
1228	Motor for sunroof
1229	Automatic chassis lubrication system component
1230	Modulating valve Roof-hatch motor
1231	Rear flap motor
1232	Motor for rear air expulsion flap
1400	Ignition distributor
1500	Ignition coil
1900	Spark plugs
2000	12V starting battery
2200	Volute electromagnetic horn
2201	Electronic horn
2202	Diaphragm electromagnetic horn
2203	Horn
2230	Electrodistributor for air horns
2400	Hydraulic braking and exhaust brake foot switch
2401	Telma retarder foot switch
2402	Load sensing switch under accelerator pedal
2403	Brake pedal valve 3-phase switch
2404	Retarder foot switch
2405	Sender unit on electronic accelerator pedal
2406	Accelerator pedal sender unit (AVS)
2500	Charging signal relay
2501	General Current Relay
2502	Combined isolator switch/relay
2503	Telma retarder control unit
2504	Delayed opening relay for keeping GCR (*) energized
2505	GCR with automatic circuit breaker
2506	Electronic relay for radiator water level signal0
2507	Relay with delayed NC contact for de-energizing GCR with engine off and safety devices turned on
2508	Relay for sound-controlled direction indicator light
2509	Relay for switching on rotary beacons
2510	Starting relay
2511	Pre-heating relay
2512	Rich mixture control relay
2513	Relay for high/low beam lights
2514	Relay for key reverse rotation inhibitor electromagnetic control
2515	Relay for accelerator lock while the vehicle is hydraulically operated
2516	Relay for trailer exhaust brake solenoid valve
2517	Relay for Webasto heater
2518	Relay for Webasto heater w/lamp
2519	Actuator for tractor/trailer direction indicator lights
2520	Actuator for hazard/direction indicator lights

2521	Relay for energizing General Current Relay
2522	Relay for exhaust brake solenoid valve
2523	Relay for engine compartment ventilation
2524	Relay for GCR cutoff
2525	Relay for enabling connection of rear fog lamps with high beam lights on
2526	Relay for air-conditioning system
2527	Relay for fog lights and for allowing connection of rear fog lights
2528	Relay for allowing excitation of 6-diode self-rectifying alternator
2529	Relay for capacitor motor
2530	Relay for internal heating motors
2531	Relay for loading light
2532	Relay for headlight wiping/washing unit
2533	Relay for rotating beacons
2534	Relay for lamp test
2535	Relay for cab tilted and gear engaged sound signal
2536	Relay for connnection of water recirculation pump during vehicle starting
2537	Relay for allowing direct drive at low speed
2538	Relay for stopping vehicle with doors open
2539	Relay for connection of stop request w/lamp
2540	Relay for hazard lights
2541	Actuator for tractor/trailer right direction indicator lights
2542	Actuator for tractor /trailer left direction indicator lights
2543	Relay for fog lamps and for allowing connection of rear fog lamps
2544	Relay for connection of stop request w/lamp
2545	Relay for stopping vehicle and closing doors
2546	Relay for lamp test
2547	Relay for allowing gear engagement with brake pedal fully depressed
2548	Relay for connection of parking and low beam lights with running
2549	Relay for connection of electrical retarder
2550	Relay for fog headlights
2551	Relay for windscreen defrosting by means of Webasto heater
2552	Relay for headlamp washer/wiper unit
2553	Relay for switching on low beam lights with high beams on
2554	Flasher light relay
2555	Relay for allowing connection of rear fog lamps with high beam lights on
2556	Relay for connection of main generator w/lamp and for allowing connection of air-conditioning system with engine running
2557	Relay for remote starting with cab uncoupled and for starting from driving place with cab coupled up
2558	Relay for allowing remote starting with cab uncoupled
2559	Relay for 2-speed rear axle or 2x5 speed transmission
2560	Relay for turning off stop request w/lamp with doors open
2561	Relay for turning off direction indicator flasher light in emergency condition
2562	Relay for allowing connection of exhaust brake solenoid valve
2563	Relay for allowing connection of air-conditioning system with engine running

2564 Relay for stop request single-tone bell
2565 Relay for turning off fog lamps with high beam lights on
2566 Relay for light black-out
2567 Relay for turning off fog lamps with low beam lights on
2568 Relay for allowing engine remote starting
2569 Relay for turning off forced ventilation at high speed
2570 Relay for turning off Webasto from safety control unit
2571 Relay for turning off GCR with ignition key and/or external lights on
2572 Relay for opening deaeration door with outside air intake door open
2573 Relay for inhibiting exhaust brake connection while the vehicle is hydraulically operated
2574 Relay for inhibiting defroster connection by means of igntition key with Webasto on
2575 Relay for stopping engine with gears engaged and low air pressure in suspension system
2576 Relay for inhibiting door opening with vehicle running
2577 Speed limiter relay
2578 Relay for allowing reverse gear engagement with vehicle stationary
2579 Relay for fan belt broken w/lamp and buzzer
2580 Relay for connection of ventilation motors in permanent duct
2581 Relay for connection of ventilation motors in diffuser duct
2582 Relay for connection of interior/front heating motors/1st speed
2583 Relay for connection of interior/rear heating motors/2nd speed
2584 Engine stopping relay
2585 Relay for de-energizing alternator with GCR open
2586 Relay for inhibiting exterior lighting with GCR open and battery+ earthed
2587 Relay for enablement of vehicle starting with transmission in neutral
2588 Relay for turning on stop request signal light
2589 Relay for keeping no.2588 above energized
2590 Relay for connection of rear fog lamps with low beamlights on
2591 Relay for tachograph supply
2592 Relay for starting from ground with parking brake on and from cab with engine door closed
2593 Relay for turning on interior lighting
2594 Relay for turning on interior lighting with safety control on
2595 Relay for engaging normal/splitter gears
2596 Relay for keeping Webasto earthed with isolator switch off
2597 Relay for inhibiting gear engagement withair suspensions unloaded
2598 Relay for connection of number plate lights
2599 Relay for supply of Webasto heater through the timer
2601 Relay for connection of foul air intake motors
2602 Relay for connection of foul air intake motors
2603 Relay for connection of foul air intake motors
2604 Relay for connection of air expulsion front flap motors
2605 Relay for connection of air expulsion rear flap motors
2606 Service relay for rear outside air intake flaps when air- conditioning system is set in operation
2607 Delayed closing relay for rear outside air intake flaps when air-conditioning system is set in operation
2608 Relay for turning off air intake motors when air-conditioning system is set in operation

2609	Relay for allowing connection of internal heating
2610	Relay for allowing connection of conditioned air
2613	Relay
2614	Relay
2615	Relay for enablement of forced ventilation
2616	Relay for enablement of forced ventilation and conditioned air with engine running
2617	Relay for enablement of ventilation
2618	Relay for enablement of individual ventilation
2619	Relay for allowing connection of ventilation motors in 1st speed (40 A)
2620	Relay for allowing connection of ventilation motors in 1st speed (40 A)
2621	Relay for allowing connection of ventilation motors in 1st speed (40 A)
2622	Relay for allowing connection of ventilation motors in 2nd speed (40 A)
2623	Relay for allowing connection of ventilation motors in 2nd speed (40 A)
2624	Relay for allowing connection of ventilation motors in 2nd speed (40 A)
2625	Relay for connection of individual ventilation motors (40A)
2626	Relay for allowing air intake through the ventilation control device
2627	Relay for allowing rear outside air intake flaps (minimum opening)
2628	Relay for connection of rear internal flap motors
2629	Relay for connection of A/C capacitor motors
2630	Relay for connection of A/C capacitor motors
2631	Relay for connection of A/C capacitor motors
2632	Relay for connection of A/C capacitor motors
2633	Relay for connection of A/C capacitor motors
2634	Relay for switching on compressor
2635	Relay for switching on compressor
2636	Compressor enablement relay
2637	Compressor enablement relay
2638	Relay for electric heater smog control
2640	Relay, solenoid valve for stopping water delivery to electric heater compartment
2642	Relay, solenoid valve for stopping water delivery to electric heater compartment
2644	Relay, solenoid valve for stopping water delivery to electric heater compartment
2800	Fuel enrichment jet solenoid
2801	Key rotaton inhibiting solenoid
2802	Engine stopping electromagnet
2803	Electric starter electromagnet
2804	Electromagnet for engaged gear signal on clutch pedal (AVS)
2909	Hitched up cab component (E15) for rh/lh roof rotary beacon
3000	Driving and traffic beam headlight
3001	Front headlight cluster (driving and traffic/parking and turn signal lights/thermal glass)
3002	Driving and traffic beam with built-in parking light
3003	High beam light Parking lights
3004	Front headlight cluster (driving and traffic/parking and turn signal lights/trim control)
3005A	Low/high beam light with parking light (low beam)

3005B	Low/high beam light with parking light (high beam)
3005C	Low/high beam light with parking light (parking)
3005E	Headlight alignment control actuator
3030	Fog headlight
3031	Blackout light
3032	Snowplough light
3033	Front headlight cluster (driving lights, fog lights)
3100	Front/side turn signal repeater
3200	Front parking and turn signal light
3201	Fraont parking light
3202	Front turn signal light
3203	Front marker light
3204	Front marker/turn signal side repeater
3220	Front BO light
3221	Front BO marker light
3222	Rotary beacon
3300	Side parking and turn signal light
3301	Side turn signal light
3302	Auxiliary turn signal light (max 42W)
3303	Side turn signal and gabarit light
3305	Side headlight system -side parking light
3400	Tail headlight cluster (parking/turn signal/stop)
3401	Tail headlight cluster (parking/turn signal/stop/reverse)
3402	Tail headlight cluster (BO parking/stop)
3403	Tail headlight cluster (parking/turn signal/stop/reverse/rear fog)
3404	Tail headlight cluster (parking/turn signal/stop/reverse/rear fog/number plate)
3405	Tail headlight cluster (parking/stop/number plate)
3406	Tail headlight cluster (parking/stop)
3407	Tail headlight cluster (parking/turn signal/stop/rear fog)
3408	Tail headlight cluster (parking/turn signal/stop/rear fog/number plate)
3409	Tail headlight cluster (BO parking/stop/turn signal)
3410	Tail parking light
3411	Tail stop light
3412	Tail turn signal light
3414	Tail lamp / turn indicator light / stop light / backup light / fog guard lights /clearance light / number plate light
3415	Tail lamp / turn indicator light / stop light / backup light / fog guard lights /clearance light / number plate light
3420	Tail marker light
3421	Loading lamp
3422	Reversing light
3423	Tail fog light
3424	BO tail marker light
3425	BO tail cross light

3426	BO stop light
3500	Number plate light
3600	Cab interior ceiling lamp
3601	Cab rear ceiling lamp
3602	Bunk ceiling lamp
3603	Steps spotlight
3604	Engine compartment spotlight
3605	Luggage compartment light
3606	Driver's place ceiling lamp
3607	Blue lights ceiling lamp
3608	Interior incandescence ceiling lamp
3609	Reading lamp
3610	Map light
3611	Interior incandescence ceiling lamp
3612	Route sign fluorescent ceiling light
3613	Front door steps spotlight
3614	Centre door steps spotlight
3615	Rear door steps spotlight
3616	Route sign ceiling light
3617	Cab interior swivel spotlight
3618	Conductor's seat spotlight
3619	Engine oil level spotlight
3620	Cab interior swivel spotlight
3621	Blue/normal light ceiling lamp
3622	Tooling compartment roof lamp
3700	Front/rear marker light
3701	Front marker light
3702	Front/rear marker light
3703	Front/rear identification light
3704	Rear marker light
3705	Side market light
3900	Symbol light
3901	Instrument light
3902	Stop request signal light (centre door)
3903	Stop request signal light (front door)
3904	Gear shift lever symbol light
3905	Heater lever symbol light
3906	EXIT sign light
3907	Cigar lighter light
4000	Dual-purpose mechanical tachometer
4001	Dual-purpose mechanical tachometer with high speed warning lamp
4002	Electronic tachometer
4010	Daily mechanical tachograph (1 driver/EEC)
4011	Daily mechanical tachograph (2 drivers/EEC)

4012 Daily mechanical tachograph (1 driver/EEC)
4013 Daily mechanical tachograph (2 drivers/EEC)
4014 Weekly mechanical tachograph (2 drivers/EEC)
4015 1-driver mechanical tachograph with speed limiter current outlet
4016 Mechanical tachograph with speed limiter current outlet with high speed warning lamp
4030 Sender unit for electronic tachometer
4031 Sender unit for electronic tachograph
4040 Signal amplifier for speed pulse
4041 Signal converter for tachometer
4042 Electronic adapter for tachometer
4043 Reduction unit for tachograph (dangerous cargo vehicles)
4100 Mechanic mile counter with double odometer
4101 Mechanic mile counter with double odometer and warning lamp signaling dangerous speed
4102 Electronic mile counter
4110 Daily mechanical mile tachograph (1 driver/EEC)
4111 Daily mechanical mile tachograph (2 drivers/EEC)
4200 Engine oil pressure gauge
4201 Brake system air pressure gauge
4202 Engine oil pressure gauge with built-in w/lamp
4203 Front brake system air pressure gauge with built-in w/lamp
4204 Rear brake system air pressure gauge with built-in w/lamp
4205 Dual-reading front/rear brake system air pressure gauge
4206 Front brake system air pressure gauge
4207 Rear brake system air pressure gauge
4208 Dual-reading front brake system air pressure gauge
4209 Dual-reading rear brake system air pressure gauge
4210 Absolute pressure gauge (EGR)
4230 Sender unit for front brake system air pressure gauge
4231 Sender unit for rear brake system air pressure gauge
4232 Sender unit for engine oil pressure gauge
4233 Sender unit for brake system air pressure gauge
4234 Sender unit for front brake system moderate air pressure gauge
4235 Sender unit for rear brake system moderate air pressure gauge
4236 Absolute pressure sensor (EGR)
4237 Static sender unit, engine oil pressure gauge
4400 Fuel level indicator
4401 Fuel level indicator with built-in w/lamp
4410 Engine oil level indicator
4415 Engine oil topup indicator
4500 Control, fuel level indicator
4501 Control, fuel level indicator with w/lamp contact
4510 Control, engine oil level indicator
4520 Control, brake fluid level indicator
4521 Control, clutch fluid level indicator

4522 Control, windshield washing fluid level indicator
4523 Control, radiator water level indicator
4524 Control, power steering oil level indicator
4525 Control, rear brake fluid level indicator
4526 Control, front brake fluid level indicator
4527 Control, power steering oil level indicator (3rd axle)
4530 Control, reserve reservoir water level indicator
4538 Sender unit, engine oil pressure gauges
4700 Thermometer, engine coolant termperature
4701 Thermometer, converter oil temperature
4702 Thermometer, crankcase temperature
4703 Thermometer, engine coolant termperature with built-in w/lamp
4704 Thermometer, transmission oil temperature
4705 Thermometer, engine oil temperature with built-in w/lamp
4710 Thermometer, external temperature
4716 Quartz clock
4717 Digital clock
4730 Sender unit, engine coolant termperature thermometer
4731 Sender unit, crankcase temperature thermometer
4732 Sender unit, converter oil temperature thermometer
4733 Sender unit, engine oil temperature thermometer
4734 Sender unit, transmission oil temperature thermometer
4736 Sender unit, external temperature thermometer
4737 Engine coolant temperature (EGR)
4800 Mechanical rev counter
4801 Mechanical rev counter module with engine overspeeding signalling device
4802 Electronic rev counter module
4803 Mechanical rev counter module with engine overspeeding signalling device
4804 Electronic rpm meter
4805 Mechanical rpm meter
4806 Electronic rpm meter with built-in instrument light dimmer
4830 Sender unit, electronic rpm meter
4831 Rpm meter inductive sender unit
4832 T.D.C. electromagnetic sensor
4833 Rpm sensor (AVS)
4834 Engine rpm fault diagnosis sensor (n=1/1)
4835 Engine rpm fault diagnosis sensor (n=1/2 on injection pump)
4836 Output rpm sensor (AVS)
4900 Battery charge indicator
4901 Power unit operation hour counter
4902 Compressor operation hour counter
4903 Inclinometer
4904 Voltmeter
5000 Combined module, FIAT engine vehicles

5001 Combined module, KHD engine vehicles
5002 Instrument module, FIAT engine vehicles
5003 Instrument module, KHD engine vehicles
5004 Combined module, medium weight FIAT engine vehicles
5005 Combined module, medium weight KHD engine vehicles
5020 Switch, central emergency unit control
5030 9-reading multiple instrument
5141 Switch, power take-off on
5200 Switch, windshield defrosting electric heater
5201 Switch, Webasto heater
5202 Switch, heated rearview mirrors
5203 Switch, fog lights
5204 Switch, rear fog lights
5205 Switch, loading lamp
5206 Switch, fuel boost device and preheating
5207 Switch, stop request enablement
5208 Switch, internal aerators
5209 Switch, exhaust brake enablement
5210 Switch, vehicle front raising system
5211 Switch, vehicle rear raising system
5212 Switch, front headlight cluster thermal lens
5213 Switch, rotary beacons
5214 Switch, refrigerator
5215 Switch, driver's light
5216 Switch, blue internal lights
5217 Switch, heating from engine
5218 Switch, reading lights
5219 Switch, forced ventilation
5220 Switch, internal heating
5221 Switch, rear interior heating
5222 Switch, air-conditioning system control
5223 Switch, power take-off
5224 Switch, driver's place ventilation
5225 Switch, windshield
5226 Switch, external lights
5227 Switch, release of vehicle operation with doors open
5228 Switch, conductor's place light
5229 Switch, interior lighting
5230 Switch, front brake system air pressure
5231 Switch, rear brake system air pressure
5232 Switch, engine oil pressure
5233 Switch, parking brake on
5234 Switch, hydraulic drive
5235 Switch, trailer exhaust brake

5236 Switch, converter oil pressure
5237 Switch, air suspension system failure
5238 Switch, body tilted
5239 Switch, brake system failure
5240 Switch, air cleaner restriction
5242 Switch, brake system pressure drop
5243 Switch, 2x5 transmission or 2-speed rear axle (gear shift lever)
5244 Enablement switch, low air pressure circuit
5245 Enablement switch, high air pressure circuit
5246 Switch activated on its own when shifting from normal to splitter gears
5247 Switch, partial/total centre axle unload solenoid valve
5248 Switch, exhaust brake on
5249 Switch, transmission low air pressure
5250 Switch, reversing light
5251 Switch, trailer uncoupled
5252 Switch, cab unlatched (hydraulic control)
5253 Switch, cab unlatched (mechanical control)
5254 Switch, accelerator lock prearrangement (hydraulic drive)
5255 Enablement switch, hydraulic braking system and exhaust brake
5256 Switch, stop
5257 Switch, cab interior lighting
5258 Switch, start inhibiting from engine compartment with gear engaged
5259 Switch, cross differential lock
5260 Switch, longitudinal differential lock
5261 Switch, clutch control device, 2x5 speed transmission
5262 Switch, front door open
5263 Switch, rear door open
5264 Enablement switch, normal/splitter gears
5265 Enablement switch, internal aerator
5266 Switch, engine compartment light
5267 Switch, luggage compartment light
5268 Switch, exhaust brake
5269 Enablement switch, exhaust brake (transmission)
5270 Switch, power take-off on
5271 Switch, speed lmiting device (4th speed)
5272 Enablement switch, 2-speed rear axle, electrical load sensing valve
5273 Switch, clutch wear
5274 Enablement switch, exhaust brake (under clutch pedal)
5275 Switch, speed limiting device (splitter gears)
5276 Switch, fan belt broken
5277 Switch, start inhibiting from engine compartment with parking brake off
5278 Switch, transmission in neutral
5279 Enablement switch, gear engagement
5280 Main current switch

5281 Speedometer switch, high switch w/lamp
5282 Speedometer switch, egine overspeeding bell
5283 Thermometer switch, engine coolant temperature
5284 Thermometer switch, engine oil temperature
5285 Thermometer switch, crankcase temperature
5286 Thermometer switch, converter oil temperature
5287 Thermometer switch, engine compartment ventilation system failure
5288 Thermometer switch for switching on engine compartment ventilation system
5289 Thermometer switch, recirculation water temperature
5290 Speed switch,Telma retarder connection enablement
Speed switch, driver's door lock enablement
5291 Thermometer switch, interior heating motors
5292 Speedomenter switch, exhaust brake enablement
5293 Speedomenter switch, ventilation cutoff at high speed
5294 Thermometer switch, front interior heating motors
5295 Thermometer switch, rear interior heating motors
5296 Switch, internal aerators control
5297 Thermometer switch, transmission oil temperature
5298 Thermometer switch, fan belt broken
5299 Thermometer switch, transmission oil cooling motor
5300 Pushbutton, warning lamp test
5301 Pushbutton, headlight wiping/washing unit
5302 Pushbutton, antiskid operation check
5303 Pushbutton, engine stopping
5304 Pushbutton, windshield washing unit
5305 Pushbutton, headlight washing unit
5306 Pushbutton for side window resistors
5307 Pushbutton for allowing engagement of reverse gear
5308 Pushbutton for right door window with built-in w/lamp
5309 Pushbutton for headlamp washer unit with built-in w/lamp
5310 Pushbutton for preventing gear engagement with low air pressure in suspension system
Pushbutton, gear engagement enablement
5311 Pushbutton with built-in w/lamp for allowing engine starting with ether
5312 Pushbutton for engine starting with ether
5313 Pushbutton for vehicle starting bell
5314 Pushbutton for service door mechanical lock resetting solenoid valve
5315 Pushbutton for windscreen power blind
5316 Pushbutton for vehicle alignment control (travelling condition)
5317 Pushbutton for added axle lifting/lowering system
5318 Pushbutton, starting assistance
5319 Pushbutton for luggage compartment doors
5320 Dual pushbutton for vehicle raising (front)
5321 Dual pushbutton for vehicle raising (rear)
5322 Sunroof pushbutton

5323 MEMORY/OFF switch
5324 Speed increase/decrease switch (EDC)
5325 'RESET'/ 'TEST' pushbutton, centralized and additional lubrication
5326 Dual pushbutton for centralized door closing system
5327 Roller blind component
5330 Pushbutton for engine preheating and starting selector switch
5331 Pushbutton for engine starting from engine compartment
5332 Pushbutton for stopping engine from engine compartment
5333 Pushbutton for stopping swing door motor (clockwise)
5334 Pushbutton for stopping swing door motor (counterclockwise)
5335 Pushbutton, G.C.R. closing
5336 Pushbutton, G.C.R. opening
5337 Pushbutton for front door control with built-in w/lamp
5338 Pushbutton for rear door control with built-in w/lamp
5339 Pushbutton for refilling compensation tank through water recirculating pump
5340 Stop request pushbutton
5341 Hostess call pushbutton
5342 Pushbutton for electropneumatic horns
5343 Power window pushbuttom
5344 Pushbutton for de-energizing G.C.R. and connecting alternator D+ to earth
5345 Pushbutton for centre door control with built-in w/lamp
5346 Multiple lamp test pushbutton
5347 Pushbutton for supply of key reverse rotation inhibitor solenoid with G.C.R. open
5348 Front door pushbutton
5349 Centre door pushbutton
5350 Rear door pushbutton
5351 Pushbutton for control of rear door from conductor's place
5352 Pushbutton for control of front door from outside
5353 Pushbutton for closing G.C.R. and earthing of delayed G.C.R. cutout relay
5354 Pushbutton for preheating and rich mixture control
5355 Pushbutton panel for automatic transmission gear control
5356 Pushbutton for lh power window
5357 Pushbutton for control of front door with symbol light
5358 Pushbutton for control of centre door with symbol light
5359 Pushbutton for control of rear door with symbol light
5360 Pushbutton for display of engine oil level
5361 N.O. safety pushbutton for swing door system
5362 N.C. safety pushbutton for swing door system
5363 Pushbutton panel for swing door system
5364 Pushbutton for enabling vehicle operation with doors open
5365 Pushbutton for fault diagnosis with chassis levelling adjustment control
5366 Pushbutton for energizing exhaust brake cutout relay at low speed
5367 Pushbutton for cab tilting servo system
5368 Pushbutton, EDC fault diagnosis TEST

5369 Pushbutton, front grille open signal, cab tilting servo system
5370 Pushbutton, engine stopping from engine compartment
Front left-hand side pushbutton, driver's light
5380 Rear flap limit switch
5400 Switch for external air intake door motor
5401 Switch for complete bus sign motor
5402 Switch for high/low/flasher lights
5410 Key switch for normal/reduced gear engagement solenoid valve
5411 General current switch
5412 Stop signal switch
5413 Switch for parking brake w/lamp and vehicle operation with doors open
5420 8-function steering column switch
5421 4-function steering column switch
5422 5-function steering column switch
5423 6-function steering column switch
5500 Electric/air horn switch
5501 MAX/MIN Webasto heater switch
5502 Automatic/manual Telma retarder connection switch
5503 Interior lighting switch
5504 Forced ventilation and air-conditioning switch
5505 Switch for hazard lights with built-in w/lamp
5506 Windscreen wiper switch
5507 Switch for turning on external lights with G.C.R. off
5508 Switch for controlling front door from inside/outside
5509 Switch for controlling rear door from driver's/conductor's place
5510 Switch for fog lights and release of rear fog lights
5511 Switch with built-in w/lamp, fog lights and rear fog lights enablement
5512 Driver's ventilation switch
5513 Retarder connection switch
5514 Exterior lighting switch
5515 Hazard lights switch
5516 2-function switch: a) direction indicator lights b) horn pushbutton
5517 2-function switch: a) windscreen wipers b) windscreen washer unit
5518 Normal/blue interior lighting switch
5519 Blackout light switch
5520 Safety unit switch
5521 Adjustable rearview mirror switch
5522 Driver's place heating switch
5523 Switch, headlight trim control
5524 Air-operated emergency battery disconnector, dangerous cargo vehicles (France)
5525 Switch for disconnection of G.C.R. and earthing of alternator D+
5526 Switch for disconnecting G.C.R. and de-energizing alternator
5530 Automatic transmission switch
5535 Switch for headlamp alignment adjustment device

5540 Switch, blue lights and overhead luggage compartment lights
5600 Ignition switch
5601 Ignition switch, steering lock
5602 Ignition switch, starting and preheating device
5603 Ignition switch , starting/preheating/steering lock
5604 Ignition switch for allowing starting with doors closed
5620 Starting lever switch
5621 Starting and preheating lever switch
5630 Lever switch for connection of Telma retarder with 2-light intensity level w/lamp
5631 Telma retarder lever switch
5632 Heating system lever switch
5633 Ventilation system lever switch
5634 Retarder lever switch
5635 E-GAS lever switch
5730 5-function steering column unit
5800 36-optical indicator panel
5801 36-optical indicator panel (MD custom-made)
5802 36-optical indicator panel (FIAT custom-made)
5803 10-optical indicator panel (lights/engine/cab tilting)
5804 10-optical indicator panel (brakes/engine)
5805 10-optical indicator panel (transmission/miscellaneous applications)
5815 Optical indicator panel (military vehicles)
5817 Trapdoor opening w/lamp
5818 Luggage compartment door w/lamp
5819 Lubrication w/lamp
5820 Tractor antiskid system failure w/lamp
5821 Battery charging failure w/lamp
5822 Preheating w/lamp
5823 Brake lining pre-wear w/lamp
5824 Brake lining total wear w/lamp
5825 Clutch wear w/lamp
5826 Engine oil temperature w/lamp
5827 Air suspension system failure w/lamp
5828 Brake system failure w/lamp
5829 Parking brake engaged w/lamp
5830 Engine coolant/engine oil/brake air pressure w/lamp repeater
5831 Air cleaner restriction w/lamp
5832 General lighting on w/lamp
5833 Stop requestw/lamp
5834 Tractor turn signal on lights w/lamp
5835 Trailer turn signal on lights w/lamp
5836 Hazard lights on w/lamp
5837 Heated rearview mirror w/lamp
5838 Vehicle front raising w/lamp

5839 Vehicle rear raising w/lamp
5840 Refrigerator w/lamp
5841 Forced ventilation w/lamp
5842 Heating through KHD engine w/lamp
5843 Webasto heating system w/lamp
5844 Telma retarder on w/lamp
5845 Rear fog light w/lamp
5846 High beam lights on w/lamp
5847 Exhaust brake w/lamp
5848 Front headlight cluster heated lens w/lamp
5849 Interior heating w/lamp
5850 Engine compartment ventilation system failure w/lamp
5851 Internal aeration motors w/lamp
5852 Auxiliary generator failure w/lamp
5853 Doors open w/lamp
5854 Engine oil temperature w/lamp
5855 Driver's ventilation w/lamp
5856 Windscreen defrosting heater w/lamp
5857 Engine oil pressure w/lamp
5858 Front brake air pressure w/lamp
5859 Rear brake air pressure w/lamp
5860 Transmission oil low pressure w/lamp
5861 Transmission oil pressure w/lamp
5862 Transmission oil pressure w/lamp
5863 Transmission in neutral w/lamp
5864 Air suspension system failure w/lamp repeater
5865 Engine oil pressure w/lamp repeater
5866 Brake air pressure w/lamp repeater
5867 Air-conditioner cooling system failure w/lamp
5868 Air-conditioner cooling system regular operation w/lamp
5869 Air-conditioning system w/lamp
5870 Front door w/lamp
5871 Centre door w/lamp
5872 Rear door w/lamp
5873 Doors open w/lamp repeater
5874 Brake lining wear/parking brake failure w/lamp
5875 Brake system pressure drop w/lamp (ICP)
5876 Brake fluid level w/lamp
5877 Power take-off w/lamp
5878 Cab unlatched w/lamp
5879 G.C.R. automatic opening w/lamp
5880 Engine coolant temperature w/lamp
5881 Front left air suspension pressure w/lamp
5882 Front right air suspension pressure w/lamp

5883	Rear air suspension pressure w/lamp
5884	W/lamp for vehicle operation with doors open
5885	Driver's place ventilation w/lamp
5886	Windscreen defroster/driver's place heating w/lamp
5887	Radiator water level w/lamp
5888	Side window resistor w/lamp
5889	Engine compartment door w/lamp
5890	Vehicle raising w/lamp
5891	3rd axle up w/lamp
5892	Tilted body w/lamp
5893	Differential lock warning lamp
5894	Fan belt broken w/lamp
5895	Normal/splitter gears w/lamp
5896	Hydraulic converter brake w/lamp
5897	G.C.R. closed w/lamp
5898	Rotating beacons on w/lamp
5899	Cross differential lock w/lamp
5900	Direction indicator/hazard flasher light, double load
5901	Direction indicator/hazard flasher light, single load
5902	Bimetal direction indicator flasher light
5903	Bimetal emergency flasher light
5920	Bimetal front brake air pressure flasher light
5921	Bimetal rear brake air pressure flasher light
5922	Bimetal door opening flasher light repeater
5923	Seat belt circuit flasher light
5924	Bimetal water/oil/air flasher light repeater
5925	Booked stop flasher light
5926	Parking brake flasher light
5930	Windscreen wiper unit intermittent operation
6100	8-diode 12-way connector
6101	7-diode 12-way connector
6102	7-diode 12 way connector
6103	3-diode 5 way connector
6104	3-diode connector with common positive (1A)
6105	3-diode connector with common negative (1A)
6106	8-diode 12-way connector
6107	3-diode connector with common positive (3A)
6108	4-diode 7-way connector
6109	3-diode connector for cab/ground starting system
6110	4-diode connector for holding GCR energized
6111	4-diode holder container with common negative
6112	6A 1-diode holder container
6113	1A 1-diode holder container
6114	1-zener diode holder container

6115 2-diode holder container with common cathode
6116 4-diode 8-way holder container
6117 3A 1-diode holder container
6120 Preheating on signalling resistor
6121 Engine coolant temperature indicator compensating resistance
6122 Instrument light electronic dimmer
6123 Optical indicator electronic dimmer
6124 Heated rearview mirror
6125 Optical indicator and instrument light electronic dimmer
6126 Light instrument rheostat
6127 Current limiting resistance, tachograph supply
6128 Crankcase temperature indicator compensating resistance
6129 Thermal starter drop resistance
6130 Side window resistance
6131 12 V charging system drop resistance
6332 Current limiting resistance, thermal starter supply
6133 Resistance for driver's place ventilation motor
6134 Resistance for windscreen defroster motor
6135 Adjustable heated rearview mirror
6136 Heated adjustable rearview mirror and mirror washer unit
6137 Load increase resistance for side direction indicator lights
6138 Evaporator 2nd speed regulation rheostat
6139 Fuel heating resistance
6140 KSB ignition timer variable resistance
6141 Wide-angle heated rearview mirror
6142 Heated rearview mirror for wheels
6143 Wide-angle heated adjustable rearview mirror
6144 Adjustable heated parking rearview mirror
6145 Resistance for fuel filter heating
6146 Parallel resistance, battery charging failure
6147 Fuel preheating thermoresistance
6148 Driver's seat heating thermoresistance
6149 Co-driver's seat heating thermoresistance
6150 Diode preventing current return to solenoid valve for deaeration channel door
6151 Diode preventing current return to solenoid valve for permanent channel door (1/3 opening)
6152 Diode preventing current return to solenoid valve for water/oil heat exchanger
6153 Diodepreventing demagnetization of instruments and indicators
6154 Current return-preventing diode for front brake air pressure w/lamp
6155 Current return-preventing diode for rear brake air pressure w/lamp
6156 Current return-preventing diode for front door w/lamp
6157 Current return-preventing diode for centre door w/lamp
6158 Current return-preventing diode for rear door w/lamp
6159 Current return-preventing diode for cab unlatched w/lamp
6160 Diode for protection device

6161	Diode for keeping G.C.R. energized with heating system on
6162	Current return-preventing diode for battery charging failure w/lamp
6163	Neutral signal return-preventing diode upon operation of the emergency switch (automatic transmission)
6180	100 microfarad capacitor, delayed relay dump
6181	Capacitor for reduction of speed signal noise pulses
6190	Fuel heating thermoline
6191	Pre-resistor, windshield heating time relay
6192	Windshield heating thermoresistor
6193	Diodes resistors- rheostat, ASR proportioning solenoid valve (speed limiting device)
6194	Diodes resistors- temperature sensor replacer rheostat, pre-heating system
6400	Windshield washer electric pump
6401	Headlight washer electric pump
6500	FIAT type windscreen wiper unit
6501	Windshileld wiper unit (European type)
6502	Headlight wiper unit
6800	Radio receiver set
6801	Loudspeaker
6802	Antenna
6803	Radio receiver set - Tape recorder
6804	Preamplifier
6805	Microphone
6806	24V/12V power supply
6807	Amplifier - Power pack
6808	Microphone (driver)
6809	Microphone (hostess)
6810	Junction block, monitor/video camera supply
6820	Radio interference suppressor
6830	City Band transreceiver
7000	16 fuse carrier
7001	16 fuse carrier
7002	80A 1 power fuse carrier
7003	16A 2 power fuse carrier
7004	6 fuse carrier
7005	6 fuse carrier
7006	6 fuse carrier
7007	6 fuse carrier
7008	6 fuse carrier
7009	6 fuse carrier
7010	6 fuse carrier
7011	6 fuse carrier
7012	8 fuse carrier
7013	8 fuse carrier
7014	1 fuse carrier
7015	1 fuse carrier (10 A)

7016	10 fuse carrier
7017	10 fuse carrier
7018	12 fuse carrier
7019	12 fuse carrier
7020	2-way power fuse carrier (50 A)
7021	2-way power fuse carrier (1x25 A / 1x50 A)
7030	1-way fuse carrier (16 A)
7031	1-way fuse carrier (8 A)
7032	1-way fuse carrier (3 A)
7033	1-way fuse carrier (25 A)
7034	1-way fuse carrier (5 A)
7035	1-way fuse carrier (25 A)
7036	1-way fuse carrier (10 A)
7037	1-way fuse carrier (7.5 A)
7038	1-way fuse carrier (15 A)
7050	Automatic magnetothermal cutout
7060	6-way automatic switch carrier
7061	6-way automatic switch carrier
7062	6-way automatic switch carrier
7063	6-way automatic switch carrier
7064	6-way automatic switch carrier
7065	6-way automatic switch carrier
7066	6-way automatic switch carrier
7067	6-way automatic switch carrier
7068	6-way thermal cutout carrier
7069	6-way thermal cutout carrier
7070	6-way thermal cutout carrier
7071	6-way thermal cutout carrier
7072	6-way thermal cutout carrier
7073	6-way thermal cutout carrier
7074	6-way thermal cutout carrier
7075	6-way thermal cutout carrier
7200	Unipolar current outlet
7201	7-pole standard connector for electrical connection to trailer
7202	Auxiliary 7-pole standard connector for electrical connection to trailer
7203	Bipolar connector for 9-diode alternator harness knife switch with built-in RTE
7204	12-pole connector for electrical connection to trailer
7205	Remote starting bipolar current outlet
7206	Unipolar current outlet for infrared ray equipment
7207	7-pole connector for 12 V connection to trailer
7208	Bipolar current outlet
7209	Trailer-to-tractor antiskid coupling joint
7210	19-pole connector for tractor-to-trailer connection
7211	28-pole connector for tractor-to-trailer connection

7212 Fault diagnosis connector for ABS
7213 13-pole connector for tractor-to-trailer connection (dangerous cargo vehicles)
7215 15-pole tractor-to-trailer counnector
7216 Hostess light
7500 Central Interconnecting Unit
7505 Air horn control unit
7520 Front terminal board
7521 Centre terminal board
7522 Shunt terminal board
7800 Fuel delivery solenoid valve
7801 Solenoid valve for engaging normal and reduced speeds
7802 Solenoid valve for load sensing valve emergency operation with air suspension system failure
7803 Solenoid valve for accelerator lock (hydraulic drive)
7804 Solenoid valve for holding direct drive and hydraulic braking control
7805 Exhaust brake solenoid valve
7806 Fuel regulation solenoid valve (high altitude)
7807 Solenoid valve for connection of fuel tank to atmosphere (thermostarter)
7808 Front door solenoid valve
7809 Rear door solenoid valve
7810 Solenoid valve for engaging normal speeds
7811 Solenoid valve for engaging reduced speeds
7812 Solenoid valve, vehicle front raising system
7813 Solenoid valve, vehicle rear raising system
7814 Solenoid valve for horns
7815 Water - oil heat exchanger solenoid valve
7816 Cross differential lock solenoid valve
7817 Longitudinal differential lock solenoid valve
7818 Speed limiter solenoid valve
7819 Power takeoff solenoid valve
7820 Bell for engine overrevving
7821 Bell for front brake system low air pressure
7822 Bell for rear brake system low air pressure
7823 Bell for stop request
7824 Single-tone bell for hostess call
7825 Bell for fan belt broken
7826 Bell for G.C.R. open
7827 Single-tone bell for stop request
7828 Bell for transmission oil/engine coolant high temperature
7829 Bell forenginecoolant temperature/brake system air pressure/transmission oil
7830 Bell for seat belts unfastened
7831 Bell for maximum speed with all-wheel drive on
7832 Bell for layshaft overrevving with easyshift
7833 Bell for hostess call
7834 Vehicle lowering bell

7835 Bell for faulty trailer air compressor system
7836 24V thermostarter
7837 19 V preheating plugs
7838 12 V preheating plugs
7839 12 thermal starter
7840 Preheating sender
7846 Cigar lighter
7847 Fuel delivery electronic regulator (adjusts delivery to exhaust gas temperature)
7848 Thermocouple for exhaust gas temperature electronic regulator
7849 Vacuum indicator for fuel regulator solenoid valve (high altitude)
7850 Fluorescent ceiling spotlight for interior lighting
7851 Electrical load sensing valve for 2-speed rear axle
7852 Converter for interior lighting fluorescent light
7853 Fluorescent lamp converter for sign lighting
7854 Ceiling spotlight for sign lighting
7860 Solenoid valve for antipollution device (EGR)
7861 Solenoid valve for KSB device
7862 Solenoid valve for engine oil top up
7863 Solenoid valve for chassis automatic lubrication system pump
7870 Solenoid valve for low speed reducer unit
7871 Solenoid valve for high speed reducer unit
7872 Solenoid valve for two-speed rear axle
7873 Solenoid valve for permanent channel door
7874 Solenoid valve for diffuser channel door (1/3 opening)
7875 Solenoid valve for diffuser channel door
7876 Solenoid valve for deaeration channel door
7877 Solenoid valve for preventing jumps between speeds
7878 Solenoid valve for preventing line jumps
7879 Solenoid valve for partial/total centre axle unloading
7880 Solenoid valve for antiskid system
7881 Solenoid valve for allowing gear engagment
7882 Solenoid valve for hydraulic braking
7883 Solenoid valve for stopping vehicle with doors open
7884 Solenoid valve for centre door
7885 Solenoid valve for discharging air with forward gear engaged
7886 Engine stopping solenoid valve
7887 Solenoid valve for vehicle raising
7888 Solenoid valve for reverse gear clutch brake "action on the little surface of the piston"
7889 Solenoid valve for reverse gear clutch brake "action on the big surface of the piston"
7890 Solenoid valve for epicyclic train brake incorporating the turbine rotor
7891 Solenoid valve for pump wheel brake
7892 Solenoid valve for converter exhaust valve
7893 Solenoid valve for engaging input clutch
7894 Solenoid valve for engaging direct drive clutch

7895	Solenoid valve for reducing oil pressure
7896	Solenoid valve for differential lock
7897	Centre door limiting solenoid valve
7898	Centre door control solenoid valve
7899	Front door limiting solenoid valve
8000	ZF transmission
8001	Antiskid device
8002	Water Webasto heater
8003	Air Webasto heater
8004	Windshield defrosting electric heater unit
8005	Telma retarder
8006	Radio equipment
8007	Air-conditioning system
8008	Hydraulic converter
8009	Automatic transmission
8010	Drier
8011	EDC injection pump
8013	Compressor
8200	Water boiler
8205	Air boiler
8210	Metering device
8215	Electronic control unit
8219	Independent heater, electronic control and signalling unit
8220	Mechanical timer
8221	Electronic timer
8222	Ambient thermostat
8223	Webasto switch
8224	Preselector clock (independent heater)
8225	Auxiliary fuel pump
8230	Ignition coil
8235	Time solenoid valve (TV), heater water recirculation
8236	Time solenoid valve (TV), by-pass water recirculation
8240	Independent heating microswitch (water recirculation open)
8241	Independent heating microswitch (water recirculation open)
8250	Air-conditioning system control unit
8251	Ambient thermostat control unit
8252	Potentiometer control for setting electronic thermostat temperature
8253	Electronic thermostat temperature sensor
8254	Air-conditioning system control and signalling unit
8255	Air-conditioning system thermostat and switch
8260	Electromagnetic pulley
8261	Min pressure switches (drier filter)
8262	Max pressure switches (drier filter)
8265	Actuator for air-conditioning doors

8266 Switch with built-in w/lamps for door actuator
8270 Air-conditioning system microswitch (water recirculation closed)
8275 External temperature sensor (automatic air-conditioning system)
8276 Sun radiation sensor (automatic air-conditioning system)
8500 Brake shoe wear control unit
8501 Brake shoe wear sensors
8502 ZF transmission electronic control unit
8503 Vehicle speed inductive sensor
8504 Antiskid system control unit
8505 Antiskid system electronic control unit
8506 Antiskid system sensors
8507 Speed limiting device electronic control unit
8508 Speed limiter gearmotor
8509 Speed limiter frequency generator
8510 Automatic circuit breaker for G.C.R. cutout
8511 Route sign control unit
8512 Front bus number indicator
8513 Side bus number indicator
8514 Automatic transmission electronic control unit
8515 Preheating system electronic control unit
8516 Ticket punching machine
8517 Vehicle stationary signalling device
8518 Vehicle speed sender
8519 Amperometric transformer for automatic G.C.R. circuit breaker
8520 12 V charging system device
8521 12 V system for trailer supply
8522 Service hour counter
8523 Rich mixture control unit
8524 Radiator water level electronic control unit
8525 Radiator water level signalling sensor
8526 Engine oil level electronic control unit
8527 Radiophone
8528 Pre/after heating control unit
8529 Antiskid safety electronic control unit
8530 Antiskid information electronic control unit (infomodul)
8531 Water in fuel filter electronic control unit
8532 Water in fuel filter signalling sensor
8533 Engine supply load sender
8534 Swing door control unit
8535 Reatrder electronic control unit
8536 Air pressure sender for retarder control unit
8537 Oil pressure sender for retarder control unit
8538 Retarder control unit water temperature sender
8539 Adjustable rearview mirror control

8540 Differential lock control unit
8541 Front axle break lining wear circuit sensors
8542 Rear axle break lining wear circuit sensors
8543 IVECO Control display
8544 IVECO Control electronic control unit (tractor)
8545 IVECO control electronic control unit (trailer)
8546 Control unit for turning on low voltage low beam lights
8547 Failure signalling control unit with bell
8548 Electronic accelerator actuator motor
8549 Electronic accelerator control unit
8550 Chassis levelling control unit
8551 Rear axle stroke sender with chassis levelling adjustment unit
8552 Front axle left-hand side stroke sender with chassis levelling adjustment unit
8553 Front axle right-hand side stroke sender with chassis levelling adjustment unit
8554 Layshaft inductive sender
8555 Cooling fan adjustment control unit (hydrostatic)
8556 Cooling fan adjustment thermistor
8557 Antipollution device control unit (EGR)
8558 Tachograph signal amplifier
8559 Cardan shaft rpm inductive sender
8560 Cardan shaft rpm signal amplifier
8561 Rear axle brake system cooling fluid temperature control unit
8562 Automatic chassis lubrication system control uni
8563 Engine oil automatic topup control unit
8564 Drive axle lh pressure sensor (ECAS)
8565 Drive axle rh pressure sensor (ECAS)
Min/Max pressure switch (compressor no. 1)
8566 Lift axle lh pressure sensor (ECAS)
Min/Max pressure switch (compressor no. 2)
8567 Lift axle rh pressure sensor (ECAS)
8568 ECAS remote control
8569 Electronic accelerator motor (AVS)
8570 EDC control unit
8571 Accelerator load sensor (EDC)
8572 Coolant temperature sensor (EDC)
8573 Turboblower air temperature sensor (EDC)
8574 Turboblower air pressure sensor (EDC)
8575 Roller blind motor electronic control unit
8576 Steering system oil hydraulic flow indicator (1st circuit)
Steered wheels sensor
8577 Steering system oil hydraulic flow indicator (2nd circuit)
8581 ECAS component, 6x2c chassis levelling control
8582 ECAS component, 6x2c chassis levelling control
8583 ECAS component, 6x2c chassis levelling control

8601 Centralized door locking unit component
8602 Engine compartment high temperature control unit
8603 Engine compartment high temperature sensor
Check and control unit, centralized lubrication
8610 Single-tone electronic control unit
9000 Retarder w/lamp
9001 W/lamp for gear engaged with low air pressure in suspension system
9002 Engine compartment temperature w/lamp
9003 Fuel reserve w/lamp
9004 Ticket punching machine w/lamp
9005 Radiophone w/lamp
9006 Signs on w/lamp
9007 After heating w/lamp
9008 Engine overrevving w/lamp
9009 Seat belts unfastened w/lamp
9010 Trailr antiskid w/lamp
9011 Trailer without antiskid w/lamp
9012 Air filter restriction w/lamp
9013 Crankcase high temperature w/lamp
9014 Water in fuel filter w/lamp
9015 Stop brake w/lamp
9016 Complete bus sign displayed w/lamp
9017 Clutch fluid level w/lamp
9018 Pre/after heating w/lamp
9019 Braking circuit low oil pressure w/lamp
9020 Front axle brake lining wear w/lamp
9021 Rear axle brake lining wear w/lamp
9022 Power steering circuit failure w/lamp
9023 Radio receiver w/lamp
9024 Rear axle steering wheels locked w/lamp
9025 Second power steering circuit failure w/lamp
9026 Parking brake air pressure w/lamp
9027 Driver's place heating w/lamp
9028 Loading light w/lamp
9029 Front suspension air pressure w/lamp
9030 Vehicle lowering w/lamp
9031 Antiskid on w/lamp
9032 All-wheel drive w/lamp
9033 Rear door w/lamp
9034 Fuel heating w/lamp
9035 Max speed with all-wheel drive on w/lamp
9036 Fuel heating w/lamp
9037 Electronic accelerator alarm w/lamp
9038 ASR w/lamp

9039	Chassis levelling adjustment failure w/lamp
9040	Irregular level w/lamp (ELF)
9041	Reading lights on w/lamp
9042	Transmission oil filter restriction w/lamp
9043	Alarm intermittent operation w/lamp
9044	Windshield washing fluid level w/lamp
9045	Doors closed w/lamp
9046	Brake pressure w/lamp
9047	Traffic beam headlight w/lamp
9048	Front axle w/lamp (ELF)
9049	Rear axle with ELF w/lamp
9050	Brake fluid w/lamp
9051	Speed limiter failure w/lamp
9052	Starting assistance w/lamp (3rd axle unloading)
9053	W/lamp, cistern rail, dangerous cargo vehicles (France)
9054	Trailer air compressor system failure w/lamp
9055	3rd axle hydraulic steering system w/lamp
9056	Speed limiter failuer w/lamp
9057	Snow chains w/lamp
9058	Auxiliary heater failure w/lamp
9060	Air suspension pressure w/lamp
9061	Automatic chassis lubrication system on w/lamp
9062	Automatic chassis lubrication system failure w/lamp
9200	Switch for cross differential lock
9201	Switch for instrument light
9202	Switch for allowing direct drive at low speed
9203	Switch for vehicle operation with doors close
9204	Switch for windscreen defroster or driver's place heating
9205	Switch for driver's place heating
9206	Vehicle raising switch
9207	Switch for hydraulic braking cutout
9208	Switch with built-in w/lamp for preheating and rich mixture control
9209	Switch with built-in w/lamp for loading light
9210	Switch with built-in w/lamp for rear fog light
9211	Switch for side heated window
9212	Switch with built-in w/lamp for power takeoff
9213	Switch with built-in w/lamp for heated rearview mirrors
9214	Switch with built-in w/lamp for Webasto heater
9215	Switch for brake spring cylinder actuator solenoid valve
9216	Switch for route signs
9217	Switch for route sign light with symbol lighting lamp
9218	Switch for cutting out gear engagement inhibiting device with low air pressure in suspension system
9219	Switch for snowplough headlights
9220	Switch for cutout of rich mixture control solenoid

9221 Switch for swivel interior lighting ceiling spotlight
9222 Switch with built-in w/lamp for windscreen defrosting heater
9223 Switch wiht built-in w/lamp for instrument lighting
9224 Switch wiht built-in w/lamp for fog lights
9225 Switch wiht built-in w/lamp for auxiliary headlights
9226 Switch for ticket punching machine
9227 Radiophone switch
9228 Switch for route signs
9229 Switch with built-in w/lamp for electric starter and preheating
9230 Switch for transmission oil low pressure
9231 Switch for transmission oil high pressure
9232 Switch for odometer cutout
9233 Switch for cutout of cooling gas pressure failure electromagnetic pulley
9234 Switch for low air pressure in front suspension system
9235 Switch for signalling trailer parking brake engaged
9236 Switch for signalling low air pressure in left front suspension
9237 Switch for signalling low air pressure in right front suspension
9238 Switch for signalling low air pressure in rear suspension
9239 Switch, high gear engagement not available during braking and stop light illumination
9240 Switch, 3rd axle up
9241 Switch for turning on front door step light
9242 Switch for turning on centre door step light
9243 Switch for turning on rear door step light
9244 Switch for centre door limiting solenoid valve
9245 Switch for front door limiting solenoid valve
9246 Safety switch for front door reverse operation
9247 Safety switch for rear door reverse operation
9248 Stop signalling switch
9249 Switch for gear disengagement with low pressure in air suspension system (setting value lower than specified)
9250 Switch for gear disengagment with low pressure in air suspension system (setting value higher than specified)
9251 Switch for front door low air pressure
9252 Switch for centre door low air pressure
9253 Switch for allowing gear engagement with brake pedal fully depressed
9254 Switch for oil fliter restriction
9255 Safety switch for preventing retarder operation when air inlet setting value is higher than specified
9256 Switch for connection of braking circuit oil pump
9257 Switch for low air pressure in braking circuit
9258 Switch, power steering circuit malfunction
9259 Switch for low air pressure in parking brake circuit
9260 Switch for stop/hydraulic braking/exhaust brake signal
9261 Switch for cutout of exhaust brake with low engine rpm rate
9262 Switch for centre door opening

9263 Switch for earthing of speed limiter control unit with clutch pedal fully depressed
9264 Switch for air exhaust with forward gear engaged
9265 Switch for preventing starting from cab with engine compartment door open and light on
9266 Switch for front door open/step light on/general lighting
9267 Switch, front door open/steps light illumination/general lighting enablement
9268 Switch for rear door open/rear step light on
9269 Switch for turning engine off with gears engaged and engine compartment door open
9270 Switch for differential lock on
9271 Exhaust brake control switch (under brake pedal)
9272 Safety switch for front door reopening
9273 Safety switch for centre door reopening
9274 Kickdown solenoid valve switch (hydraulic converter)
9275 Switch for outside air door motor/windscreen defrosting recirculation system/driver's seat heating
9276 Switch for preventing starting with gears engaged
9277 Switch for signalling front wheel lining wear
9278 Switch for stopping ear engagement with rear door open
9279 Engine overrevving signalling switch
9280 Switch for signalling rear wheel lining wear
9281 Switch for signalling seat belts unfastened
9282 Switch for allowing starting and turning on of reversing lights
Switch, engine compartment spotlight
9283 Switch for preventing engine starting with engine compartment door open
Switch, engine compartment spotlight
9284 Switch for brake system failure
9285 Switch for speed limiter cutout with transmission in neutral
9286 Switch for signalling hand brake cylinder end ofstroke
9287 Switch for signalling front brake converter cylinder end of stroke
9288 Switch for signalling rear brake converter cylinder end of stroke
9289 Switch for signalling all-wheel drive on
9290 Key switch for preventing engine starting from engine compartment
9291 Switch for stop brake solenoid valve
9292 Switch for preventing gear engagement from transmission in neutral position with high rpm rate
9293 Speedometer switch for signalling maximum speed with all-wheel drive on
9294 Thermometer switch, fuel heating
9295 Pressure increase sensing switch with N connection for door control unit
9296 Thermometer switch, preheating control unit
9297 AVS emergency switch
9298 Switch for cutout of centralized lubrication control unit
9299 Temperature switch for KSB ignition timer
Switch, luggage compartment centralized control
9300 Safety switch, General Current Relay cutoff
9301 Switch for tank filling safety control device
Engaged gear display (AVS)
9302 3rd axle raising switch
9303 Radio receiver set control switch

9304 Dashboard supply switch
9305 Switch for turning on marker lights
9306 Switch for front route sign lighting
9307 Switch for locking rear axle steering wheels
9308 Switch for cutout of 2nd power steering circuit
9309 Switch for auxiliary headlights
9310 Switch for turning on internal aeration motors
9311 Switch for vehicle lowering
9312 Switch for front driving axle differential lock motor
9315 Switch with built-in w/lamp for turning on rotating beacons
9316 Switch for fault diagnosis with ABS
9317 Protection device against any transfer, when transporting dangerous goods
9318 Clutch switch with easyshift
9319 Speed switch with easyshift
9320 Switch for allowing connection of exhaust brake
9321 Switch with built-in w/lamp for allowing connection of exhaust brake
9322 AVS drive switch
9323 AVS clutch switch
9324 E-GAS/EDC clutch switch
Switch for enablement of gear engagement with brake pedal fully depressed
9325 Switch for preventing engine starting with engine compartment door open
9326 Switch for allowing connection of current outlet
9327 Switch for switching from external air intake to internal recirculation (smog)
9328 Switch, cab independent heating
9329 Switch, engine independent heating
9330 Switch for connection of retarder and stop lights
9331 Switch for fuel filter restriction
9332 Switch for releasing safety device
9333 Switch for transmission oil filter restriction
9334 Switch for releasing centre door safety device
9335 Switch for releasing front door safety device
9336 6 bar retarder switch
9337 13.5 bar retarder switch
9338 Switch for low air pressure in ELF system (5.5 bar)
9339 Switch for switching from 3rd axle upwards to downwards stroke or vice-versa with a load of 11.5 tons on axles
9340 Pressure gauge switch for switching off 3rd axle lifting stroke
9341 Switch for measuring vehicle raising actuator pressure
9342 Pressure gauge switch, 3rd axle air spring pressure
9343 Pressure gauge switch, 3rd steering axle in straight ahead driving position
9344 Pressure gauge switch for switching on 3rd steering axle lifting hydraulic pump
9345 Pressure gauge switch for switching off 3rd steering axle lifting hydraulic pump
9346 Pressure gauge switch for switching off 3rd steering axle hydraulic circuit

9347	Pressure gauge switch for enablement of 3rd axle lifting function (hydraulic circuit under pressure and ignition switch on)
9348	Pressure gauge switch for signalling trailer air compressor system failure
9349	Switch, stop lights (EDC)
9350	Switch, exhaust brake (EDC)
9351	Pressure gauge switch for trailer slowdown brake (stop lights control)
9352	Switch, automatic snow chains
9353	Switch, exhaust brake (AVS)
9354	Pressure gauge switch, 3rd axle lifting system, hydraulic circuit lowering phase
9360	Switch for turning on centre door step spotlights
9361	Switch for turning on rear door step spotlights
9362	Switch for signalling front differential lock
9363	Switch for signalling rear differential lock
9364	Switch for reduced speed range
9365	Switch for spring cylinder failure
9366	Switch for exhaust brake cutout with accelerator at idling speed
9367	Switch for exhaust brake cutout with clutch on
9368	Clutch switch (AVS)
9369	Neutral switch
9370	Speedometer switch for allowing gear engagement
9371	Switch for signalling speed group (AVS)
9372	Switch, engaged gear (AVS)
9373	Switch, 16-speed GV transmission (AVS)
9374	Accelerator idling speed switch
9375	Front converter cylinder switch
9376	Rear converter cylinder switch
9377	Speedometer switchfor disconnection of vehicle levelling adjustment unit and connection of travelling function
9378	3rd axle (lift) disconnection speedometer switch EMS switch while the air-conditioning system is turned on
9379	3rd axle (steer) disconnection speedometer switch
9380	Switch, axle straight ahead driving position
9381	4-output speedometer switch (3/10/45/not used km/h)
9382	Kick-down switch (AVS) Accelerator pedal switch, retarder cutoff
9383	Chassis automatic lubrication system check limit switch
9384	Retarder cutoff switch under accelerator pedal
9385	Switch for inhibiting engine starting with engine compartmenet door open
9386	Sunroof switch
9386	Roof hatch switch
9387	Engaged gear transmission switch (EASYSHIFT)
9388	Clutch switch (EASYSHIFT)
9389	Driving switch (EASYSHIFT)
9390	Switch for connection of driver's seat heating
9391	Fuel heating switch

9392	ASR cutoff switch
9393	ABS cutodd switch (off-road vehicles)
9394	Switch for fule circuit heating (Thermoline) with connection check
9398	Retarder cutoof switch under accelerator pedal Signal switch, electronic suspension low pressure
9399	RETARDER switch on/off switch under accelerator pedal
9400	Tempomat pushbutton, MEMORY/OFF functions
9401	Tempomat pushbutton, Fast/Slow functions
9420	Switch for signaling tooling compartment opening
9461	Cab tilting component, electrohydraulic pump
9470	Thermal switch for fule circuit heating (Thermoline)
9500	Delayed opening NO contact relay, headlight washing system
9501	Delayed contact relay for exhaust brake with automatic transmission
9502	Delayed contact relay for speed limiter
9503	Timed relay for automatic air-conditioning system by-pass solenoid valve Delayed excitation switch, stop request or hostess call bell
9504	Time relay, starting assistance (3rd axle unloading)
9505	Time relay, windshield heating
9506	Relay, 3rd axle lowering delayed pulse with axle load over 11 tons
9507	Electronic relay, auxiliary heater plug
9508	Delayed cutoff relay, engine stopping solenoid valve
9510	Relay for switching on step light with doors open and external lights on
9511	Relay for connection of windscreen defroster/driver's place ventilation
9512	Relay for automatic transmission electronics
9513	Relay for switch on stop lights
9514	Reversing light relay
9515	Reverse gear engagement relay
9516	Flasher light relay
9517	Relay for connection of water circulation pump motor and water - oil heat exchanger
9518	Relay for regulation of recirculation water temperature
9519	Relay for turning on parking lights and allowing connection of fog/rear fog lights
9520	Relay for keeping gears engaged with low air pressure in suspension system
9521	Relay for inhibiting engagement of high speeds while braking is performed
9522	Relay for connection/disconnection of transmission hydraulic retarder
9523	Relay for interior heating motors (1st speed)
9524	Relay for interior heating motors (2nd speed)
9525	Relay for keeping rear door open w/lamp on
9526	Relay for allowing operation of Webasto heater through the timer unit
9527	Relay for allowing connection of air-conditioning system with Webasto on
9528	Relay for prearrangement of air-conditioning system control
9529	Relay for connection of hazard light w/lamp with safety systems on
9530	Fog lamp relay
9531	Relay for connection of stop lights and exhaust brake with Telma retarder on
9532	Relay for supply of key-interlockd services through battery positive Relay, trip computer level 1

	Relay, EDC electronic control unit supply Relay, 15/50A terminal
9533	Rich mixture control relay
9534	Relay for stopping engine with gears engaged and low air pressure in suspension system
9535	Relay for connection of low beam lights
9536	Relay for connection of high beam lights
9537	Relay for electromagnetic pulley
9538	Relay for auxiliary headlights
9539	Relay for earthing of hazard light w/lamp with safety system on
9540	Relay for preventing de-energizing of G.C.R with ignition key on
9541	Relay for current antireturn through battery charge w/lamp (handling batteries off)
9542	Relay for connection of marker lights
9543	Relay for seat belt circuit
9544	Relay for inhibiting gear engagement with vehicle stationary and low air pressure in suspension system
9545	Relay for allowing gear engagement with brake pedal fully depressed
9546	Horn relay
9547	Relay for hydraulic braking reducing solenoid valve
9548	Relay for connection of external lights with safety system on
9549	Relay for braking circuit oil pump
9550	Relay for inhibitng operation of rear fog lamps with flasher light on
9551	Retarder connection relay (3rd step)
9552	Retarder connection relay (4th step)
9553	Relay for connection of exhaust brake with electric retarder on
9554	Relay for earthing of alternator D+
9555	Relay for allowing switching on of step lights/route signs/instruments with key on
9556	Relay for allowing remote starting with gears engaged
9557	Relay for gear engagement at high speed (all safety devices are cut out)
9558	Relay for inhibiting gear engagement with alarm w/lamp on
9559	Relay for inhibiting gear engagement when correct sequence is not available
9560	Exhaust brake relay
9561	Relay for connection of snowplough headlights
9562	Relay for allowing connection of rear fog lamps with fog lamps and/or headlights on
9563	Relay for releasing vehicle locking device with doors open
9564	Relay for connection of booked stop indicator and disconnection of stop request bell
9565	Relay for de-activation of Webasto preheating and connection of main earthing point at beginning of combustion
9566	Relay for switching on direction indicator w/lamp with lamp test on
9567	Relay for switching on hazard light w/lamp with lamp test on
9568	Speed control relay
9569	Relay for holding D+ earthing (G.C.R. cutoff and engine running)
9570	Relay for releasing vehicle locking device with doors open and parking brake engaged
9571	Relay for inhibiting current return to 30 of G.C.R. through engine stopping pushbutton with safety device switch on
9572	Relay for switching off low beam lights with high beams on
9573	Relay for switching off High/Low beam lights with fog lights on
9574	Relay for switching off rear fog lamps with high beam lights on

9575	Relay for enabling switching on of day lights Relay for keeping the engine at idling speed while gears are engaged
9576	Relay for allowing connection of parking lights with engine off
9577	Relay for preventing gear engagement with engine high rpm rate and/or alarm w/lamp on
9578	Relay for illumination of gear engagement key
9579	Relay for preventing gear engagement with safety devices
9580	Headlight control relay
9581	Relay for connection and check of brake lining wear w/lamp
9582	Relay for connection of key reverse rotation inhibitor solenoid and day lights
9583	Relay for connection of fog lamps and disconnection of day lights
9584	Relay for connection of fog lamps and disconnection of high/low beam lights
9585	Relay for electric retarder cutout with antiskid on
9586	Relay for preventing gear engagement from pushbutton panel
9587	Relay for allowing connection of parking lights with engine off
9588	Relay for connection of low voltage low beam lights
9589	Relay for connection of stop lights
9590	Relay for supply of automatic transmission control unit
9591	Relay for Webasto cutout and connecton of emergency w/lamp with safety switch on
9592	Relay for connection of failure bell control unit with engine running
9593	Relay for earthing of D+ with safety control on or G.C.R. off
9594	Relay for setting vehicle in "running" order through terminal 50
9595	Relay for holding 3rd axle lifting function energized
9596	Relay for holding 3rd axle system on
9597	Relay for switching on electric heater (1st speed)
9598	Relay for switching on electric heater (2nd speed)
9599	Relay for enablement of electric heater with terminal 15/a on
9600	Emergency combined battery disconnector relay
9609	Time relay for delayed disconnecting of the ride recorder
9610	Relay for connection of hazard w/lamp
9611	Relay for connection of failure bell control unit with engine running
9612	Relay for connection of internal ventilation motors
9613	Relay for connection of internal aeration motors
9614	Relay for connection of electric retarder (stage 1 and 2)
9615	Relay for brake air pressure solenoid valve
9616	Relay for allowing front differential lock
9617	Relay for fuel heating
9618	Relay for inhibitng engine starting from engine compartment with gears engaged
9619	Relay for preventing gear engagement while the vehicle is accelerating or transmission is in neutral
9620	Power take-off relay
9621	Relay for sensor cutout in case of a failure in the opposite sensor
9622	Relay for switching on reading lights
9623	Relay for switching on internal lights (stage 1)
9624	Relay for switching on internal lights (stage 2)
9626	Relay, KSB solenoid valve Relay, turn signal/hazard lights actuator Relay, electrical battery disconnector

9627	Relay, vehicle chassis levelling on front axle side (travelling position)
9628	Relay, vehicle chassis levelling on rear axle side (travelling position)
9629	Relay, speed limiter, uncoupling while gears are engaged
9630	Relay, trailer stop lights, parking brake on
9631	Relay for holding front/rear axle in travelling position
9632	Relay for holding 3rd axle lifting hydraulic pump between coupling /uncoupling stage
9633	Relay for switching on 3rd axle lifting hydraulic pump
9634	Relay for fuel heating circuit
9635	Relay for pump control with independent heating off
9636	Relay for heated rearview mirror
9637	Relay, terminal 15a (contact key interlocked-general services and user cutoff during starting stage)
9638	Relay, independent heating with battery disconnector on
9639	Relay, cab tilting servomechanism
9640	Relay for antiskid connection w/lamp
9641	Relay for switching off retarder with antiskid on
9642	Relayfor switching on low beams lights (low voltage) Relay, retarder cutoff with ABS on
9643	Relay for connection of low voltage low beam lights
9644	Relay for switching on brake system failure w/lamp
9645	Relay for rear brake shoe wear signal
9646	Relay for exhaust brake cutout with low rpm rate Relay, horns
9647	Relay for stopping engine with transmission in neutral
9648	Relay for doors closed w/lamp
9649	Relay for rear axle with ELF w/lamp
9650	Relay for ABS failure w/lamp
9651	Relay for Girling brake system failure w/lamp
9652	Relay for switching off low beam lights with parking lights on
9653	Relay for switching off day lights with fog lights on
9654	Relay for switching off 3rd axle lifting phase
9655	Relay, large/small water recirculation solenoid valve Relay for reducing EMS operation stroke while braking is performed
9656	Relay for switching off lift axle system with starting assistance (axle unloading on)
9657	Relay, open engine water recirculation solenoid valve, engine running
9658	Relay, trailer slowdown brake (stop lights)
9659	Relay for switching off reversing light, BO circuit on
9660	Relay, antiskid no. 1
9661	Relay, antiskid no. 2
9662	Relay for retarder supply
9663	Relay for connection of hazard lights with safety control on
9664	Relay for connection of low beam lights with engine running
9665	Relay for connection of low beam lights
9666	Relay for preventing current return through generator w/lamp with battery cutout
9667	Relay for pedal contact switch (from stop lights to retarder)
9668	Relay for door control
9669	Relay for ALV with ABS/ASR

9670	Relay, speed governor on Relay, engine test EDC
9671	Relay for holding vehicle chassis levelling adjustment (front axle travelling side) with switch in stop position
9672	Relay for holding vehicle chassis levelling adjustment (rear axle travelling side) with switch in stop position
9673	Relay for holding chassis levelling adjustment in travelling condition with front axle switch on either upwards or downwards position only
9674	Relay for holding chassis levelling adjustment in travelling condition with rear axle switch on either upwards or downwards position only
9675	Relay, 3rd axle lowering
9676	Relay, front/rear axle straight ahead travelling position
9677	Relay for switching 3rd axle from lifting to lowering stage or vice-versa
9678	Relay, actuator bellows breather valves (3rd axle lifting)
9679	Relay for holding 3rd axle system off
9680	Relay for disconnection of engine/transmission assembly timer with engine off
9681	Relay for disconnection of w/lamps with blackout circuit on
9682	Relay for enablement starting assistance with 13 ton load un rear axle
9683	Relay for rear steering axle level adjustment during lowering stroke
9684	Relay for engine stopping cutoff solenoid valve (ignition on)
9685	Relay, lift axle lowering phase automatic holding relay
9686	Relay, speed limiting device
9688	Relay, EDC system cutoff
9690	Relay for holding starting assistance function (3rd axle unloading)
9691	Relay, 3rd axle lowering after starting assistance function (i.e. after 3rd axle unloading)
9692	Relay for switching from battery positive after battery disconnector to lh terminal 58 (dangerous cargo vehicles/France)
9693	Relay for switching from battery positive after battery disconnector to rh terminal 58 (dangerous cargo vehicles/France)
9694	Relay for switching from earth connection after battery disconnection to battery negative insulated earth
9695	Relay for switching from outdoor air intake to internal recirculation system (smog)
9696	Relay for switching on air-conditioning system for a short time
9697	Relay for switching on electric heater (1st and 2nd speed)
9698	Relay for w/lamp dimming with blackout circuit on
9699	Relay for w/lamp and instrument light dimmer with blackout circuit on Kick-down relay
9700	Relay for switching off 3rd steering axle hydraulic steering system over 45 km/h (EDC protection polarized relay)
9701	Relay, heated air drier - Relay for switching off 3rd steering axle hydraulic steering system over 45 km/h
9702	Relay for switching on air drier
9703	Relay for reverse gear signal
9704	Relay for starter motor with clutch on
9705	Relay for switching off exhaust brake
9706	Relay for holding stop lights (longitudinal differential lock switch solenoid valve with ABS on)
9707	Relay for switching off automatic air-conditioning system while engine is turned off/on
9708	Relay for switching on cab heating
9709	Relay for switching on 3rd axle system (raising stage)
9710	Relay for switching on hydraulic pump (hydraulic lowering pressure below 20 bar)
9711	Relay for switching on 3rd axle raising system when rear axle lowering control signal comes on

9712	Relay for switching on engine stopping timer for a short time while ignition is switched off (terminal 15)
9713	Relay for switching off IVECO CONTROL with BO circuit on
9714	Relay for signalling engine coolant partial recirculation to control unit
9715	Relay for holding chassis self-levelling function with vehicle running
9716	Relay for lift axle quick air feed or quick breather valve during lowering phase
9717	Relay, breather valve during lift axle lowering phase
9718	Relay for stopping rear axle levelling control in travelling position (STOP) with axle load over 1.3 tons
9719	Relay for enabling starting assistance signal with chassis levelling in travelling position
9720	Load realy, windshield heating Relay, steered wheels sensor
9721	Relay for stopping power take-off switch on relay with engine running
9722	Relay for stopping starter motor with engine running
9723	Relay for cutting off associated components when main current switch is turned off
9724	Relay for switching on neutral position signal, terminal 15 (automatic transmission) Relay, SAMT, LIMP-HOME
9725	Relay for 3rd axle hydraulic steering system axle down
9726	Hold relay, 3rd steering axle centering signal cut off with front axle wheel in staright ahead driving position
9727	Hold relay, starting assistance cut off, self-holding system at a speed equal to orgreater than 25 Km/h
9728	Instrument light relay Relay, trip computer level 1
9729	Relay for switching on incandescence resistance (thermostarte)
9730	Relay for switching on 3rd steering axle solenoid valve unit
9731	Enablement relay for turning on 3rd axle lifting system pushbutton (speed less than 2 Km/h)
9732	Relay for turning off turn signal/hazard lights when B.O system is turned on
9733	Relay for turning off steps and cab interior lights when B.O system is turned on
9734	Relay for positioning 3rd steering axle in straight ahead driving position (axle up)
9735	Hold relay, General Current Relay
9736	Relay, terminal D+
9737	Relay, fuel supply opening with fuel circuit on
9743	Relay for fule circuit heating (Thermoline)
9749	Relay for switching over motor incandescence thermostat to dynamic resistance, in case of quick heating of the additional heating over the timer.
9800	Front door test solenoid valve
9801	Solenoid valve for releasing brake cylinder spring actuators
9802	Kickdown solenoid valve (hydraulic converter)
9803	Transmission control solenoid valve
9804	Solenoid valve for retarder graduated braking
9805	Solenoid valve for reducing hydraulic braking
9806	Retarder control solenoid valve
9807	Solenoid valve for resetting service door mechanical lock device
9808	Solenoid valve for limiting retarder operation in 1st/2nd/reversing gear
9809	Vehicle lowering solenoid valve
9810	ASR with ABS + ASR solenoid valve
9811	Chassis levelling solenoid valve
9812	Cooling fan solenoid valve
9813	EASYSHIFT solenoid valve unit

9814	Solenoid valve for inhibiting gear engagement while the vehicle is accelerating and transmission is in neutral
9815	Solenoid valve for stopping AVS solenoid valves block
9816	Solenoid valve, clutch assistance (AVS)
9817	Retarder solenoid valve assembly
9818	Solenoid valve for reducing engine rpm (AVS)
9819	Solenoid valve, retarder oil accumulator
9820	Solenoid valve unit (ELF)
9821	ELF solenoid valve
9822	Retarder proportional solenoid valve
9823	Speed limiter pressure modulator solenoid valve assembly
9824	Speed limiter quick exhaust solenoid valve
9825	Solenoid valve for locking added steering wheels in reverse gear
9826	Solenoid valve for opening air circuit to vehicle raising actuator bellows
9827	Solenoid valve for opening air circuit to 3rd axle air suspension springs
9828	Solenoid valve unit, 3rd axle hydraulic steering system
9829	Solenoid valve for opening hydraulic circuit (i.e. 3rd axle lowering)
9830	Solenoid valve, 3rd axle lowering system
9831	Solenoid valve, associated rear wheel braking with ASR on
9832	Solenoid valve for switching from large to small water circuit and vice-versa
9833	Solenoid valve for switching off added axle rasing phase (added axle unloading/starting assistance) with more than 13 ton load on rear axle
9834	Solenoid valve, engine coolant circuit off
9835	Solenoid valve for reducing air pressure in 3rd axle braking system with ABS on
9836	Quick-breather solenoid valve for gear uncoupling with speed limiter on
9837	Pressure modulator for stopping speed limiter solenoid valves
9838	Solenoid valve unit, rear axle, chassis levelling system
9839	Solenoid valve, clutch response signal (automatic transmission)
9840	Brake solenoid valve (AVS)
9841	Solenoid valve unit, automatic transmission splitter unit
9842	Solenoid valve, exhaust brake
9843	Quick-breather valve, rear axle air springs
9844	Solenoid valve, 3/2-way valve, lift axle air control system
9845	Solenoid valve for stopping longitudinal differential lock with ABS and all-wheel drive on
9900	Automatic gear selection control unit (AVS)
9901	Engaged rear display (AVS)
9902	Fuel filter heating temperature switch
9919	Control unit enabling engine starting and gear engagement, ZF automatic transmission
9951	ABS/ASR fault diagnosis jack
9953	E-GAS/EMS fault diagnosis pushbutton
9954	3-way connection block, E-GAS/edc diagnosis
9955	Retarder cutout main switch
9956	Electronic suspension systemfault diagnosis jack
TEST	3-pole connector for connection to IVECO Tester (ISO K/L line)
TEST	Fault diagnosis connector (ISO K/L line)

5-DIGIT COMPONENT CODES

03000	Self-rectifying alternator with built-in voltage regulator
03001	Self-rectifying alternator
03002	Auxiliary self-rectifying alternator with built-in voltage regulator
06000	Electronic voltage regulator
06001	Electromechanical voltage regulator
06010	Overvoltage protection device (RTE)
08000	Starter motor
12000	Motor, electric heater and windshield defrosting
12001	Motor, internal aerators
12002	Motor, engine compartment ventilation
12003	Motor, forced ventilation
12004	Motor, driver's place ventilation
12005	Motor, driver's place heating
12006	Motor, adjustable mirrors
12007	Motor, switn door
12008	Motor, brake fluid pump
12009	Motor, interior heating
12010	Motor, rh door closing
12011	Motor, lh door closing
12012	Compressor, air-conditioning system
12013	Electric fan, capacitor cooling
12014	Motor, dust expulsion
12015	Motor for outside air intake door
12016	Motor, air ejection
12017	Motor for vehicle raising pump
12018	Motor, radiator ventilation
12019	Motor,cab tilting
12020	Motor, engine oil cooling
12021	Motor for centralized lubrication pump
12022	Motor, electronic accelerator (automatic transmission)
12023	Motor, window shade
12024	Motor for added axle hydraulic pump
12025	Motor, power take-off
12026	Motor, winch control
14000	Ignition distributor
15000	Ignition coil
19000	Spark plug
19005	Thermostarter
19010	Preheating plug
20000	Starting battery
22000	Horn
22001	Horn

22002 Air horn control unit
19015 Carburettor
22005 Two-tone horn
22031 Hostess bell
22032 Bell, engine coolant temperature/brake air pressure/engine oil pressure
22033 Bell for vehicle raising system failure
22034 Bell for front differential lock on
22035 Bell for trailer braking system failure
22036 Bell for automatic transmission failure
22037 Bell for parking brake 60% on
22038 Bell for engine coolant and transmission oil temperature
22040 Bell for automatic clutch failure
24000 Foot switch, electrical retarder
24001 Switch under accelerator pedal, load sensor
24002 Foot switch, reatrder
24003 Foot switch, retarder
24004 Automatic transmission accelerator pedal sender
25000 Relay, rear fog lights enablement with low beam lights on
25001 Relay, rotary beacons
25002 Relay, parking and low beam lights with engine running
25003 Relay, fog lights
25004 Relay, flasher light
25005 Relay for switching off fog lights with low beam lights off
25006 Relay for switching on stop lights
25007 Relay for switching on reversing lights
25008 Relay for switching on low beam lights
25009 Relay for switching on high beam lights
25010 Relay for switching on auxiliary high beam lights
25011 Relay for switchin on marker lights
25012 Relay for switching on fog lights and switching off day lights
25013 Relay for switching off low beam lights with high beams on
25014 Relay for enablement of parking lights with engine off
25015 Relay for switching off low beam lights with engine off
25016 Relay for inhibiting switching on of day lights with engine off and ignition key on
25017 Relay for switching on dipped lights
25018 Relay for switching off low/high beam lights with fog lamps on
25019 Relay for switching off- day lights with fog lamps on
25020 Relay for switching on trailer stop lights
25021 Relay for allowing connection of blackout lights
25022 Relay for optical indicator blackout with blackout lights on
25023 Relay for switching off low beam lights with parking lights on
25024 Relay for enablement of day lights
25025 Relay for switching earth (after the G.C.R.) to battery insulated earth
25026 Amperometric relay for checking rotating beacons

25027 Relay for switching battery positive after the G.C.R. to trailer external lights on left-hand side
25028 Relay for switching battery positive after the G.C.R. to trailer external lights on right-hand side
25029 Relay for cutoff of IVECO Control with blackout light circuit on
25030 Reverse gear relay
25031 Relay for auxiliary heater timer lighting
25032 Relay for turning off direction indicator lights/hazard lights with blackout lights on
25033 Relay for switching on BO lights
25034 Relay for switching on rear fog lights
25035 Relay for switching on external lights
25040 Relay for load cutoff while switching on BO lights
25086 Amperometric relay, auxiliary rotary beacon
25100 Relay, trailer exhaust brake solenoid valve
25101 Relay, exhaust brake solenoid valve
25102 Relay, retarder supply
25103 Relay, brake system failure warning lamp
25104 Relay for switching off retarder and/or exhaust brake with ABS on
25105 Relay for switching off ABS sensor in the event of a failure in the opposite sensor
25106 Relay for switching on Tractor ABS failure warning lamp
25107 Relay for switching on ABS information control unit
25108 Relay for retarder connection (stage 1 and 2)
25109 Relay for retarder connection (stage 3)
25110 Relay for retarder connection (stage 4)
25111 Relay unit, retarder control
25112 Relay for cutout of longitudinal differential lock with ABS on
25113 Relay for connection of stop lights while the trailer is slowing down
25114 Relay for allowing switching on of stop lights with parking brake engaged
25115 Relay for cutting off the exhaust brake through the automatic transmission
25116 Relay, exhaust brake control via service brake
25117 Relay, exhaust brake control via accelerator pedal
25118 Relay, brake pedal depressed signal
25119 Relay, exhaust brake on signal
25120 Relay, exhaust brake control with electrical retarder on
25121 Relay, Bowden cable failure signal
25200 Starting relay
25201 Relay, preheating
25202 Relay, G.C.R. energizing
25203 Relay, G.C.R. opening
25204 Relay, remote starting enablement, cab unlatched
25205 Relay, engine stopping
25206 Relay, rich mixture control
25207 Relay, alternator D+ earthing
25208 Relay, remote start enablement, gear engaged
25209 Relay for cutting off various components during starting stage
25210 Relay, starting enablement with transmission in neutral

25211 Relay with delayed opening contact for keeping G.C.R energized
25212 Relay with delayed closing contact for keeping RTE energized
25213 Relay for supply of users connected to ignition switch through battery positive
25214 Relay for fuel pipe heating
25215 Relay for inhibiting starting from engine compartment with gears engaged
25216 Relay for cutout of engine stopping solenoid valve with ignition key on
25217 Relay for temporary connection of engine stopping solenoid valve timer with ignition key off
25218 Relay for starting with clutch on
25219 Relay for user cutout with G.C.R. off
25220 Relay for allowing engine starting with antitheft device on
25221 Relay for connection of pre/after heating w/lamp
25222 Relay for allowing connection of thermal starter
25223 Relay for allowing connection of thermal starter fuel tank with atmosphere
25224 Relay for inhibiting starter operation with engine running
25225 Relay for allowing starting from cab with transmisssion in neutral or clutch pedal fully pressed
25226 Relay, G.C.R. energizing from inside the cab
25227 Relay, G.C.R. de-energizing with doors open
25228 Relay for switching on dashboard
25229 Starting inhibitor relay
25230 Relay, engine preheating solenoid valve
25300 Relay, auxiliary heater
25301 Relay, engine compartment ventilation
25302 Relay, interior ventilation
25303 Internal ventilation relay
25304 Internal aeration relay
25305 Relay for auxiliary heater cutout with safety control on
25306 Relay for electric heater and windscreen defroster
25307 Relay for air-conditioning compressor
25398 Relay for capacitor cooling fan (low speed)
25309 Relay for connection of engine coolant heater plugs
25310 Relay for allowing connection of internal heating with power load inhibiting relay
25311 Relay for rear external air intake door
25312 Relay for front air ejection door
25313 Relay for allowing forced ventilation with internal heating off
25314 Air ejection relay
25315 Relay for allowing air ejection with engine running and switch enabled
25316 Relay for allowing forced ventilation with engine running
25317 Relay for allowing air ejection with engine running
25318 Engine oil cooling relay
25319 Relay for large/small recirculation solenoid valve
25320 Relay for radiator fans
25321 Relay for connection of auxiliary heater (1st/2nd speed)
25322 Relay for connection of auxiliary heater (1st speed)
25323 Relay for connection of auxiliary heater (2nd speed)

25324 Relay for connection of auxiliary heater with G.C.R. on
25325 Relay for engine coolant recirculation (open with engine running)
25326 Relay for temporary connection of air-conditioning system
25327 Relay for connection of air-conditioning system
25328 Relay for temporary connection of air-conditioning system compressor during engine starting
25329 Relay for capacitor cooling fan maximum speed
25330 Relay for cutting out air-conditioner when engine is turned off
25331 Relay for allowing conection of auxiliary heater
25332 Relay for connection of air-conditioning system
25333 Relay for connection of cab heating
25334 Relay for conneciton of auxiliary heater water pump
25335 Relay for water circulation pump cutoff with G.C.R. open
25336 Relay for engine cooling electromagnetic joint
25337 Relay for disconnecting air-conditioning system compressor
25400 Relay,hazard lights
25401 Relay, hazard lights with safety control device on
25402 Relay, hazard/turn signal lights
25403 Relay for auxiliary rear right direction indicator light
25404 Relay for auxiliary rear left direction indicator light
25405 Relay, emergency warning light
25500 Relay for switching on vehicle lock device with doors open
25501 Relay for switching off vehicle lock device with doors open
25502 Relay for connection of doors closed w/lamp
25503 Relay for cutout of stop request w/lamp with doors open
25504 Relay for connection of stop request w/lamp with doors open
25505 Relay, rear door locking device
25506 Relay, interior lighting/front door opening/light level no.2 interlock
25600 Relay enabling gear engagement with brake pedal totally depressed
25601 Relay enabling reverse gear engagement with vehicle stationary
25602 Relay inhibiting gear enagement with vehicle stationary and low air pressure in suspension system
25603 Speed control relay
25604 Relay for connection of transmission power takeoff w/lamp
25605 Relay for allowing starting with transmission in neutral
25606 Relay for automatic transmission
25607 Relay, power take-off no. 1 signal
25608 Relay, power take-off no. 2 signal
25609 Relay, automatic transmission in neutral when ignition switch is turned on
25610 Relay for reverse gear signal
25611 Relay for allowing engine starting with clutch on
25612 Relay for engagement of normal/splitter gears
25613 Relay, neutral signal with brake pedal fully depressed
25614 Relay, connection of neutral position signal to terminal 15 (automatic transmission)
25615 Relay, gear selector earthing with driver's door open
25616 Relay, automatic transmission failure signal

25617 Relay, engine starting from engine compartment
25618 Relay, engaged gear signal
Relay, transmission hydraulic retarder on/off system
25619 Relay, air suspension low pressure
25800 Relay, key rotation inhibitor electromagnet (engine running)
25801 Relay, lamp test
25802 Relay, single-tone bell, stop request
25803 Relay, interior lighting
25804 Relay, interior lighting (safety control device on)
25805 Relay, horns
25806 Relay, miscellaneous lighting enablement (ignition key on)
25807 Relay for switching on stop request signs and switching off stop request bell
25808 Relay, front differential lock enablement
25809 Relay, speed limiter
25810 Relay, fuel heating circuit
25811 Relay, ignition timer (KSB)
25812 Relay, windscreen wiper unit
25813 Relay, heated rearview mirrors
25814 Relay for switching off power unit operation hour counter with engine off
25815 Relay for connection of vehicle raising system failure w/lamp
25816 Relay for connection of vehicle raising system failure w/lamp (incorrect level)
25817 Relay, settler heating circuit
25818 Relay, heated windshield
25819 Relay for connection of reading spotlights
25820 Relay, vehicle levelling (front suspension system)
25821 Relay, brake fluid level w/lamp
25822 Relay for 3rd axle lowering
25823 Relay for keeping 3rd axle up
25824 Relay for raising 3rd axle with associated air springs under pressure
25825 Prefilter heating relay
25826 Relay for switching 3rd axle raising/lowering functions
25827 Relay for cutout of 3rd axle raising stage
25828 Relay for keeping connection of 3rd axle raising pump between cutin and cutout stages
25829 Relay for setting front/rear axle in straight ahead running position
25830 Relay for holding front suspension alignment (control in stop position)
25831 Relay, rear suspension levelling control system
25832 Relay for holding rear suspension alignment (control in stop position)
25833 Relay for holding rear suspension alignment (control in lifting/lowering position)
25834 Relay for holding front suspension alignment (control in lifting/lowering position)
25835 Relay for holding front/rear axle in straight ahead running position
25836 Relay for allowing turret rotation with pilot's trap door open
25837 Relay for connection of fuel pump
25838 Relay for connection of winch remote control device
25839 Relay for allowing connection of 4th axle locking and steering solenoid valve

25840 Relay for front axle system failure w/lamp
25841 Relay for rear axle system failure w/lamp
25842 Relay for allowing connection of rear differential lock
25843 Relay for 3rd axle raising pump
25844 Relay for connection of carburetion check control unit
25845 Relay for slow speed range w/lamp
25846 Relay for fast speed range w/lamp
25847 Relay for cab tilting motor
25848 Relay for connection of 3rd axle lifting actuator bellows breather valves
25849 Relay for allowing connection of speed limiter
25850 Speed limiter relay
25851 Relay for allowing cutout of 3rd axle raising stage with load >13 tons
25852 Relay for allowing starting assistance with load < 13 tons
25853 Relay for cutout of 3rd axle hydraulic steering with speed over 45 k.p.h.
25854 Relay for slow/fast speed range switching signal
25855 Relay for connection of engine oil topup pump
25856 Relay for connection of brake system air drier
25857 Relay for speed governor cutout
25858 Relay for EDC connection
25859 Relay for lowering 3rd axle after starting assistance
25860 Relay for 3rd axle cutout with starting assistance
25861 Relay for keeping 3rd axle disconnected
25862 Relay for keeping starting assistance device in operation
25863 Relay for allowing 3rd axle lowering after starting assistance
25864 Reverse polarity preventing relay
25865 Relay for terminal 15
25866 Relay for terminal 58
25867 Relay for two-tone horns
25868 Relay for power steering failure w/lamp
25869 Delayed relay for lowering 3rd axle with load > 11 tons
25870 3rd axle raising relay
25871 Relay for connection of 3rd axle raising pump with pressure < 20 bar
25872 Relay for raising 3rd axle while rear suspensions are being lowered
25873 Relay for allowing connection of torque splitter power take-off
25874 Relay for connection of power loads with engine running
25875 Relay for connecting chassis to battery negative with antitheft device on
25876 Relay for allowing connection of torque splitter power takeoff with parking brake on
25877 Relay for automatic clutch w/lamp
25878 Automatic clutch connection relay
25879 Relay for allowing connection of total power takeoff with engine off
25880 Relay for connection of transmission power takeoff w/lamp
25881 Relay for switching off 3rd axle lowering function during starting stage
25882 Relay for brake pedal signal to EDC control unit
25883 Relay for switching off Cruise Control with retarder on

25884 Suspension raising relay
25885 Relay for allowing connection of starting assistance with chassis alignment in running order
25886 Relay for controlling 3rd axle quick exhaust valves during lowering stage
25887 Relay for switching 3rd axle air delivery valves during lowering stage
25888 Relay for allowing connection of starting assistance
25889 Relay for turning off speed limiter while gears are engaged
25890 Relay for connection of 3rd axle w/lamp
25891 Relay for allowing connection of speed limiter with key on
25892 Relay, transfer case power take-off w/lamp
25893 Relay for connection of total power takeoff
25894 Relay for connection of power loads with key on
25895 Relay for connection of trip computer light
25896 Relay for allowing starting assistance with speed <60 km/h
25897 Relay for connection of side transmission power takeoff
25898 Relay for connection of rear transmission power takeoff
25899 Relay, load cutoff with battery disconnecting switch open
25900 General Current Relay
25901 General Current Relay with automatic circuit breaker
25902 Air cutoff mechanical General Current Relay
25903 EDC cutoff relay
25904 Relay, release of 3rd axle lifting system
25905 Relay for holding lock of 3rd axle lifting system
25906 Relay for turning engine off in the case of POWER PACK failure
25907 Relay, radiator fluid level w/lamp
25908 Relay, hydraulic steering with axle down
25909 Relay for holding wheel centering inhibitor (axle in straight ahead driving position)
25910 Relay for turning on hydraulic steering system solenoid valves
25911 Relay for straight ahead driving position (steered axle up)
25912 Relay, 3rd axle lifting (V<2 KM/H)
25913 Relay, differential lock enablement
25914 Relay, engine rev up from ground enablement
25915 Relay, cab unlatched signal enablement
25916 Relay, fireproof hatch control
25917 Relay, bilge pump
25918 Relay for gas system supply
25919 Relay, vehicle running enablement
25920 Relay for turning on gas system with transmission in neutraò
25921 Relay, gas system solenoid valve enablement
25922 Relay, remote brake pedal operation enablement
25923 Relay for switching on windshield wiper unit in 2nd speed
25924 Relay for turning on EDC (main relay)
25925 Relay for switching on rear differential lock
25926 Relay for enablement of suspension lifting and stopping of suspension lowering function
25927 Relay for enablement of suspension lowering and stopping of suspension lifting function

25928 Relay, rear window heating
25930 Relay.,G.C.R. opening with engine off and safety system on
25931 Delayed relay for switching on speed limiting device
25932 Delayed opening relay, headlight washing system
25933 Starting assistance time relay
25934 Delayed opening relay for engine stopping solenoid valve
25935 Electronic relay for auxiliary heater plug
25936 Heated windscreen time relay
25937 Time relay for connection of 3rd axle raising hydraulic pump
25938 Delayed opening relay, wheel centering when engine is switched off
25939 Delayed relay for switching off speed limiter with clutch pedal down
25941 Relay, video camera/open front door interlock
28000 Electromagnet, enriched fuel delivery
28001 Key rotation inhibitor electromagnet
28002 Engine stopping electromagnet
28003 Electromagnet for rear axle braking system coolant recirculation pump
28004 Electromagnet for air-conditioner compressor clutch
30000 High/low beam headlight
30001 High/low beam headlight with parking light
30002 Low beam headlight with parking/driving lights and headlight alignment unit
30003 High/low beam light wiht parking light and headlight alignment unit
30010 Low beam light
30011 Fog headlight
30012 BO headlight
30100 Headlight alignment unit actuator
31000 Front/side turn signal light
32000 Front parking/turn signal light
32001 Front parking light
32002 Front turn signal light
32003 Front BO parking light
32004 Front blackout parking and direction indicator light
32005 Front marker light
32006 Front side marker lamp
32010 Rotary beacon
33000 Front parking and direction indicator light
33001 Turn signal side repeater
33002 Auxialiry turn signal light
33003 Side marker lamp
33004 Side marker lamp
34000 Rear headlight cluster
34001 BO rear headlight cluster
34005 Rear parking light
34006 Rear turn signal light
34007 Stop light

34008 Reversing light
34009 Rear fog light
34010 Rear BO parking light
34011 Fifth-wheel light
34012 Cross BO headlight
34013 Side marker lamp
35000 Number plate light
37000 Front/rear marker light
37001 Front marker light
37002 Rear marker light
37003 Front/rear marker light
37004 Front/rear identification light
37005 Side marker light
39000 Cab interior ceiling lamp
39001 Cab rear ceiling lamp
39002 Bunk ceiling lamp
39003 Steps spotlight
39004 Engine compartment spotlight
39005 Luggage comparment spotlight
39006 Driver's place spotlight
39007 Blue light ceiling lamp
39008 Incandescence interior ceiling lamp
39009 Reading light
39010 Map light
39011 Fluorescent interior ceiling lamp
39012 Route signs fluorescent ceiling lamp
39013 Route signs ceiling lamp
39014 Front door steps spotlight
39015 Centre door steps spotlight
39016 Rear door steps spotlight
39017 Cab interior swivel spotlight
39018 Conductor's place ceiling lamp
39019 Blue/normal interior ceiling lamp
39020 Cigar lighter light
39021 Instrument light
39022 Cab interior swivel spotlight
39023 Light pipe lamp
39024 Booked stop ceiling spotlight
39025 Rear door ceiling spotlight
39026 Side door ceiling spotlight
39027 Bunk ceiling spotlight
39030 Lamp, cab side compartment lighting
39050 Support, fluorescent interior lighting converter
39051 Converter, fluorescent interior lighting

39052 Converter, route signs fluorescent lamps
39053 Support, fluorescent route signs lighting converter
40000 Mechanical tachometer
40001 Electronic tachometer
40002 Electronic tachometer with clock
40010 Mechanical tachograph
40011 Electronic tachograph
40012 Mechanical tachograph with speed limiter current outlet
40013 Electronic tachograph with speed limiter current outlet
40030 Electronic tachometer sender unit
40031 Electronic tachograph sender unit
40032 Tachometer/tachograph sender unit
40033 Tachograph and speedometer sender (EDC)
40035 Electronic tachometer adaptor with fixed constant
40036 Electronic tachograph signal repeater
40037 Tachograph signal converter
40038 Speedometer signal converter
40045 Vehicle speed sensor
40046 Inductive type chassis height sensor (rear axle)
40047 Inductive type chassis height sensor (front axle)
40060 Voltage dropper unit, tachograph, TMP vehicles
42000 Pressure gauge, engine oil pressure
42001 Pressure gauge with built-in w/lamp, engine oil pressure
42002 Pressure gauge, front brake air pressure
42003 Pressure gauge, rear brake air pressure
42004 Pressure gauge with built-in w/lamp, front brake air pressure
42005 Pressure gauge with built-in w/lamp, rear brake air pressure
42006 Double-reading pressure gauge, front brake air pressure
42007 Double-reading pressure gauge, rear brake air pressure
42008 Pressure gauge, front/rear brake air pressure
42009 Air pressure gauge for front tyres
42010 Air pressure gauge for rear tyres
42011 Double-reading pressure gauge, front/rear brake air pressure
42012 Pressure gauge,brake oil pressure
42013 Pressure gauge, methane gas pressure
42030 Sender unit, engine oil pressure gauge
42031 Sender unit, front brake air pressure gauge
42032 Sender unit, rear brake air pressure gauge
42033 Sender unit, front brake graduated pressure gauge
42034 Sender unit, rear brake graduated pressure gauge
42035 Absolute pressure sensor
42036 Sender unit, front tyre air pressure gauge
42037 Sender unit, rear tyre air pressure gauge
42038 Sender unit, air delivery (2) pressure gauge

42039 Sender unit, intake air pressure gauge
42040 Sender unit, air delivery (1) pressure gauge
42041 Sender unit, brake oil pressure gauge
42042 Transducer, methane gas pressure gauge
42045 Sender unit for outdoor temperature gauge
42050 Front axle stroke sender unit (with chassis levelling adjustment unit)
42051 Left axle stroke sender unit (with chassis levelling adjustment unit)
42052 Right axle stroke sender unit (with chassis levelling adjustment unit)
42100 Switch, front brake air pressure signal
42101 Switch, rear brake air pressure signal
42102 Switch, parking brake signal
42103 Switch, exhaust brake-interlocked trailer brake
42104 Switch, brake system failure signal
42105 Switch, exhaust brake signal
42106 Switch stop signal
42107 Switch, parking brake pressure signal
42108 Switch for trailer retarder signal
42109 Safety switch for braking system low air pressure
42110 Safety switch for braking system high air pressure
42111 Switch for stop light check with EDC on
42112 Switch, stop light test (EDC on)
42113 Exhaust brake switch (EDC)
42114 Exhaust brake switch (automatic transmission)
42115 Parking brake on (60 %) signalling switch
42200 Switch, air suspension failure signal
42201 Switch, front air suspension failure signal
42202 Switch, rear air suspension failure signal
42203 Switch, front rh air suspension failure signal
42204 Switch, front lh air suspension failure signal
42205 Hydraulic circuit switch for 3rd axle raising system
42206 Left drive axle switch for 3rd axle raising system
42207 Right drive axle switch for 3rd axle raising system
42208 Left lift axle switch for 3rd axle raising system
42209 Right lift axle switch for 3rd axle raising system
42250 Switch, transmission air pressure signal
42251 Switch, gear disengagement with low air suspension pressure
42252 Switch for enabling gear engagement with brake pedal fully depressed
42253 Automatic transmission low air pressure signalling switch
42350 Switch, body tilted
42351 Switch, air cleaner restriction
42352 Switch, transmission power take-off signal
42353 Switch, 3rd axle up signal
42354 Switch for air suspension system failure
42355 Switch for front door safety lock device

42356 Switch for rear door safety lock device
42357 Switch for front door limiting solenoid valve
42358 Switch for rear door limiting solenoid valve
42359 Safety switch for front door reverse operation (closing direction only)
42360 Safety switch for rear door reverse operation (closing direction only)
42361 Pressure increase sensing switch with N connection for door control unit
42362 Switch for starting assistance solenoid valve
42363 Switch for changing 3rd axle raising/lowering functions with load > 11.5 tons
42364 Switch for cutout of 3rd axle raising function
42365 Switch for detecting 3rd axle air spring pressure
42366 Switch for setting 3rd steering axle in straight ahead travelling position
42367 Air-conditioner switch
42368 Pressurization signalling switch
42369 Switch for signalling low pressure in services
42370 Fan oil filter restriction signalling switch
42371 Switch for detecting 3rd axle raising actuator pressure
42372 Switch for detecting pressure overload in rear springs
42373 Switch for allowing 3rd axle raising with air pressure in hydraulic circuit and key on
42374 EDC clutch switch
42375 Switch for drier filter minimum pressure
42376 Switch for drier filter maximum pressure
42377 Switch for connection of 3rd axle raising system hydraulic pump
42378 Switch for cutout of 3rd axle raising system hydraulic pump
42379 Switch for allowing connection of transmission power take-off
42380 3rd axle raising system switch located in hydraulic lowering circuit
42381 Drive axle switch for switching 3rd axle lifting/lowering stroke
42382 3rd axle switch for switching lifting/lowering stroke
42383 Switch, front door steps light
42384 Switch, centre door steps light
42385 Switch, rear door steps light
42386 Switch, NBC low pressure signal
42387 Switch, fire-fighting cylinders pressure signal
42388 Switch, differential lock signal
42500 Switch, brake oil pressure signal
42550 Switch, engine oil pressure signal
Engine oil reservoir level switch
42551 Switch, oil filter restriction signal
42600 Switch, transmission oil low pressure signal
42601 Switch, transmission oil high pressure signal
42602 Switch, cooling fluid low pressure signal
42603 Switch, cooling fluid high pressure signal
42604 Power steering oil pressure signalling switch
42605 Converter oil pressure signalling switch
42606 Coolant average pressure signalling switch

42607 Centralized lubrication pump switch
44000 Fuel level indicator
44001 Fuel level indicator with built-in w/lamp
44002 Engine oil level indicator
44030 Sender unit, fuel level indicator
44031 Sender unit, fuel level indicator with w/lamp contact
44032 Engine oil indicator control
44033 Brake fluid level indicator control
44034 Clutch fluid level indicator control
44035 Windshield fluid level indicator control
44036 Radiator waterlevel indicator control
44037 Power steering fluid level indicator control
44038 Front brake fluid level indicator control
44039 Rear brake fluid level indicator control
44040 Headlight washer fluid level indicator control
44041 Engine oil high level indicator control
44042 Transmission oil level indicator control
44043 Engine oil level sender unit
44044 Engine oil low level indicator control
47000 Clock
47010 Thermometer, engine coolant temperature
47011 Thermometer, engine coolant temperature with built-in w/lamp
47012 Thermometer, transmission oil temperature
47013 Thermometer, engine oil temperature
47014 Thermometer, engine oil temperature with built-in w/lamp
47015 Thermometer, external temperature
47030 Sender unit, thermometer, engine coolant temperature
47031 Sender unit, thermometer, transmission oil temperature
47032 Sender unit, thermometer, engine oil temperature
47033 Sender unit, thermometer, external temperature
47034 Engine coolant temperature sensor (EGR)
47035 Engine coolant temperature sensor
47036 Engine coolant temperature sensor for preheating system
47037 Engine coolant temperature sensor for engine cooling system
47038 Exhaust gas temperature sensor
47039 Battery tank temperature sensor
47040 Intake air temperature sensor
47041 Water temperature sender for retarder control unit
47042 Fuel temperature sensor
47100 Switch, engine coolant high temperature signal
47101 Switch, engine oil temperature signal
47102 Switch, engine compartment ventilation failure signal
47103 Switch for switching on engine compartment ventilation system
47104 Switch for switching on engine cooling electromagnetic joint

47105 Switch, preheating system
47106 Switch, fuel heating
47107 Switch, forced ventilation
47108 Switch, settler heating
47109 Switch, ignition timer (KSB)
47110 Switch, engine coolant high temperature signal (retarder system)
47111 Temperature gauge switch, fuel pipe heating enablement
47150 Switch, transmission oil high temperature signal
47200 Switch, brake system air drier resistor
47201 Switch for signalling brake fluid circulation pump failure
47202 Switch for signalling high coolant temperature in rear axle braking system
47203 Switch, outdoor temperature
47204 Switch for allowing internal heating with engine coolant temperature ≥ 60 °C
47205 Converter oil high temperature signalling switch
47206 Switch for turning off 3rd axle lifting pump
47207 Switch/sender unit, engine water temperature indicator
48000 Mechanical rev counter
48001 Electronic rev counter
48030 Electronic rev counter sender unit
48031 T.D.C. sensor
48032 Crankshaft pulse sender (diagnostic system)
48033 Flywheel pulse sender (diagnostic system)
48034 Rev counter sender unit signal amplifier
48035 Engine rpm sensor
48036 Engine rpm sensor signal amplifier
48037 Automatic transmission input rpm sensor
48038 Automatic transmission sender unit on accelerator pedal
48039 T.D.C. sensor (vehicles with EGR)
48040 Automatic transmission output rpm sensor
48041 Engine rpm sensor (fault diagnosis)
48042 Engine rpm sensor (on timing gear)
48043 Turbocharger speed sensor
48044 Km odometer sensor
48045 Injector inductive sensor
49000 Battery charge indicator
49001 Amperometer
49002 Hour counter
49003 Wheel direction indicator
49004 Inclinometer
49005 Voltmeter
49006 Air delivery measuring device with temperature sender unit
49007 Km odometer (LCD)
49030 Sender unit, wheel direction indicator
49031 Sender unit, turret direction indicator

50000 IVECO Control display panel
50001 Self-diagnosis combined module
50002 Engaged gear display (automatic transmission)
50010 Display control unit (SIB)
50011 Minidream control unit (SIB)
50012 CRT monitor (SIB)
50013 Keyboard (SIB)
52000 Switch, windshield defrosting electric heater
52001 Switch with built-in w/lamp, windshield defrosting electric heater
52002 Switch, auxiliary heater
52003 Switch with built-in w/lamp, auxiliary heater
52004 Switch, heated rearview mirrors
52005 Switch with built-in w/lamp, heated rearview mirrors
52006 Switch, rear fog light
52007 Switch with built-in w/lamp, rear fog light
52008 Switch, fifth-wheel light
52009 Switch with built-in w/lamp, fifth-wheel light
52010 Switch, preheating and fuel rich mixture unit
52011 Switch with built-in w/lamp, preheating and fuel rich mixture unit
52012 Switch, stop request enablement
52013 Switch, internal aerators
52014 Switch, vehicle raising system
52015 Switch, rotary beacons
52016 Switch, driver's light
52017 Switch, interior blue lights
52018 Switch, reading lights
52019 Switch, power take-off
52020 Switch with built-in w/lamp, power take-off
52021 Switch, interior lighting
52022 Switch, route sign lights
52023 Switch, auxiliary headlights
52024 Switch with built-in w/lamp, auxiliary headlights
52025 Switch, ticket punching machine
52026 Switch, radiophone
52027 Switch, route signs
52028 Switch, antistarting from engine compartment
52029 Switch, safety centre unit
52030 Switch, interior heating
52031 Vehicle raising switch with built-in w/lamp
52032 Vehicle lowering switch with built-in w/lamp
52033 Refrigerator switch with built-in w/lamp
52034 Switch with built-in w/lamp for fluorescent interior lights
52035 Switch with built-in w/lamp, rotary beacons
52306 Switch with built-in w/lamp, heated windshield

52037 Front axle air suspension switch
52038 Rear axle air suspension switch
52039 Switch for closing G.C.R.
52040 Switch for engaging bilge pump
52041 Switch for allowing turret rotation
52042 Switch for switching on instrument and w/lamp control board
52043 Switch for turning on pressurization
52044 Switch for engaging differential lock
52045 Switch for engaging all-wheel drive
52046 Switch for engaging 4th axle lock
52047 Switch for retarder cutoff
52048 Switch for retarder cutoff (from brake pedal)
52049 Switch with built-in w/lamp for increasing engine idling speed
52050 Switch with built-in w/lamp for allowing stop request
52051 Switch with built-in w/lamp for sign lighting
52052 Switch with built-in w/lamp for centralized lubrication
52053 Switch with built-in w/lamp for engine independent heating
52054 Switch for connection of rotating beacons and horn stand-by
52055 Switch with built-in warning lamp for turning on the radio through the voltage dropper unit
52056 Switch with built-in w/lamp for ASR cutout
52057 Switch with built-in w/lamp for ABS cutout
52058 Switch with built-in w/lamp for fuel pipe heating
52059 Automatic transmission speed selector
52060 Switch with built-in w/lamp for turning on air-conditioning system in 2nd speed
52061 Switch with built-in w/lamp, winch operation
52062 Switch for release of starter motor
52063 Switch with built-in w/lamp, engine ventilation cutoff
52064 Switch, BO lights
52065 Switch, semi-BO headlight
52066 Switch, BO headlight
52067 Switch with built-in w/lamp, parking lights
52068 Switch for end-of-line (E.O.L.) programming
52069 EDC fault diagnosis switch
52070 Switch for engaging side power takeoff
52071 Switch for engaging rear power takeoff
52072 Automatic transmission speed selector during limp-home operation
52073 Switch for engaging limp-home operation with automatic transmission
52074 Switch for engaging torque splitter power takeoff
52075 Switch for opening General Current Relay
52076 Switch, internal air ejection
52077 Switch, Economy function
52078 Switch, fog lights
52079 Switch, stop brake solenoid valve
52080 Switch with built-in w/lamp, low beamm lights

52081 Switch, gas system solenoid valves enablement
52082 Switch with built-in w/lamp, fog lights
52083 Switch with built-in w/lamp, hazard lights
52084 Switch with built-in warning lamp for turning on rear differential lock device
52090 Suspension levelling switch (ECAS)
52091 Switch with built-in warning lamp for turning on rear window heating
52200 Air/electrical horn switch
52201 Manual/automatic electric retarder switch
52202 Switch for operating front door from inside/outside
52203 Switch for engaging NBC
52204 Switch for air-conditioning system
52205 Switch for selecting air-conditioner speed
52206 Switch for engaging winch
52207 Switch for blackout lights
52208 Switch for high/low beam lights
52209 Switch with built-in w/lamp for retarder cutoff
52210 Switch with built-in w/lamp for retarder cutoff (from brake pedal)
52211 Switch for impulse or continuous two-tone cycle
52212 Switch for horn (city/extra city bus use)
52213 Switch for 1st driver/2nd driver
52214 Switch for normal/splitter gear engagement solenoid valves
53215 Switch with built-in w/lamps for switching on: A) engine preheating B) Interior heating
52216 Switch for turning on heater with built-in w/lamps for : A) On B) Malfunction
52217 Switch for turning on power take-off from cab inside/outside
52218 Switch, Cruise Control operation from cab inside/outside
52300 Interior lighting switch
52301 Hazard lights switch
52302 Switch with built-in w/lamp, hazard lights
52303 Windshield wiper switch
52304 Switch, fog lights and rear fog lights enablement
52305 Switch, driver's seat ventilation
52306 Switch, retarder
52307 Switch, exterior lighting
52308 Switch, normal/blue interior lights
52309 Switch, BO lights
52310 Switch, adjustable mirrors
52311 Switch with built-in w/lamp, aerators
52312 Switch, headlight alignment control
52313 Switch, vehicle lifting/lowering system
52314 Switch, front axle air suspension system
52315 Switch, rear axle air suspension system
52316 Switch, 3rd axle raising/lowering system
52317 Switch, BO headlight
52318 Switch with built-in w/lamp for interior heating

52319 Switch with built-in w/lamp for air ejection
52320 Switch with built-in w/lamp for 3rd axle raising/lowering system
52321 Switch with built-in w/lamp for fog lights and rear fog lights enablement
52322 Switch with built-in w/lamp for front axle air suspension
52323 Switch with built-in w/lamp, front axle air suspension
52324 Switch, exhaust brake prearrangement
52325 Switch for turning on interior lighting from bunk
52500 Ignition key switch, services
52501 Ignition key switch, starting and preheating-interlocked services
52502 Ignition key switch, starting-interlocked services
52520 Lever switch, starting
52521 Lever switch, starting and preheating
52522 Lever switch for engaging electric retarder
52523 Foot switch for engaging electric retarder
52524 Lever switch for engaging hydraulic retarder
52525 Foot switch, hydraulic retarder
52600 General Current Relay
52601 Air cutoff mechanical main current switch, TMP vehicles
53000 Switch, lamp test
53001 Switch, headlight wiper/washer unit
53002 Switch, engine stopping
53003 Switch, windshield washer unit
53004 Switch, headlight washer unit
53005 Switch with built-in w/lamp, headlight washer unit
53006 Switch, starting from engine compartment
53007 Switch, engine stopping from engine compartment
53008 Switch for closing General Current Relay
53009 Switch for opening General Current Relay
53010 Switch, front door
53011 Switch with built-in w/lamp, front door
53012 Switch, centre door
53013 Switch with built-in w/lamp, centre door
53014 Switch, rear door
53015 Switch with built-in w/lamp, rear door
53016 Switch stop request
53017 Switch, hostess call
53018 Switch for opening General Current Relay and earthing of alternator D+
53019 Switch for operating front door from outside
53020 Switch, engine oil level display
53021 Switch, vehicle operation enablement with doors open
53022 Switch, front differential lock
53023 Switch for closing General Current Relay
53024 Switch for headlamp washer unit
53025 Fault diagnosis switch for vehicle raising/lowering system

53026 Engine stopping switch
53027 Sun roof switch
53028 Switch for vehicle running function
53029 Switch for 3rd axle raising system
53030 Switch for starting assistance
53032 Alternator resetting switch
53033 Engine starting switch
53034 Fire-fighting system resetting switch
53035 Switch for enabling fire-fighting cylinders
53036 Switch for engaging tyre inflating system
53037 Switch for turning off tyre inflating system
53038 Switch for checking tyre inflating system
53039 Switch for engaging rear differential lock
53040 Switch for assisted cab tilting system
53041 Switch for checking EDC system
53042 Switch with built-in w/lamp for ABS cutout
53043 Switch for chassis automatic lubrication system
53044 Switch, engine rev up from ground
53045 Switch, display drier devices
53046 Switch with built-in w/lamp for firing smoke-dischargers
53047 Switch for unwinding winch rope
53048 Switch for unwinding winch rope
53049 Switch for gas system control unit diagnosis (Deltec)
53051 Suspension lifting switch
53052 Suspension lowering switch
53053 Test pushbutton coupling, automatic transmission
53300 Switch, power window on driver's side
53301 Speed control button strip, automatic transmission
53302 Switch, power window on passenger's side
53303 Button strip, swing-sliding door opening
53304 Switch for front axle air suspension
53305 Switch for rear axle air suspension
53306 Switch for sunroof motor
53307 Switch for winch winding control
53308 Switch for winch winding remote control
53309 Switch for 3rd axle raising system
53310 Switch for engaging transmission total power takeoff
53311 Switch for controlling window blind
53312 Switch box, Cruise Control device
53313 Switch with built-in w/lamp, rear fog lights
53500 Switch for signalling engine compartment door open
53501 Switch, stop signal
53502 Switch, door open signal
53502 Switch, reversing lights

53504 Switch for signalling front differential lock
53505 Switch for signalling rear differential lock
53506 Switch for signalling all-wheel drive engaged
53507 Switch for signalling splitter gears engaged
53508 Switch for preventing engine starting with gear engaged and reversing light on
53509 Switch, interior lighting
53510 Switch, steps light
53511 Switch, cab unlatched signal
53512 Switch for preventing engine starting with parking brake off
53513 Switch, max permitted speed signal
53514 Limit switch, front brake system converter cylinder
53515 Limit switch, rear brake system converter cylinder
53516 Switch for turning off speed limiter with transmission in neutral
53517 Switch, cross differential lock signal
53518 Switch for turning on luggage compartment spotlights
53519 Switch for turning on engine compartement spotlights
53520 Switch for engaging exhaust brake
53521 Switch for signalling longitudinal differential lock
53522 Switch for signalling front door open and steps light on
53523 Switch for signalling rear door open and steps light on
53524 Safety switch for front door reopening
53525 Safety switch for centre door reopening
53526 Safety switch for rear door reopening
53527 Switch for rich mixture control w/lamp
53528 Switch for signalling front axles correctly aligned
53529 Switch for signalling 4th axle correctly aligned
53530 Switch for signalling all-wheel drive
53531 Switch for signalling parking brake engaged
53532 Kickdown switch
53533 Switch for engaging engine idling speed
53534 Switch for retarder cutout (from accelerator pedal)
53535 Switch for signalling fast gears engaged
53536 Switch for signalling transmission power takeoff engaged
53537 Switch for 3rd added axle differential lock engaged
53538 Tilted body signalling switch
53539 Switch for signalling automatic snow chains engaged
53540 Clutch control switch for 2x5 transmission
53541 Switch for allowing cab tilting with grille open
53542 Trapdoor open signalling switch
53543 Switch for volumetric sensor cutout
53544 Switch for signalling automatic transmission conditioning system on
53545 Transmission in neutral signalling switch
53546 Switch for gear engagement with hood closed
53547 Switch for secondary signal from brake pedal to EDC control uni

53548 Switch for exhaust brake cutoff with accelerator at idling speed
53549 Electronic accelerator clutch switch
53550 Switch for gear engagement and running direction (automatic transmission)
53551 Switch for signalling torque splitter in neutral
53552 Switch for signalling transfer case power takeoff engaged
53553 Switch for setting front axle in straight ahead driving position
53554 Switch for signalling hand brake cylinder failure
53555 Switch for inhibiting engine remote starting with gears engaged
53556 Automatic transmission clutch switch
53557 Exhaust brake switch (automatic transmission)
53558 "Speed group" signalling switch (automatic transmission)
53559 Engaged gear switch (automatic transmission)
53560 Transmission in neutral signallng switch (automatic transmission)
53561 Automatic transmission emergency switch
53562 16-speed GV automatic transmission switch
53563 Gear switch (automatic transmission)
53564 Switch for engine antistarting device with gears engaged
53565 Switch, brake pedal fully depressed signal
53566 Switch for signalling accelerator pedal fully pressed
53567 Switch for signalling side power takeoff engaged
53568 Switch for signalling rear power takeoff engaged
53569 Switch, exhaust brake off signal
53570 Switch, front door opening signal
53571 Switch, centre door opening signal
53572 Switch, rear door opening signal
53573 Switch, door unlocked signal
53574 Switch, intermediate speed engagement
53575 Limit switch for turning off gas system with fuel door open
53377 Switch, Bowden cable failure signal
53578 Switch, door open signal
53800 Switch, stop signal
53801 Switch, cross differential lock (Rockwell rear axles)
53802 Switch for signalling Rockwell axle differential lock engaged (3rd axle)
53803 EDC control switch (speed control)
53804 EDC control switch (speed data storage)
53900 Switch for controlling 3rd axle raising/lowering system
53905 Switch with built-in w/lamp for 3rd axle raising/lowering system
54000 General Current Switch
54030 4-function steering wheel switch
54031 5-function steering wheel switch
54032 8-function steering wheel switch
54033 6-function steering wheel switch
55000 Speedometer switch, electric retarder enablement
55001 Speedometer switch, exhaust brake enablement

55002 Speedometer switch, air suspension system enablement
55003 Speedometer switch, pneumatic suspension system enablement
55004 Speedometer switch, 3rd axle raising cutoff
55005 Speedometer switch, 3rd steering axle cutoff
55006 Speedometer switch for turning on dust ejection motor
55007 Speedometer switch, 4th axle lock enablement
55008 Speedometer switch, longitudinal differential lock enablement
55009 Multiple speedometer switch
55010 Electronic switch for two-tone horn
55011 Speedometer switch for allowing engagment of rear differential lock
58000 Warning lamp, general lighting on
58001 Warrning lamp, rear fog light on
58002 Warning lamp, high beam lights on
58003 Warning lamp, rotating beacons on
58004 Low beam lights on w/lamp
58006 Led signalling failure in front right parking light/tractor front right marker light
58007 Led signalling failure in front left parking light/tractor front left marker light
58008 Led signalling tractor number plate light failure
58009 Led signalling failure in rear right parking light/right stop light/rear right fog lamp/tractor rear right marker light
58010 Led signalling failure in rear left parking light/left stop light/rear left fog lamp/tractor rear left marker light
58011 Led signalling failure in parking/marker/stop/rear fog/trailer number plate lights
58012 Led signalling general lighting efficiency
58050 Warning lamp, brake lining pre-wear
58051 Warning lamp, brake lining wear
58052 Warning lamp, brake system failure
58053 Warning lamp, parking brake engaged
58054 Warning lamp, electrical retarder on
58055 Warning lamp, exhaust brake on
58056 Warning lamp, front brake system pressure
58057 Warning lamp, rear brake system pressure
58058 Warning lamp, brake fluid level
58059 Warning lamp, retarder on
58060 Wrning lamp, parking brake pressure
58061 Warning lamp, ABS failure
58062 Warning lamp, front axle brake lining wear
58063 Warning lamp, rear axle brake lining wear
58064 Warning lamp, trailer ABS failure
58065 Warning lamp, trailer/tractor ABS disconnected
58066 Warning lamp, ASR failure
58067 Warning lamp, brake fluid pump failure
58068 Warning lamp, rear axle brake coolant high temperature
58069 Warning lamp, ASR/speed limiter
58070 Warning lamp, speed limiter failure

58071 Front axle brake system failure w/lamp
58072 Rear axle brake system failure w/lamp
58073 Trailer brake system failure w/lamp
58974 Parking brake engaged w/lamp
58075 Brake sysetm pressure drop w/lamp (ICP)
58076 Stop brake w/lamp
58077 Brak system oil pressure w/lamp
58092 Front axle brake lining wear signalling led
58093 Rear axle brake lining wear signalling led
58098 Insufficient brake fluid level signalling led
58100 Warning lamp, battery charge failure
58101 Warning lamp, preheating on
58102 Warning lamp, engine oil high temperature
58103 Warning lamp, air cleaner restriction
58104 Warning lamp, engine oil low pressure
58105 Warning lamp, engine coolant high temperature
58106 Warning lamp, radiator water level
58107 Warning lamp,after-heating on
58108 Warning lamp, oil filter restriction
58109 Warning lamp, fuel heating on
58110 Warning lamp, preheating on
58111 Battery charging failure w/lamp (auxiliary alternator)
58112 Rich mixture control w/lamp
58113 Fan oil filter restriction w/lamp
58114 Warning lamp, battery isolator switch open
58115 Warning lamp, engine coolant low temperature
58116 Warning lamp for A) engine coolant level B) engine coolant high temperature
58117 Warning lamp for A) engine oil low pressure B) engine oil high temperature
58136 Low radiator water level signalling led
58150 Warning lamp, forced ventilation on
58151 Auxiliary heating system w/lamp
58152 Warning lamp, interior heating on
58153 Warning lamp, driver's place ventilation on
58154 Warning lamp, windshield defrosting electric heater on
58155 Warning lamp, air-conditioning systemon
58156 Warning lamp, NBC low pressure
58157 Warning lamp, NBC filter restriction
58158 Warning lamp, NBC filter on
58160 Dual optical indicator module with led
58165 Auxiliary heater failure w/lamp
58200 Warning lamp, tractor turn signal lights on
58201 Warning lamp, trailer turn signal lights on
58202 Warning lamp, hazard lights on
58250 Warning lamp, suspension system failure

58251 Warning lamp, low pressure in front lh air suspension system
58252 Warning lamp, low pressure in front rh air suspension system
58253 Warning lamp, low pressure in rear air suspension system
58254 Warning lamp, low pressure in air suspension system
58255 Warning lamp, suspension system not in "running" condition
58300 Warning lamp, doors open
58301 Warning lamp, front door open
58302 Warning lamp, centre door open
58303 Warning lamp, rear door open
58304 Warning lamp repeater, doors open
58305 Warning lamp, vehicle starting enablement with door open
58306 Warning lamp, doors closed
58310 Warning lamp, pilot's hatch unlocked
58311 Warning lamp, rear door unlocked
58350 Warning lamp, transmission oil temperature (high)
58351 Warning lamp, transmission air pressure (low)
58352 Warning lamp, transmission oil pressure (low)
58353 Warning lamp, transmission oil pressure (high)
58354 Warning lamp, transmission in neutral
58355 Low transmission oil level w/lamp
58356 Automatic transmission failure w/lamp
58357 Test warning lamp, automatic transmission
58360 Automatic clutch failure w/lamp
58400 Warning lamp, clutch wear
58401 Warning lamp repeater, brake system/engine oil low pressure, engine coolant high temperature
58402 Warning lamp, stop reques
58403 Warning lamp, heated rearview mirrors on
58404 Warning lamp, vehicle raising system
58405 Warning lamp, vehicle front raising system
58406 Warning lamp, vehicle rear raising system
58407 Warning lamp, refrigerator on
58408 Warning lamp, transmission side power take-off on
58409 Warning lamp, cab unlatched
58410 Warning lamp, engine compartment door open
58411 Warning lamp, 3rd axleup
58412 Warning lamp, body tilted
58413 Warning lamp, differential lock
58414 Warning lamp, cross differential lock
58415 Warning lamp, longitudinal differential lock
58416 Warning lamp, fuel reserve
58417 Warning lamp, ticket punching machine on
58418 Warning lamp, radiophone on
58419 Warning lamp, route signs on
58420 Warning lamp, water in fuel pre-filter

58421 Warning lamp, rear door open
58422 Warning lamp, rear differential lock
58423 Warning lamp, front differential lock
58424 Warning lamp, all-wheel drive on
58425 Warning lamp, max speed with all-wheel drive on
58426 Warning lamp, splitter gears on
58427 Warning lamp, max permitted speed
58428 Warning lamp, power steering fluid level
58429 Warning lamp, windscreen washer fluid level
58430 Warning lamp, engine oil level
58431 Starting assistance w/lamp
58432 Vehicle raising system failure w/lamp
58433 Warning lamp, vehicle raising system malfunction
58434 Engine overrevving w/lamp
58435 EDC system failure w/lamp
58436 E-GAS system failure w/lamp
58437 Fault repeater w/lamp
58438 Carburetion checking system failure w/lamp
58439 Fast gears engaged w/lamp
58440 3rd steering axle w/lamp
58441 Transmission rear power takeoff w/lamp
58442 Automatic chassis lubrication w/lamp
58443 Automatic chassis lubrication failure w/lamp
58444 Engine oil topup w/lamp
58445 Automatic snow chains w/lamp
58846 Tool compartment open w/lamp
58447 Telescopic rest (work headlamp) extended w/lamp
58448 Stabilizer struts protruding w/lamp
58449 Transmission centre power takeoff w/lamp
58450 Fire-extinguisher fluid pump w/lamp
58451 220 V alternator w/lamp
58452 Winch on w/lamp
58453 Led signalling trailer power module off
58454 Led signalling trailer power module on
58455 Rail up w/lamp
58456 Torque splitter in neutral w/lamp
58457 Torque splitter power takeoff w/lamp
58458 Transmission front power takeoff w/lamp
58459 Antitheft device signalling led
58460 Rotating beacon w/lamp
58461 Cylinder empty w/lamp
58462 Fire w/lamp
58463 Warning lamp A) Fire B) Cylinder empty
58464 Warning lamp, gas system control unit diagnosis (GAC)

58465 Warning lamp, gas system control unit diagnosis (DELTE)
58466 Economy Power on/
Oil topup warning led
58700 Led, battery charging failure
58701 Led, EDC failure
58702 Led, preheating on
58703 Led, ABS failure
58704 Led, ASR on
58705 Led, AIRBAG failure
58706 Led, rear fog lamp on
58707 Led, tractor turn signal lights on
58708 Led, hazard lights on
58709 Led, trailer turn signal lights on
58710 Led, water in fuel prefilter
58711 Led, retarder on
58713 Led, ECAS system failure
58714 Led, emergency handle pulled on
58715 Led, PTO on
58716 Led, ACS on
58717 Led, Immobilizer on
58718 Brake system failure warning led
58719 Led, parking brake on
58720 Led, radiator water level
58721 Led, transmission oil temperature (high)
58722 Led, engine oil pressure (low)
58723 Led, handle locked
58724 Led, door open
58725 Led, air cleaner restriction
58726 Led, front axle failure
58727 Led, rear axle signal
58728 Led, power steering fluid level
58729 Led, windscreen washer fluid
58730 Led, engine oil level
58731 Led, seat heating on
58732 Led, external lights on
58733 EGR failure warning led
58734 EDB failure warning led
58900 36-optical indicator panel
58901 18-optical indicator panel
58902 10-optical indicator panel
58903 10-optical indicator panel
58904 10-optical indicator panel
58905 10-optical indicator panel
58906 10-optical indicator panel for braking system and miscellaneous components

58907 10-optical indicator panel with speed limiting device, noABS (Europe)
58908 10-optical indicator panel with speed limiting device (Extra-European countries)
58909 32-optical indicator panel
58910 6-optical indicator panel
58911 5-optical indicator panel
58912 5-optical indicator panel for fire-fighting system
58913 9-optical indicator panel
58914 1-optical indicator panel plus instrument lighting control
58915 2-optical indicator panel
58916 10-optical indicator panel for vehicles fitted with electronic suspension system
58917 31-optical indicator panel plus instruments
58918 32-optical indicator panel plus instruments
59000 Electronic flasher light, turn signal/hazard light - single load
59001 Electronic flasher light, turn signal/hazard light - double load
59030 Flasher light, water/oil/air repeater signal
59031 Flasher light, door opening repeater signal
59032 Flasher light, stop request signal
59033 Flasher light, parking brake w/lamp
59100 Windshield wiper unit intermittent operation
59200 Timer for tyre inflation system
59201 Timer for engine ventilation cutoff
59202 Timer for interior compartment ventilation
59203 Timer for turning on winch solenoid valve
61000 1A 3-diode holder container (2 with common cathode)
61001 1A 3-diode holder container (2 with common anode)
61002 3A 3-diode holder container (2 with common cathode)
61003 1A 4-diode holder container (2 with common anode)
61004 1A 4-diode holder container (2 with common cathode)
61005 1A 1-diode holder container
61006 1 resistance and 1A 55-diode holder container
61007 1 resistance and 1A 46-diode holder container
61008 1 resistance and 1A 39-diode holder container
61009 6A 1-diode holder container
61010 1-diode holde container for preventing return of neutral signal when the emergency switch is operated
61011 3A 1-diode holder container
61012 1A 23-diode holder container
61013 1A 51-diode holder container with lamp test relay
61014 1A 20-diode holder container
61100 Compensation resistance, engine coolant excessive temperature (danger)
61101 Resistance, fuel heating
61102 Rheostat for antipollution device (EGR)
61103 Variable resistance for ignition timer control (KSB)
61104 Resistance, brake system air drier
61105 Rheostat for vehicle raising/lowering system

61106 Resistance, heated windshield system
61107 Resistance, settler heating
61108 Current limiting resistance, heated windshield system
61109 Resistance, alternator self-energizing
61110 Resistance for prefilter heating and fuel settler
61111 Resistance for blackout headlight
61112 3-resistance holder container for hydraulic retarder
61113 3-resistance holder container for EDC system
61114 Resistance for fuel pipe heating
61115 Current limiting resistance for tachograph
61116 Resistance for engaging capacitor cooling fan 1st speed
61117 Resistance for engine water heating
61118 Resistance for engaging thermal starter with auxiliary heater on
61119 Resistance for engine air heating
61120 Resistance for speed limiter solenoid valve
61121 Resistance for engine preheating
61122 2-resistance holder container for exhaust brake
61123 4-resistor holding container, Economy Power and PTO
61200 Instrument light electronic dimmer
61201 Optical indicators electronic dimmer
61202 Instrument light and optical indicators electronic dimmer
61203 Instrument light rheostat
61210 Capacitor for relay delayed cutout
61211 Capacitor for reducing tachograph noise
61212 Capacitor for reducing alternator D+ noise
64000 Windshield washer electric pump
64001 Electromagnetic pump for rear axle braking system coolant recirculation
64002 Bilge pump
64003 Fuel pump
64004 Engine oil topup pump
65000 Windshield wiper unit
66000 Headlight wiper unit
66005 Headlight washer pump
66010 Headlight washer unit timer
68000 Radioreceiver set
68001 Loudspeaker
68002 Antenna
68003 Preamplifier
68004 Microphone
68005 24V/12V Power pack
68006 Radio noise suppressor
68007 City Band
68010 ** Transreceiver set
68011 Interphone system switch box

68012 Interphone headset, microphone, breastset
70000 6-fuse holder
70001 8-fuse holder
70002 10-fuse holder
70003 12-fuse holder
70004 14-fuse holder
70005 16-fuse holder
70050 1-way 3A fuse holder
70051 1-way 5A fuse holder
70052 1-way 8A fuse holder
70053 1-way 16A fuse holder
70054 1-way 25A fuse holder
70055 1-way 7.5A fuse holder
70056 1-way 10A fuse holder
70057 1-way 15A fuse holder
70058 1-way 20A fuse holder
70059 1-way 4A fuse holder
70060 1-way 40A fuse holder
70061 1-way 30A fuse holder
70062 1-way 100A fuse holder
70063 1-way 150A fuse holder
70064 1-way 60A fuse holder
70065 1-way 50A fuse holder
70080 6-way magnetothermal cutout carrier
70081 6-way magnetothermal cutout carrier
70082 6-way magnetothermal cutout carrier
70083 6-way magnetothermal cutout carrier
70084 6-way magnetothermal cutout carrier
70085 6-way magnetothermal cutout carrier
70086 6-way magnetothermal cutout carrier
70087 6-way magnetothermal cutout carrier
70088 6-way magnetothermal cutout carrier
70100 Automatic magnetothermal cutout
70101 Automatic thermal switch
72000 Standard 7-pole coupling for electrical connection to trailer
72001 Auxialiry 7-pole coupling for electrical connection to trailer
72002 12-pole coupling for electrical connection to trailer
72003 Standard 7-pole coupling for 12V electrical connection to trailer
72004 19-pole coupling for electrical connection to trailer
72005 28-pole coupling for electrical connection to trailer
72006 7-pole coupling for ABS tractor/trailer electrical connection
72007 9-pole coupling for electrical connection to ground diagnostic equipment
72008 3-pole/38-pole connection, fault diagnosis with IVECO Tester
72009 4-pole coupling for connection to carburetion testing fault diagnosis equipment

72010 15-pole coupling for electrical connection to trailer
72011 5-pole coupling for electrical connection with air-conditioner/heater
72012 16-pole coupling for connection with automatic transmission
72013 24-pole coupling for transmission connection (automatic transmission)
72014 5-pole coupling for automatic transmission diagnostics
72015 Auxiliary 7-pole coupling for 12V connection to trailer
72016 13-pole coupling for 12V connection to trailer
72017 Automatic transmission 37-pole coupling
72018 Clutch 10-pole electrical coupling connector (automatic transmission)
72019 Gear actuators 19-pole elecrtrical coupling connector (automatic transmission)
72020 1-way coupling forr end-of-line programming
72021 Ground diagnostic equipment 30-pole electrical coupling connector
72022 Remote engine starting 2-pole electrical coupling connector
72023 2-pole coupling, multiplex line
72024 2-pole coupling, PWM line
72025 Current outlet
72050 Unipolar current outlet
72051 Bipolar current outlet
72052 Remote engine starting bipolar current outlet
72053 2A current outlet
72054 6A current outlet
72055 Bipolar current outlet for work headlight
72056 Bipolar current outlet for battery charging equipment
72057 220V/16A 2-pole + earth current outlet
75000 Central Interconnecting Unit
75005 1 fuse and 5 relay holder control unit
75006 2 fuse and 5 relay holder control unit
75007 1 fuse and 1 relay holder control unit
75010 Rear terminal strip
78000 Solenoid valve for connection of fuel tank to atmosphere (thermostarter)
78001 Engine stopping solenoid valve
78002 Carburettor cutoff solenoid valve
78003 Cutoff system partialising solenoid valve
78004 Carburettor breather solenoid valve
78005 Carburetion testing solenoid valve
78006 Engine cooling partialising solenoid valve
78007 Fuel inhibitor solenoid valve (in case of a failure in EDC system)
78008 Engine slowdown solenoid valve
78009 Tubine circuit closing solenoid valve
78010 Engine idlign speed intercepting solenoid valve
78011 CUT OFF control solenoid valve
78012 Methane system gas reducer solenoid valve
78013 Pressure regulator solenoid valve
78014 Engine preheating solenoid valve

78015 Solenoid valve, radial jet pump
78050 Exhaust brake control soelnoid valve
78051 Hydraulic braking system solenoid valve
78052 ABS system solenoid valve
78053 ASR control solenoid valve
78054 Solenoid valve for engaging retarder
78055 Solenoid valve for retarder oil accumulator
78100 Front door control solenoid valve
78101 Centre door control solenoid valve
78102 Rear door control solenoid valve
78103 Solenoid valve for vehicle lock with doors open
78104 Front door travel limiting solenoid valve
78105 Rear door travel limiting solenoid valve
78106 Front door control solenoid valve
78107 Rear door control solenoid valve
78150 Soelnoid valve for normal/splitter gear engagement
78151 Solenoid valve for quick clutch engagement
78152 Solenoid valve for slow clutch engagement
78153 Solenoid valve for quick clutch release
78154 Solenoid valve for slow clutch release
78155 Solenoid valve for longitudinal differential lock
78160 Quick breather solenoid valve for gear uncoupling with speed limiter device
78163 Solenoid valve assembly for automatic transmission
78164 Solenoid valve for clutch response signal (automatic transmission)
78165 Solenoid valve for solenoid valve cutoff (automatic transmission)
78166 Solenoid valve for clutch support (automatic transmission)
78167 Brake/transmission solenoid valve (automatic transmission
78168 Clutch solenoid valve
78169 Solenoid valve assembly for splitter unit (automatic transmission)
78170 Solenoid valve for inertia brake
78171 Solenoid valve for splitter control
78172 Solenoid valve for gear selection
78173 Solenoid valve for gear engagement
78174 Solenoid valve for engaging normal gears
78175 Solenoid valve for engaging splitter gears
78176 Solenoid valve for automatic transmission air control
78177 Solenoid valve for pump wheel clutch control
78178 Solenoid valve for direct drive clutch control
78179 Solenoid valve for reverse ger and converter brake control
78180 Pressure reducer solenoid valve
78181 Converter exhaust solenoid valve
78200 Vehicle raising solenoid valve
78201 Vehicle front raising solenoid valve
78202 Vehicle rear raising solenoid valve

78203 Solenoid valve for horns
78204 Differential lock solenoid valve
78205 Cross differential lock solenoid valve
78206 Longitudinal differential lock solenoid valve
78207 Speed limiting device solenoid valve
78208 Transmission total power take-off solenoid valve
78209 Solenoid valve for antipollution devices (EGR)
78210 Solenoid valve for front axle air suspension system
78211 Solenoid valve for rear axle air suspension system
78212 Solenoid valve for opening air circuit of 3rd axle air suspension springs
78213 Solenoid valve for opening hydraulic circuit (3rd axle lowering system)
78214 Engine testing solenoid valve
78215 Solenoid valve for total/partial 3rd axle unloading
78216 Solenoid valve assembly for 3rd axle hydraulic steering system
78217 Solenoid valve for cooling/heating fluid fluid control
78218 Winch enabling solenoid valve
78219 Solenoid valve for engaging tyre inflating system
78220 Solenoid valve for checking tyre inflation
78221 Solenoid valve for locking 4th axle
78222 Solenoid valve for enabling 4th axle steering function
78223 Solenoid valve for engine ventilation cutoff
78224 Solenoid valve for winch winding/unwinding
78225 Solenoid valve for fire extinguisher cylinders
Solenoid valve, condensate drainage
78226 Solenoid valve for engaging front-wheel drive
78227 Solenoid valve for radiator water recirculation
78228 Solenoid valve for heating system
78229 Solenoid valve for snooperscope washer unit
78230 Solenoid valve for snooperscope drier unit
78231 Solenoid valve for pressurization
78232 Solenoid valve for connecting air circuit with raising system actuator bellows
78233 Vehicle raising solenoid valve assembly
78234 Engine oil topup solenoid valve
78235 Solenoid valve for engine/cab water recirculation
78236 Solenoid valve for cab water recirculaiton
78237 Solenoid valve for water recirculation with engine off
78238 Rear axle solenoid valve assembly for chassis alignment
78239 Front axle solenoid valve assembly for chassis alignment
78240 Solenoid valve for quick rear suspension unloading
78241 Solenoid valve for inhibiting starting assistance with more than 13 tons on rear axle
78242 Front axle electropneumatic distributor
78243 Electropneumatic distributor
78244 Transfer case power take-off enablement solenoid valve
78245 Solenoid valve for switching off transmission total power take-off

78246 Solenoid valve for disengaging longitudinal differential lock
78247 Solenoid valve for electronic injection
78248 Solenoid valve for variable geometry turbine control
78249 Solenoid valve for 3rd axle air-operated valves
78250 Solenoid valve for 3rd axle lowering
78251 Solenoid valve for engaging transmission side power take-off
78252 Solenoid valve for engaging transmission rear power takeoff
78253 Solenoid valve for holding transfer case in neutral position with power take-off on
78254 Gas sytem control solenoid valve
78256 Solenoid valve, Waste Gate unit
80000 Power window motor on driver's opposite side
80001 Power window motor on driver's side
82000 Windshield defroster unit
82005 Auxiliary air heater
82010 Air-conditioning system electronic control unit
82025 Front differential engaging device
84000 Water boiler
84001 Air boiler
84005 Auxiliary heater electronic control unit
84006 Auxiliary heater control unit
84008 Hand-operated air-conditioner thermostat
84009 Internal temperature sensor
84010 Metering device
84011 Air-conditioning system control unit
84012 Timer
84013 Ambient thermostat
84014 Auxiliary fuel pump
84015 Ignition coil
84016 Control switch
84017 Electronic timer
84018 Heater water pump
84019 Electromagnetic pulley
84020 Outdoor temperature sensor
85000 Cigar lighter
85003 Heated rearview mirror (trailer)
85004 Heated rearview mirrot (wheel)
85005 Heated rearview mirror
85006 Electrically-adjusted heated rearview mirror (main)
85007 Electrically-adjusted heated rearview mirror (draw up)
85008 Electrically-adjusted heated rearview mirror (wide angle)
85010 Rearview mirror control
85015 Ticket punch machine
85020 Electronic regulator, fuel delivery depending on exhaust gas temperature
85021 Thermocouple, electronic regulator

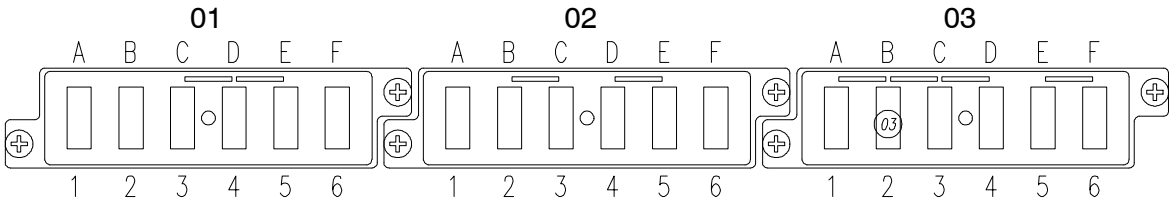
85022 Electromagnetic joint, engine cooling
85023 Electrical key lock
85026 Current outlet voltage dropper unit (2A max)
85027 Current outlet voltage dropper unit (6A max)
85028 Rear differential lock device
85029 Servomotor device for E-GAS system
85030 Accelerator pedal position transducer
85031 Voltage dropper unit for current outlet (11 a max)
85032 Voltage dropper unit for tachograph
85033 12 V trailer voltage dropper unit
85034 Differential lock control lever
85035 Air-suspended seat (driver's side)
85036 Heated air-suspended seat (driver's side)
85037 Air-suspended seat (driver's opposite side)
85038 Heated air-suspended seat (driver's opposite side)
85040 Sunroof motor with built-in switch
85041 Smoke discharger pipe
85045 3rd axle raising hydraulic pump
85050 Pump actuator (automatic transmission)
85051 Automatic transmission actuator
85053 Automatic transmission input rpm sensor
85054 Automatic transmission output rpm sensor
85055 Load sender unit (automatic transmission)
85056 Accelerator pedal sender unit (automatic transmission)
85057 Vehicle speed inductive sensor (automatic transmission)
85058 Automatic transmission
85059 Gear engaged signalling sensor
85060 Selector position signalling sensor
85061 Speed range signalling sensor
85062 Splitter on signalling sensor
85065 Remote control for aligning suspensions and raising 3rd axle
85066 Relay for adjusting self-levelling suspension system
85070 Speed inductive sensor, gas system
85071 Actuator, gas system
85072 Mixer valve, gas system
85073 Electronic ignition, gas system
85074 Engine rpm inductive sensor, gas system
85075 Engine idling speed governor, gas system
85076 WASTEGATE valve, gas system
85077 Intake manifold pressure sensor, gas system
85078 Throttle valve position sensor, gas system
85079 Engine coolant temperature sensor, gas system
85080 External air temperature sensor, gas system
85081 LAMBDA sensor, gas system

85100 Solenoid group, electric retarder
85110 Automatic clutch control unit
85111 Accelerator load sensor (automatic clutch)
85112 Motor for automatic clutch accumulator unit
85113 Solenoid valve for automatic clutch
85114 Gear shift lever sensor (automatic clutch)
85115 Transmission selector position sensor (automatic clutch)
85116 Clutch position sensor (automatic clutch)
85117 Low accumulator fluid pressure sensor (automatic clutch)
85118 Clutch position sensor
85130 Antitheft device control unit
85131 Volumetric sensor
85132 Antitheft device self-supplying syren
85150 EDC control unit
85151 EDC injection pump
85152 Accelerator load sensor (EDC)
85153 Coolant temperature sensor (EDC)
85154 Turbofan air temperature sensor (EDC)
85155 Turbofan air temperature sensor, (EDC)
85156 Turbofan air pressure temperature sensor, (EDC)
85157 Pressure adjustment sensor
85158 Turbine prechamber air pressure sensor (EDC)
85159 Air pressure sensor after the turbine (EDC)
85160 Chassis alignment control device
85165 Fuel consumption measuring device
86000 Electronic control unit, brake shoe wear circuit
86001 Sensors, brake shoe wear circuit
86002 Sensors, front brake shoe wear circuit
86003 Sensors, rear brake shoe wear circuit
86004 Electronic control unit, automatic transmission
86005 Vehicle speed inductive sensor
86006 Electronic control unit, preheating system
86007 Electronic control unit, radiator water level
86008 Sensor, radiator water level
86009 Electronic control unit, engine oil level
86010 Sensor, engine oil level
86011 Electronic control unit, pre/after-heating system
86012 Electronic control unit, water in fuel pre-filter
86013 Sensor, water in fuel filter
86014 Control unit, swing-sliding door opening device
86015 Electronic control unit, retarder
86016 Control unit, differential lock
86017 Electronic control unit, IVECOControl (tractor)
86018 Electronic control unit, IVECOControl (trailer)

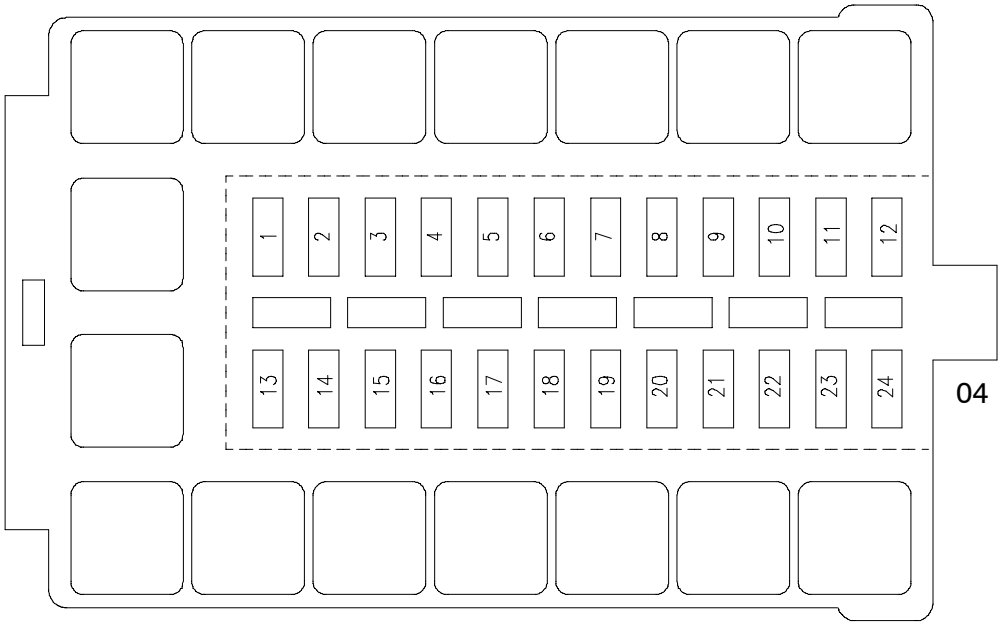
86019 Electronic control unit, high beam lights dimmer
86020 Antipollution device control unit (EGR)
86021 Heated rearview mirror control unit
86022 Rear axle braking system fluid temperature control unit
86023 Vehicle raising/lowering control unit
86024 Electric retarder control unit
86025 Speed limiter control unit
86026 Carburettor control unit
86027 Injection pump control unit
86028 Electronic control unit, trip computer
86029 Electronic control unit, centralized door closign system
86030 Sensor, sun radiation
86031 Sensor, dust and external air intake closing
86032 Control unit, sound signal, w/lamp signal repeater failure
86033 Accelerator control unit (E-GAS)
86034 Vehicle raising sensors
86035 Ignition control unit
86036 Control unit for measuring oxygen in exhaust gas (lamda sensor)
86037 Engine cooling control unit
86038 Control unit for automatic chassis lubrication system
86039 Control unit for automatic gear selection
86040 Control unit for signalling water in fuel filter (EDC)
86041 Frequency/voltage electronic converter
86042 Vehicle fleet control unit
86043 Inductive sensor, rear door closed signal
86044 Electronic control unit, rear fog lights
86045 Electronic control unit, warning lamp test
86050 Tachograph voltage dropper unit
86051 Voltage dropper unit
86060 Air bag and pretightener electronic control unit
86061 Air bag
86062 Pretightener
86100 NBC system control unit
86101 Fire-fighting system control unit
86102 Fire-fighting system auxiliary control unit
86103 Turret rotation control unit
86104 Pilot repeater control unit
86105 Tank commander repeater control unit
86106 Thermal starter w/lamp control unit
86107 Winch control unit
86108 Carburation control unit
86109 Engine oil topup control unit
86110 Automatic transmission control unit (on transmission)
86111 Alarm repeater control unit

86112 Gas system test and control unit (GAC)
86113 Gas system test and control unit (DELTEC)
86300 Flame sensor
86301 Sensor for winch rope wound up
86302 Sensor for winch rope unwound
86303 Sensor for winch rope winding check
86304 Sensor for injector position check (EDC)
86306 Atmospheric pressure detecting sensor
88000 Electronic control unit, ABS system
88001 Sensor, ABS system
88002 Electronic control unit, information, ABS system
88003 Relay and solenoid valve unit (ABS)
89000 Food heater
89010 Chafing-dish

FUSES



178AP01

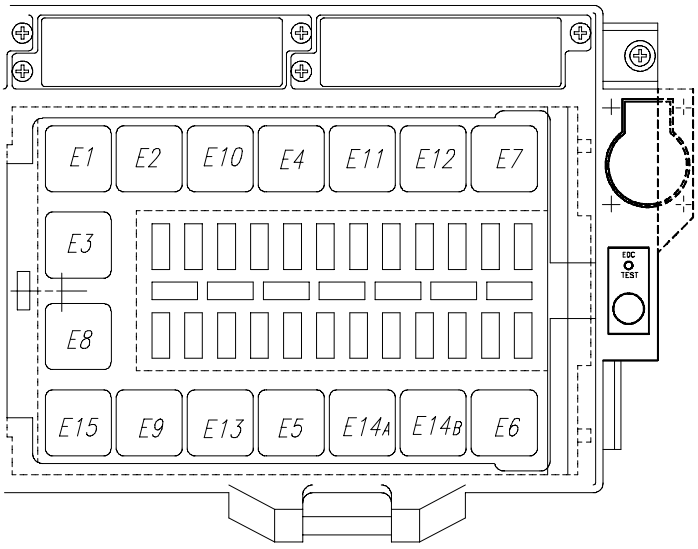


178AP02

	Pos.	Function	Amp.
01	1	Air conditioning/heated rear window	10.0
	2	Fridge	5.0
	3		
	4		
	5		
	6		
02	1		
	2		
	3	Key operated switch	5.0
	4	EDC	15.0
	5		
	6		
03	1		
	2	Heated Diesel fuel prefilter	15.0
	3		
	4		
	5		
	6	EDC	20.0

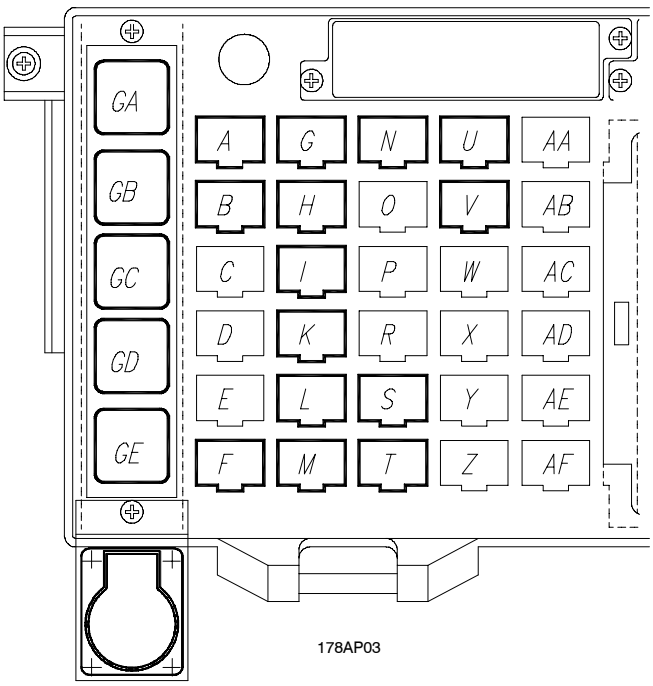
	Pos.	Function	Amp.
04	01	Lights, front headlight, L parking/panel illumination	7.5
	02	Lights, front headlight, R parking/headlight washer	7.5
	03	Dipped headlights/high beam control	3.0
	04	L dipped headlights	5.0
	05	L high beam	5.0
	06	R dipped headlight	7.5
	07	R high beam	7.5
	08		
	09	Rear fog light	5.0
	10		
	11	Horns	10.0
	12	Brake air dryer	5.0
	13	Battery charger/automatic glowplug warning light	3.0
	14	Warning light tester	3.0
	15	Windscreen wiper/timer	7.5
	16	Hazard warning lights	10.0
	17	L, R indicators	7.5
	18	Stop lights	7.5
	19	Reversing light	7.5
	20	Tachograph	3.0
	21	Cigar lighter/interior light	10.0
	22	Rotating lights	10.0
	23	Window winder/press. aria condotta autom. rim.	20.0
	24	Fan heater	15.0

REMOTE SWITCHES



178AP04

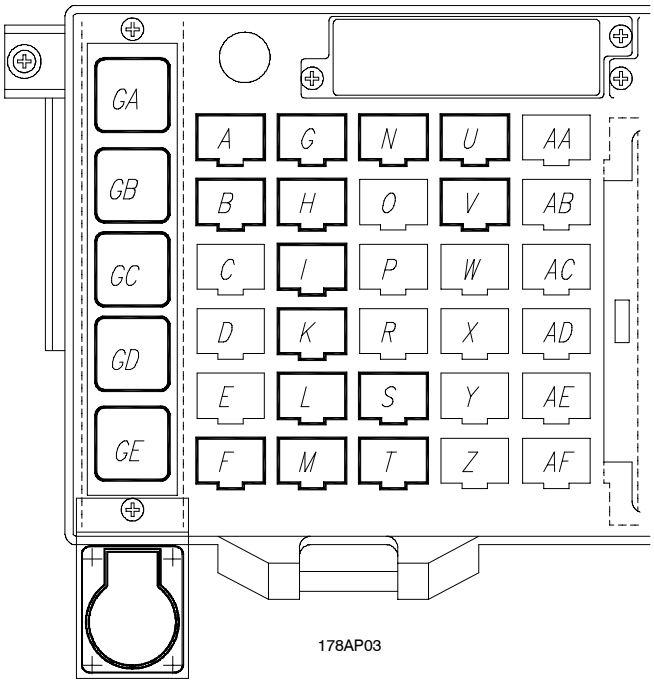
Pos.	Function	Code
E1	Starter relay	25200
E2	Dipped headlights	25013
E3	Remote switch for 15A terminal	25209
E4	Flasher	25004
E5		
E6	Stop lights	25006
E7		
E8	Diode holder	61000
E9	Windscreen wiper timer	59100
E15	Anti-starting system	25204
E10	High beams	25009
E11		
E12	Horns	25805
E13		
E14A		
E14B		



178AP03

Pos.	Function	Code
A	Prefilter heater remote switch	25817
B	D+ remote switch	25874
C	TGC anti-detach remote switch (ADR and not)	25930
D	TGC enabled warning light relay switch (ADR)	25740
E	Diodes for TGC anti-detach remote switch (ADR and not)	61004
F	EDC remote switch terminal 15	25858
G		
H		
I	Hour meter remote switch	25814
K	Neutral starting remote switch	25605
L	Rear fog light on remote switch	25034
M	Engine EDC off remote switch	25903
N	Air conditioning remote switch	25332
O		
P		
R		
S	PTO parametr. resistors	61125
T	Engine braking button resistor	61122 B
U	Engine braking resistor	61122
V	Interior light diode holder	61002
W		
X		
Y		
Z		

REMOTE SWITCHES



Pos.	Function	Code
GA	Servosteering fluid level electronic inverter	25868
GB	15/50A terminal remote switch	25213 A
GC	Engine running anti-starting system 40A	25224
GD	15/50A terminal remote switch	25213 B
GE	EDC general remote switch	25924

Pos.	Function	Code
AA	+ set adjustment relay switch	
AB	- set adjustment relay switch	
AC	Engine external switch-off remote switch	
AD	Engine external start remote switch (handbrake)	
AE	PTO1 parameter setting	
AF	PTO2 parameter setting	

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ELECTRICAL SYSTEM DIAGRAMS

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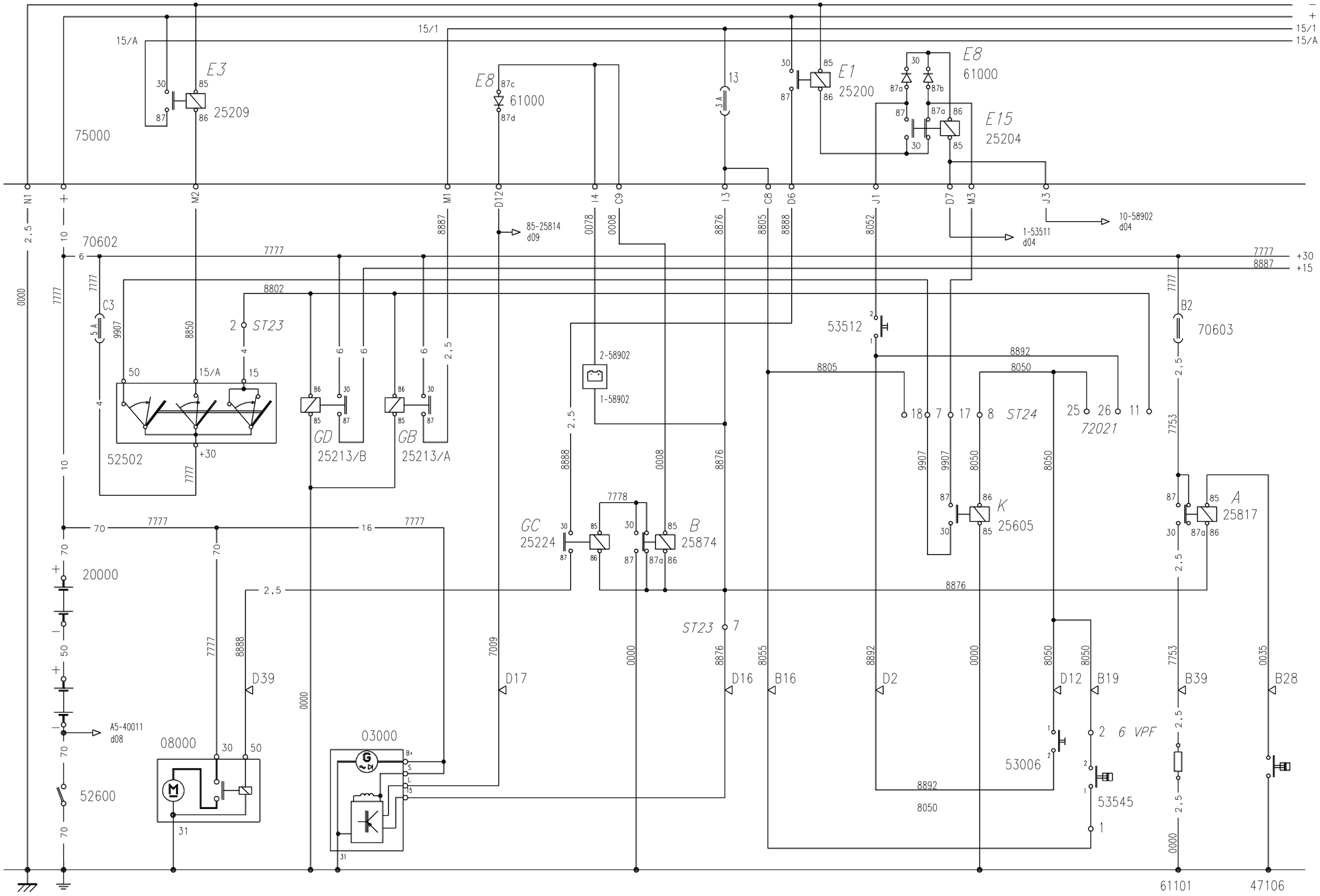
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M2
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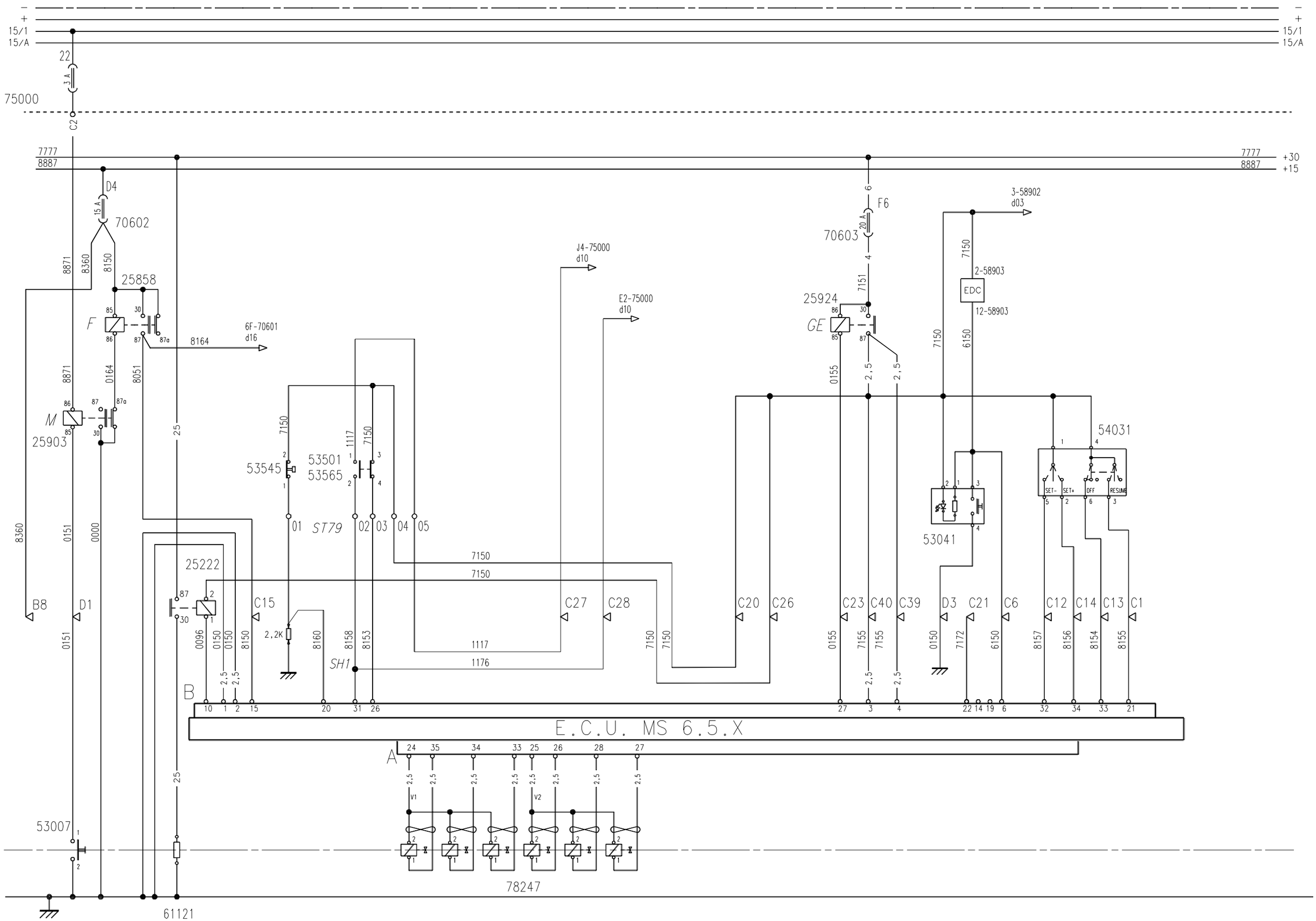
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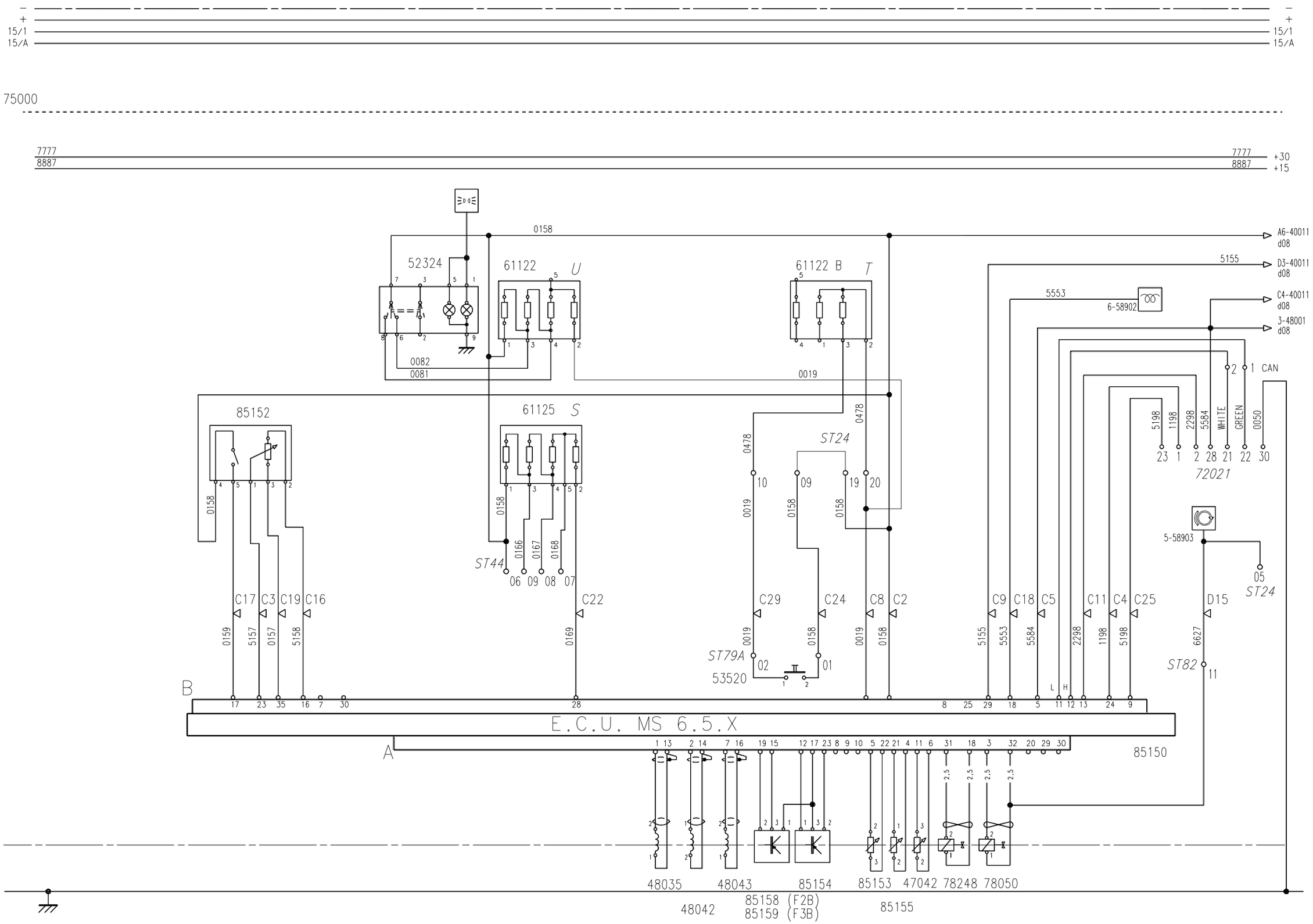
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C4-40011 d08
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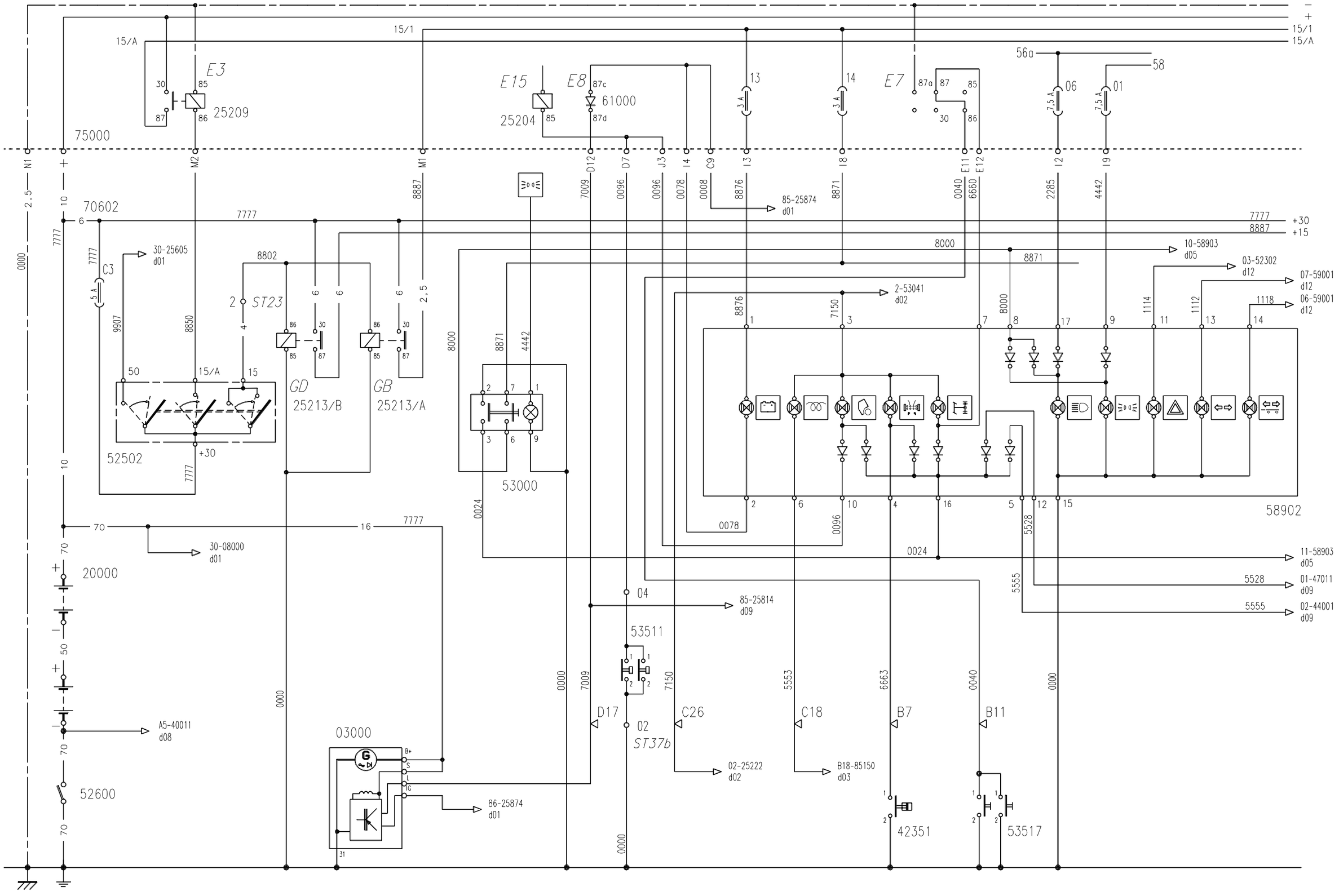
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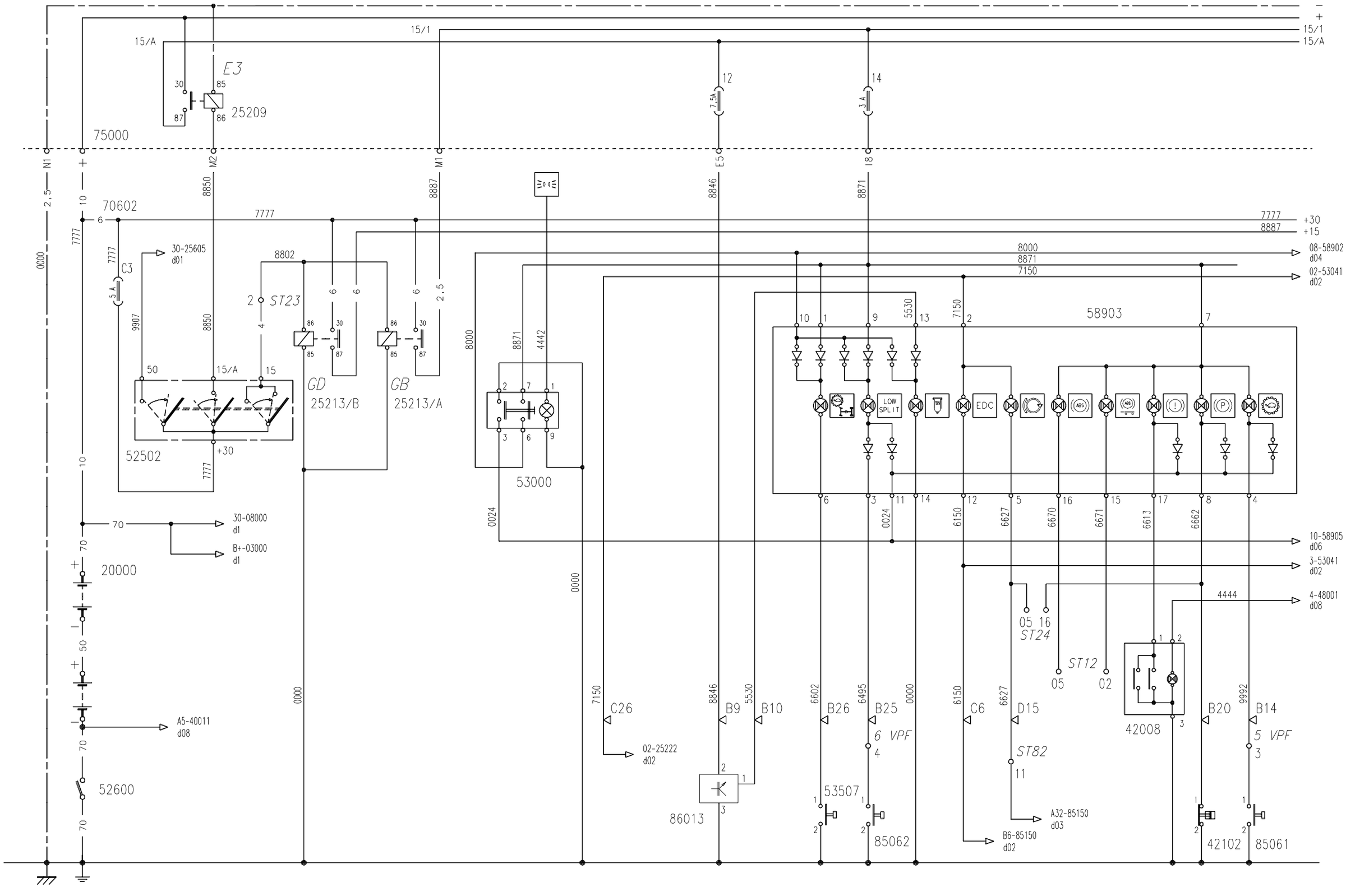
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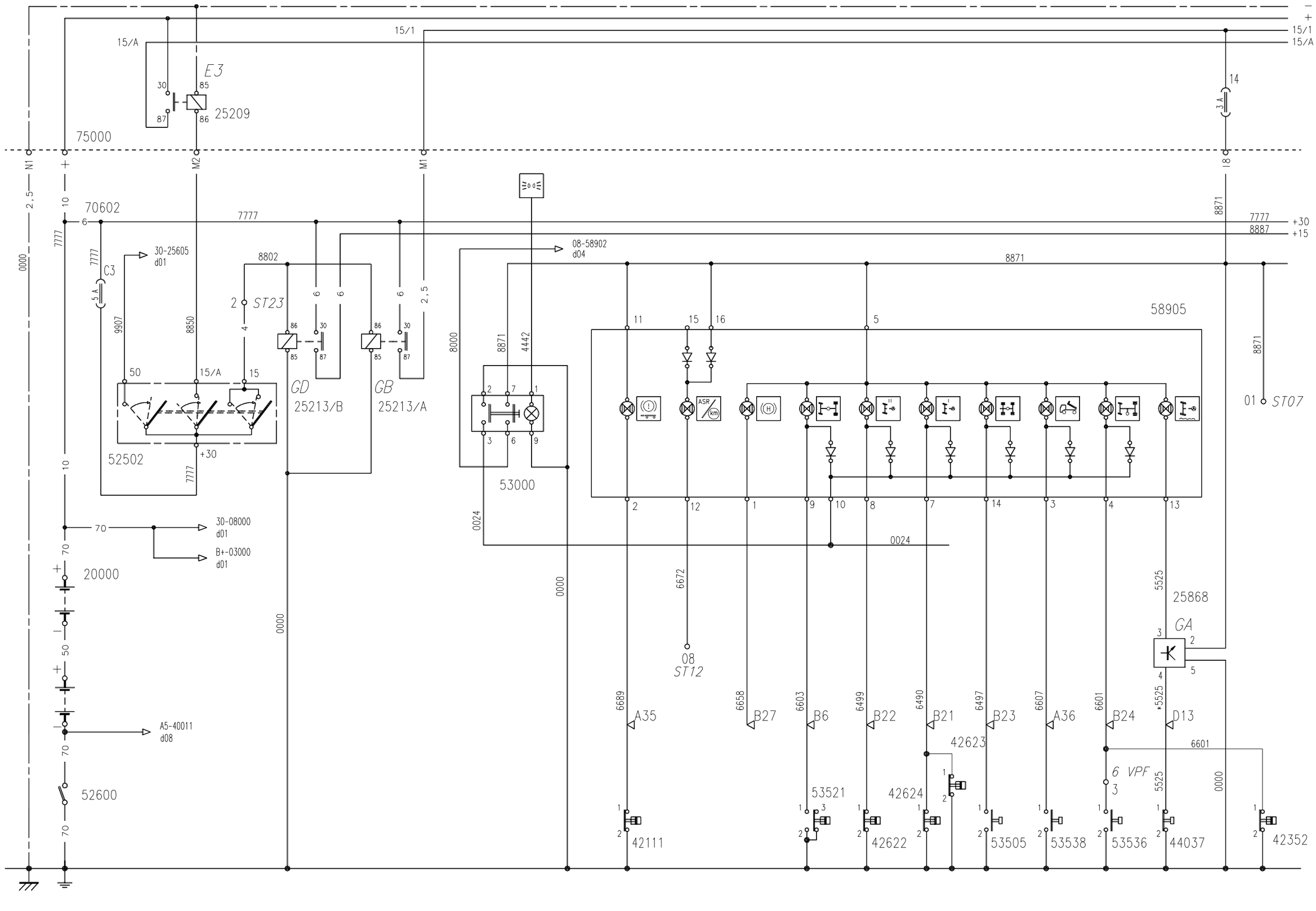
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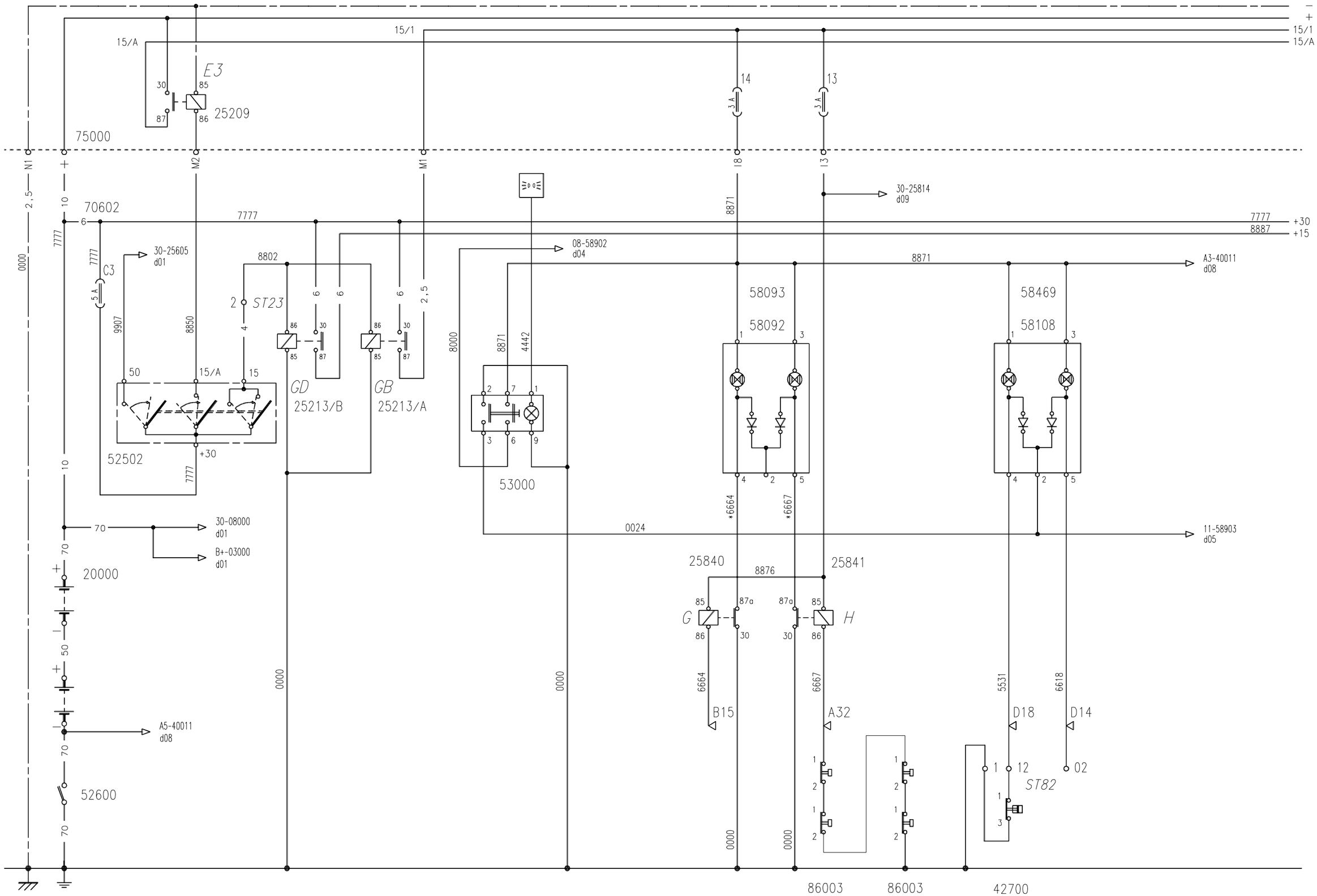
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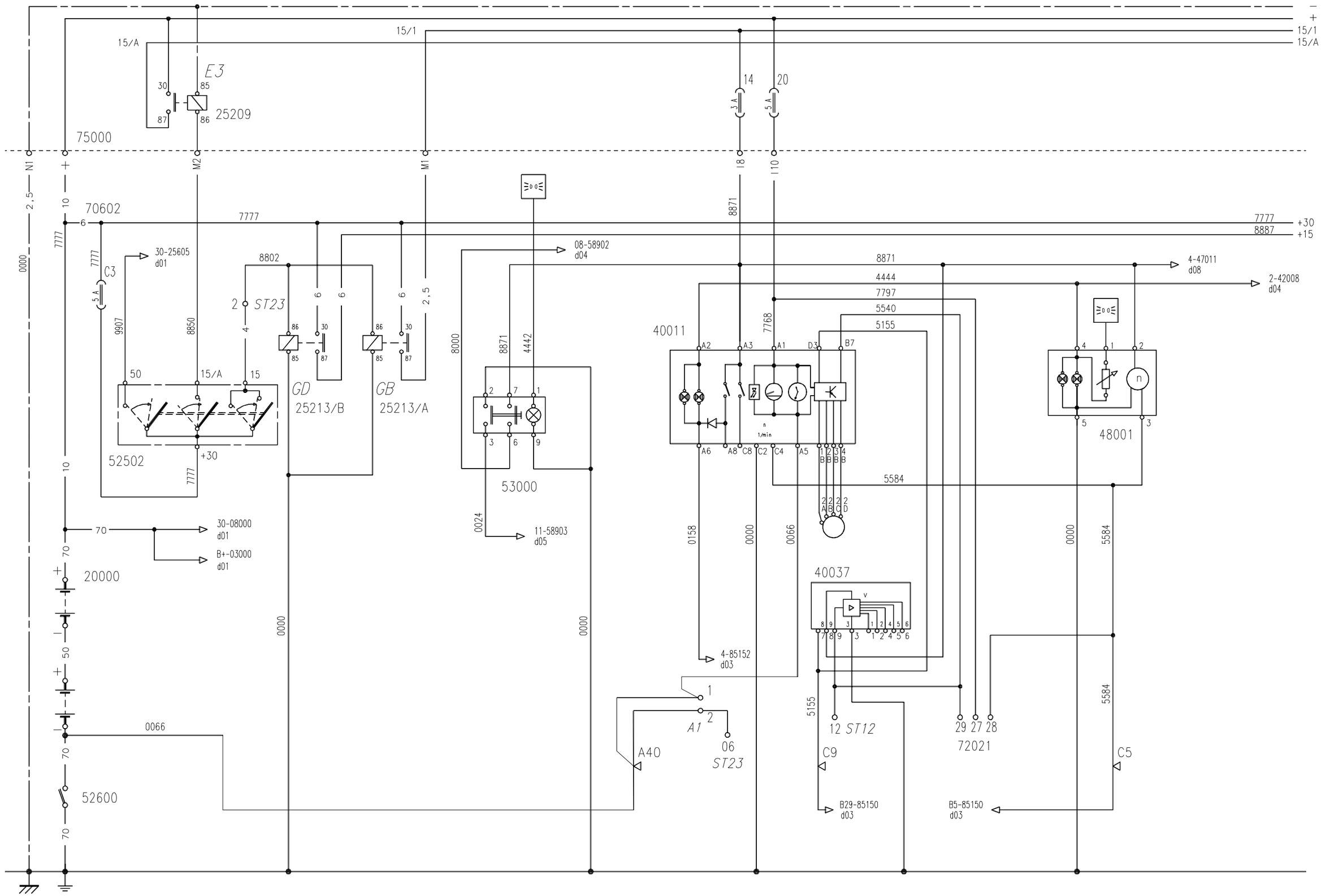
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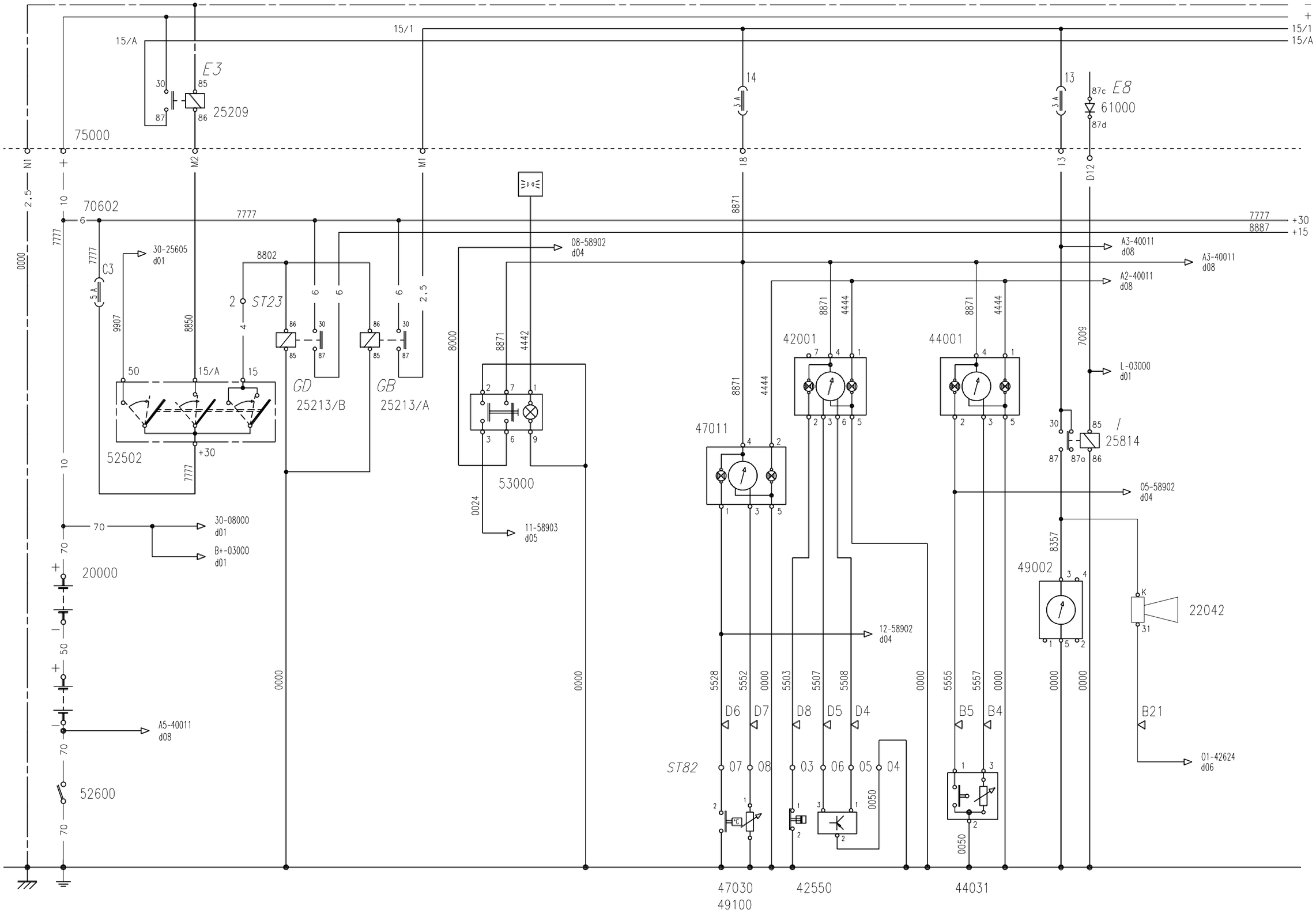
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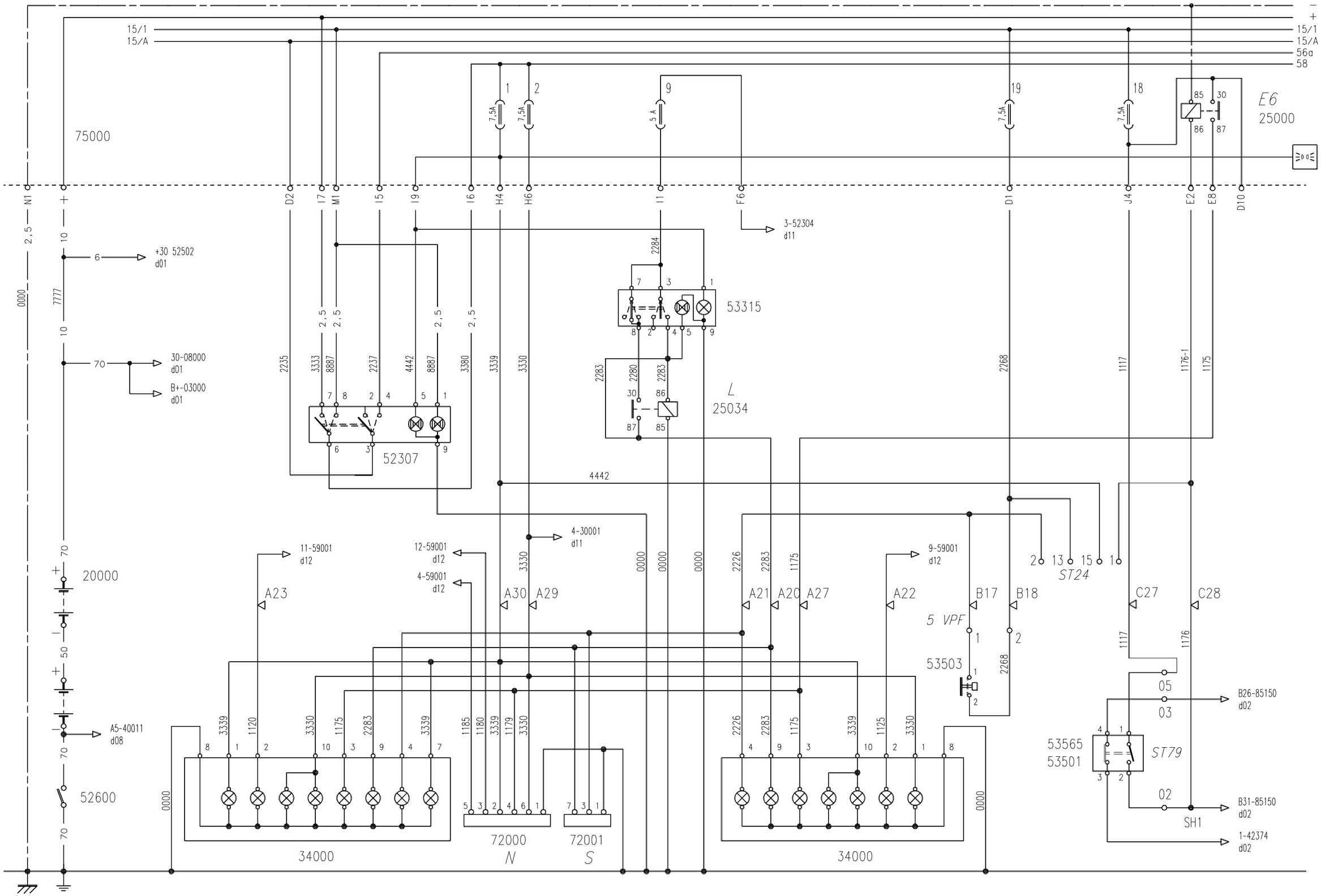
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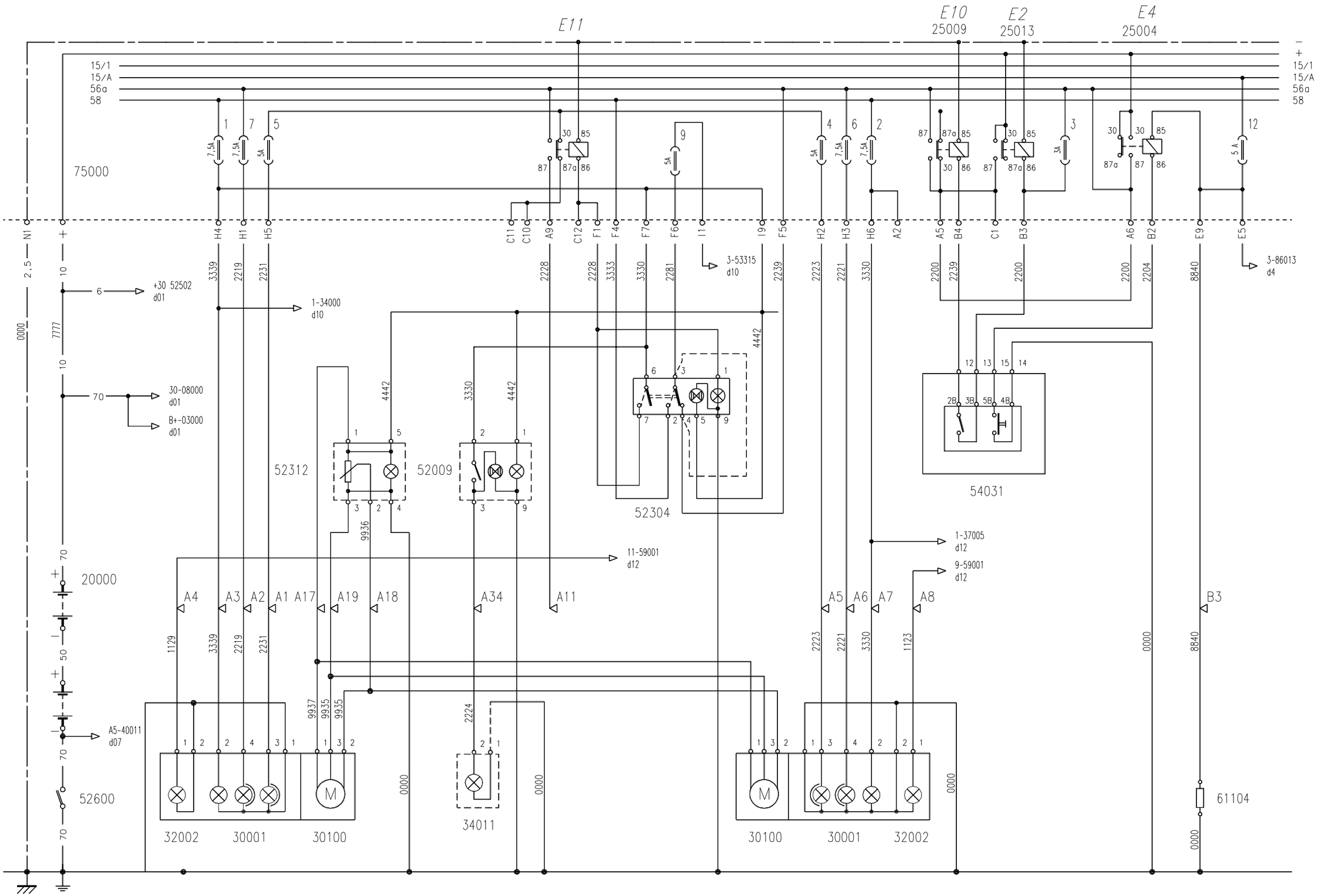
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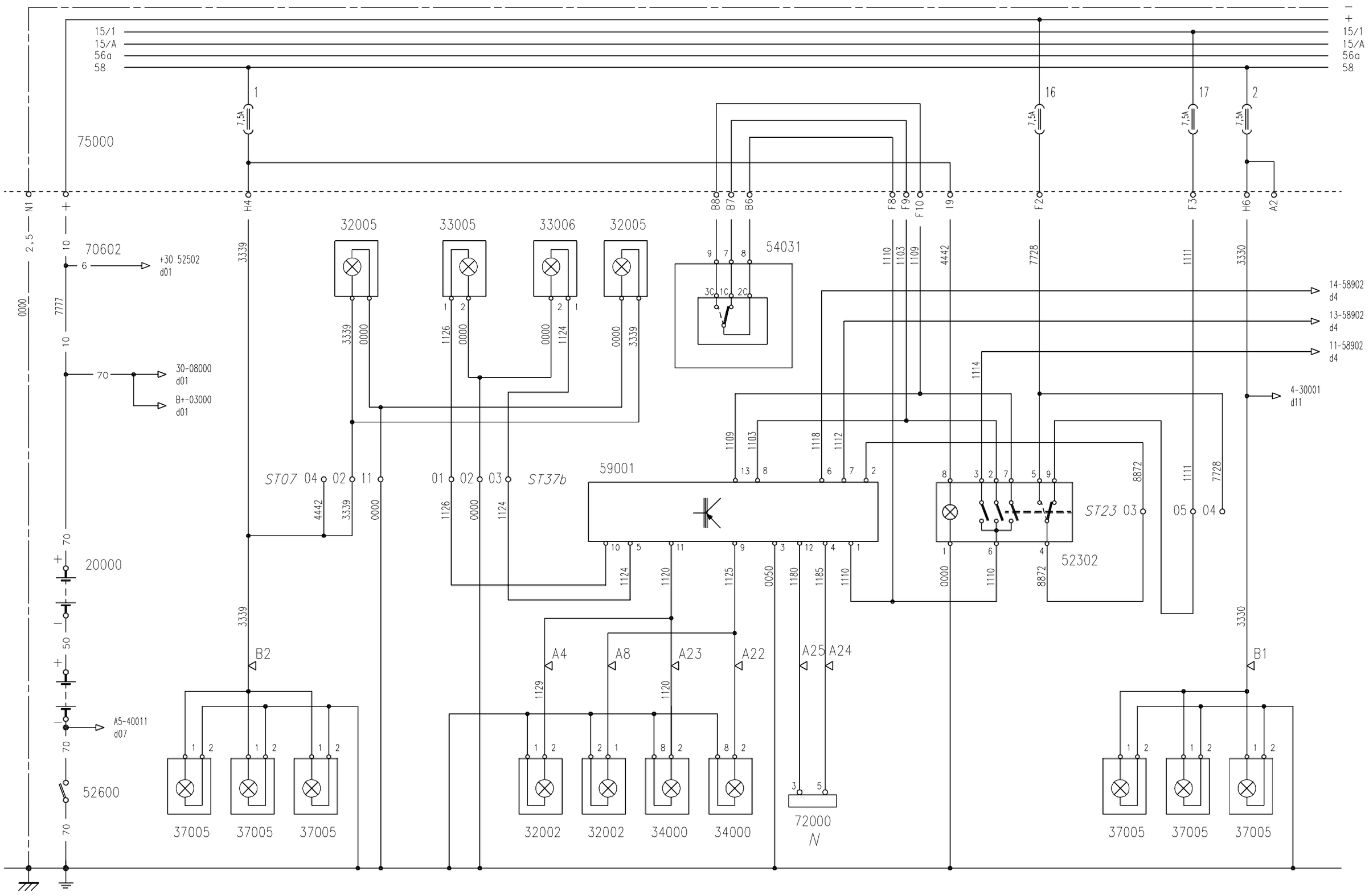
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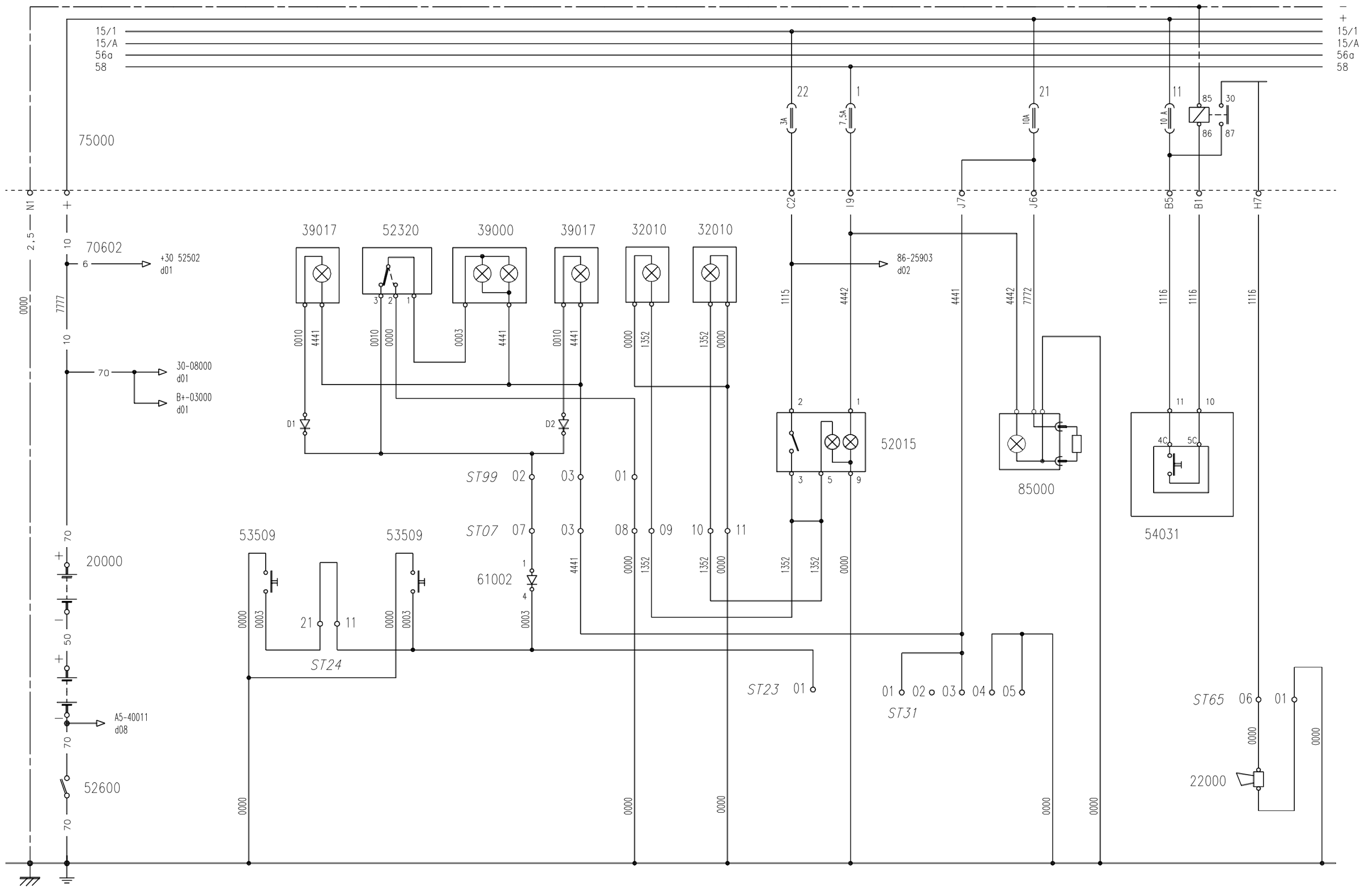
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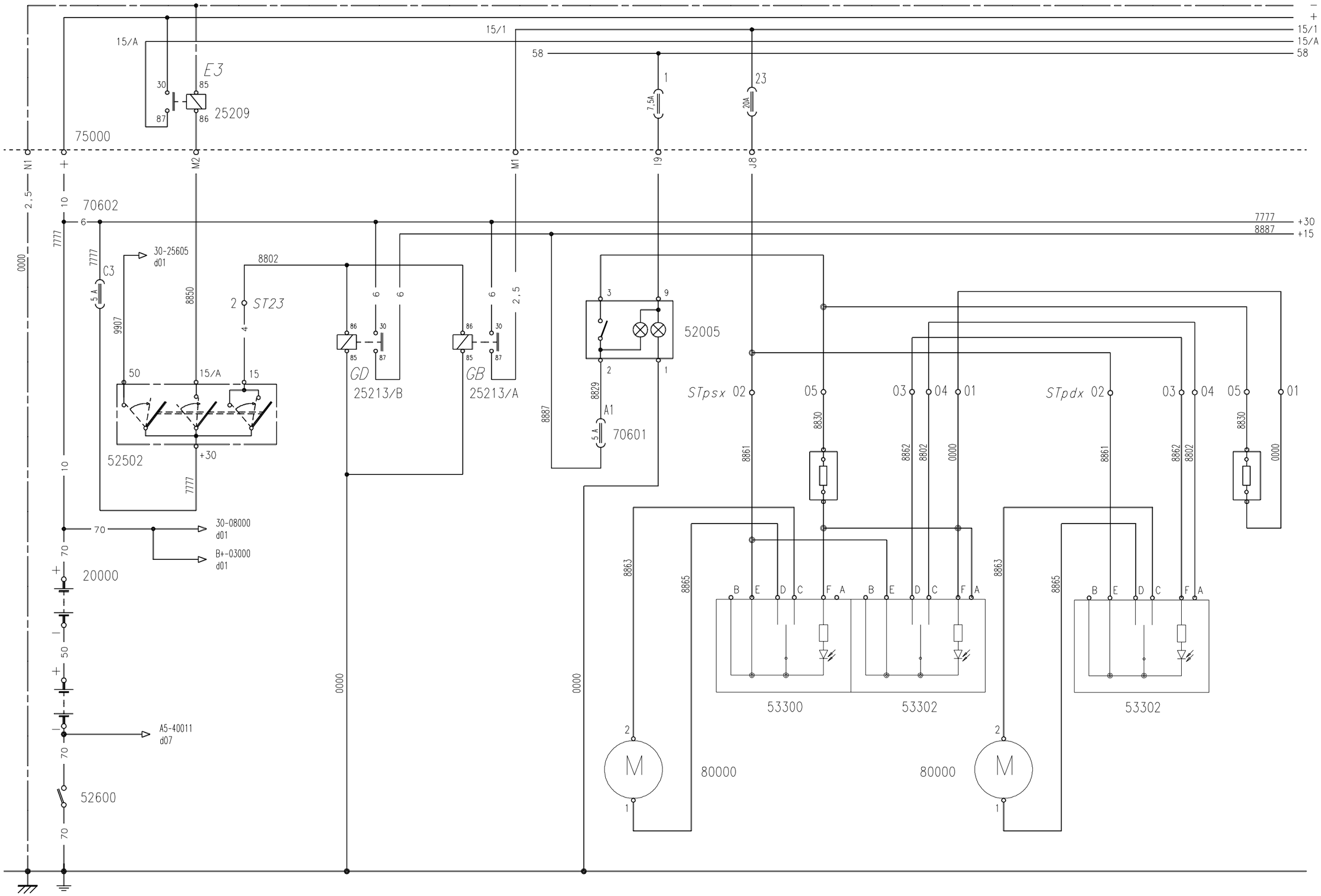
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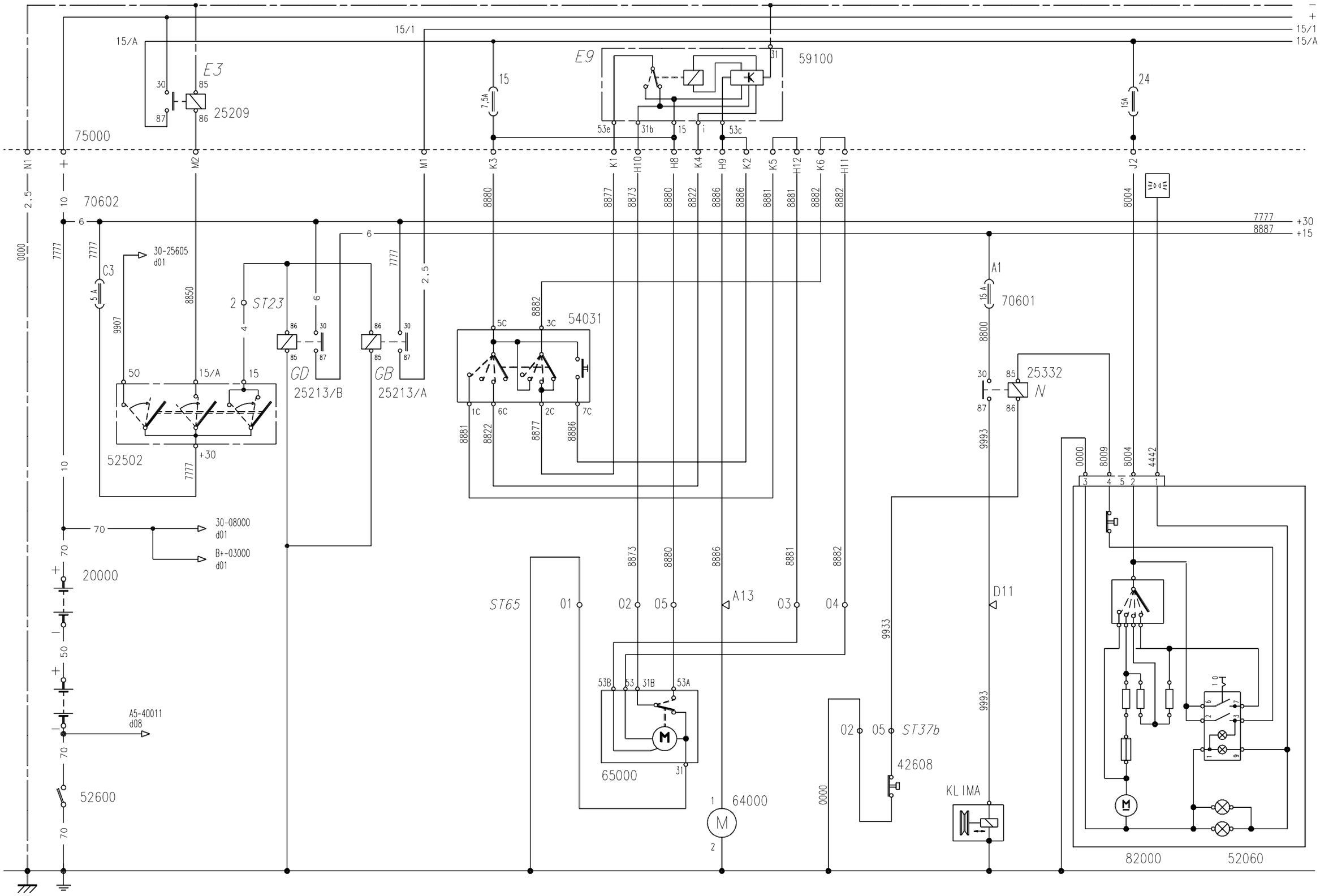
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CAB AND CHASSIS

SECTION 18

SECTION 18

Cab and chassis

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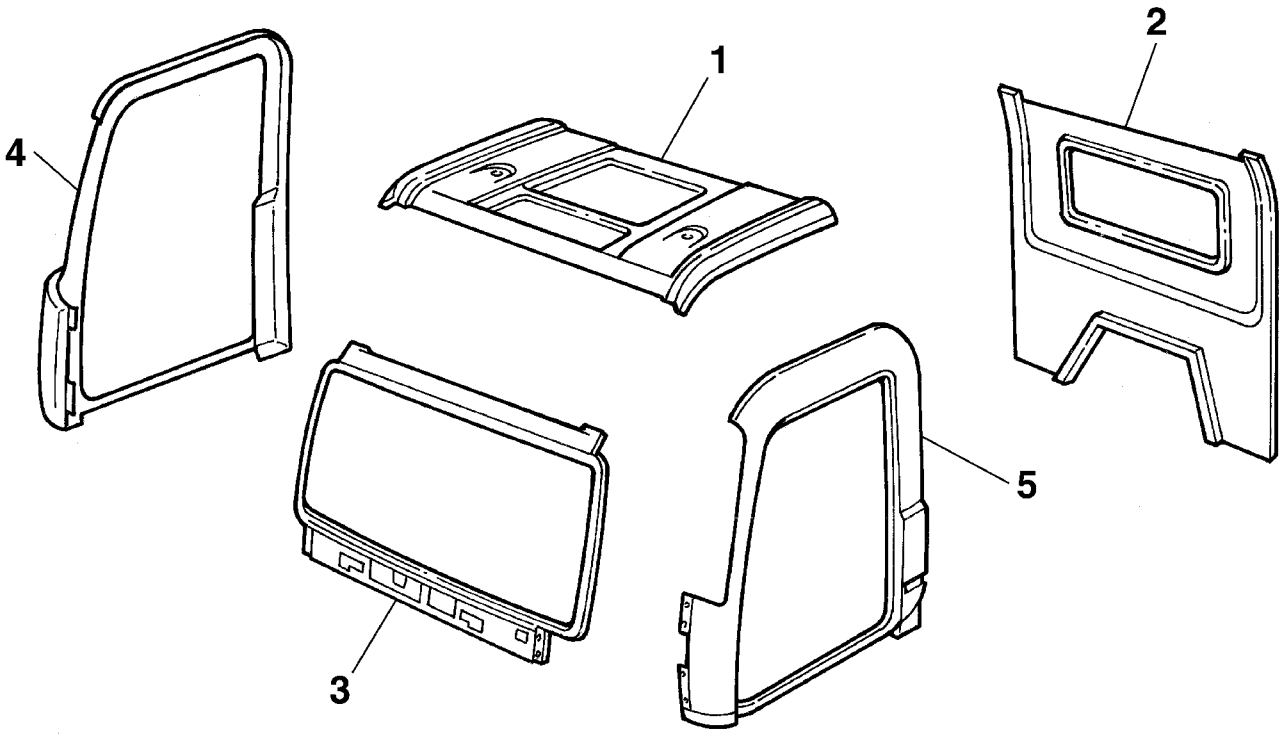
DESCRIPTION

The vehicle cab consists of several parts in fibreglass-reinforced plastic glued to each other and to a metal frame with polyurethane two-component structural adhesive.

Figure 1



1. roof - 2. rear panel - 3. front panel - 4. right side panel - 5. left side panel

CAB REPAIR

Introduction

Repairs that can be made on the cab are two basic types:

- ❑ surface repairs, regarding damage that has not, or has entirely damaged the whole thickness of the cab wall;
- ❑ structural repairs, regarding serious damage or perforation of the cab wall.

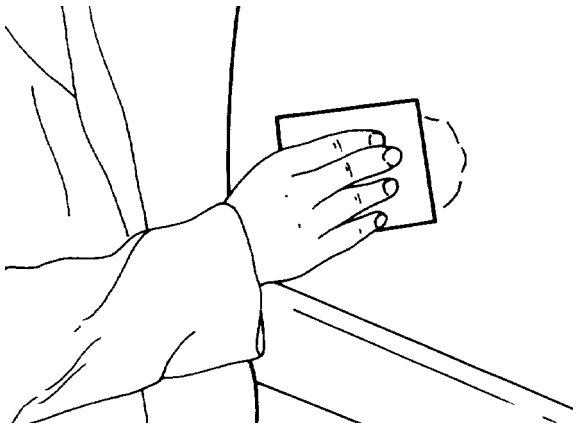
When checking it is therefore necessary to carefully inspect the body area involved in the impact externally, but above all, internally, after removing the internal trims, to verify the extent of the damage and to proceed accordingly.

Zones where the fibreglass-reinforced plastic has been broken will be torn, with the glass frayed and above all of a lighter colour in the area around the breakage (this can only be seen from inside, where there is no paint).

Surface repairs

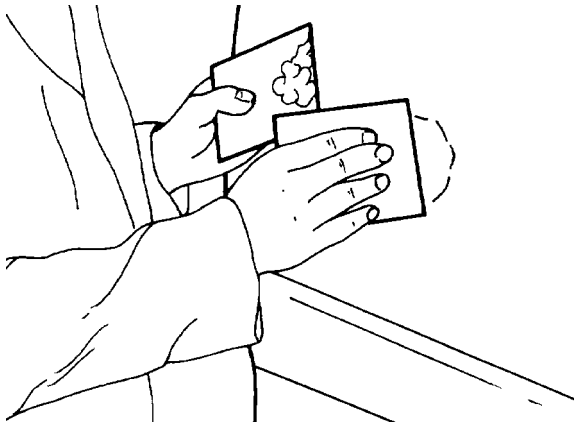
Proceed as follows:

Figure 2



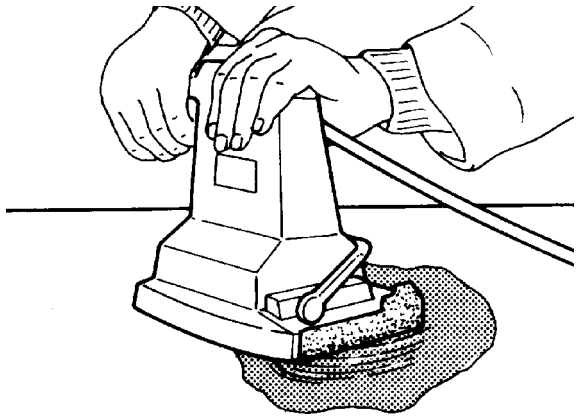
- ❑ de-grease the treated surface then pass sandpaper over the damaged part to roughen the bottom and the edges;
- ❑ prepare the special stopper, mixing with the catalyst in the percentages indicated by the manufacturer;

Figure 3



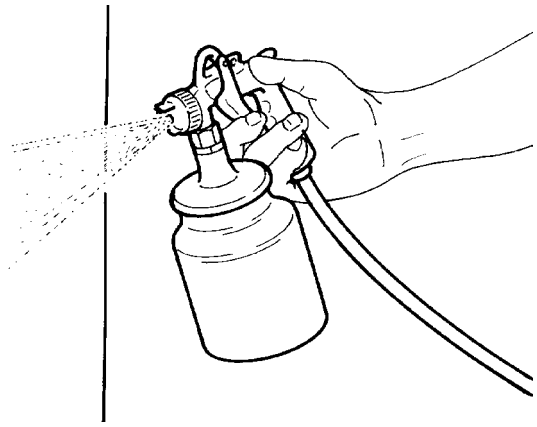
- ❑ apply the stopper, taking care to completely fill the damaged part and to avoid the forming of air bubbles;
- ❑ allow to dry until it has completely hardened;

Figure 4



- ❑ rub down to remove the excess stopper, smooth with emery paper and water until a smooth surface is obtained;

Figure 5



- ❑ paint and polish following the usual rules for car bodies.

Structural repairs

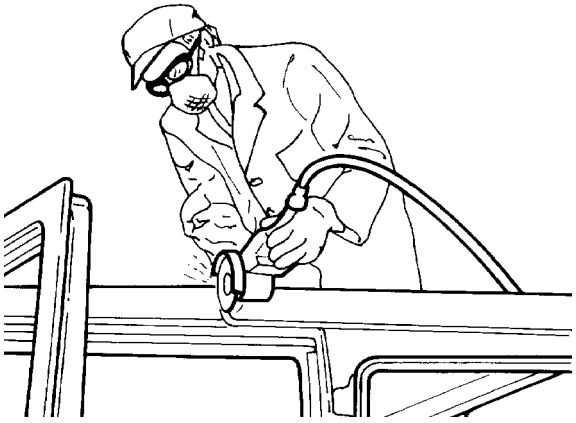
It is common knowledge that fibreglass-reinforced plastic has high mechanical resistance and deformation from impacts is almost non-existent. As a consequence, if the cab is hit, the part that receives the impact may be perforated, but the damage is always very confined because there is no surrounding plastic deformation.

Therefore to repair the cab it is necessary to cut away the damaged part and replace it with an identical piece obtained from a spare part.

Proceed as follows:

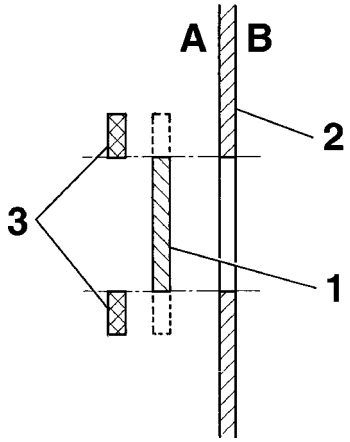
- ❑ assess which are the areas with serious damage to ask for the parts to be replaced completely or from which the parts to be replaced are to be obtained;

Figure 6



- ❑ with a jig saw and/or an abrasive grinding wheel, cut the part surrounding the break following as far as possible the body panel joints and/or the level variation lines (edges) so as to obtain a reasonably regular opening, remove any burrs and uneven cutting;
- ❑ carefully remove the residue of the previous adhesive from any points touching the metal frame;
- ❑ if the metal supporting frame has been damaged, this has to be restored to its original condition by cutting away the damaged parts and oxyacetylene welding the new parts, after carefully checking positioning and alignment;
- ❑ the replaced metal parts must be painted before continuing with the repairs on the body;

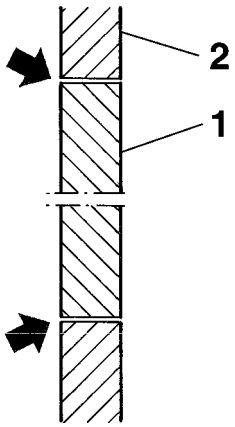
Figure 7



A: cab exterior
B: cab interior

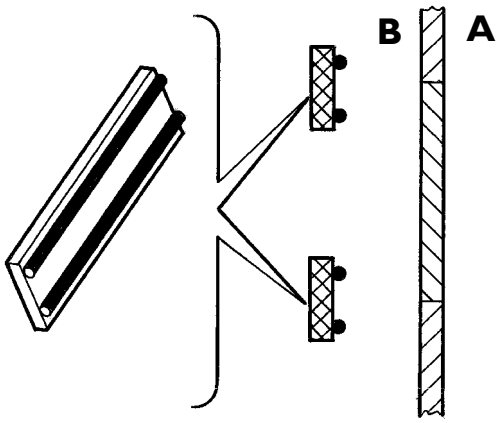
- ❑ prepare the new part (1) to be welded to the body (2) cutting it from spare parts; where the shape of the opening to be closed allows it, it is best to cut the edge about ten centimetres wider than necessary so as to obtain one or more panel strips (3) to use for support and reinforcement in the joining areas;
- ❑ thoroughly degrease the parts to be joined using a specific product;

Figure 8



- ❑ position the new part (**1**) taking great care over the alignments, bringing together with the body (**2**) using suitable equipment (clamps, adhesive tape, rods and push rods);

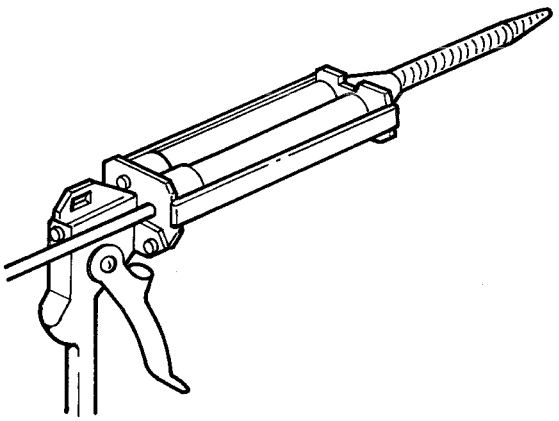
Figure 9



A: cab exterior
B: cab interior

❑ on the inner part of the prepared strips, apply two seams (arrow) of the specific polyurethane two-component structural adhesive using the special application tool; apply adhesive also on any points that contact the metal frame;

Figure 10



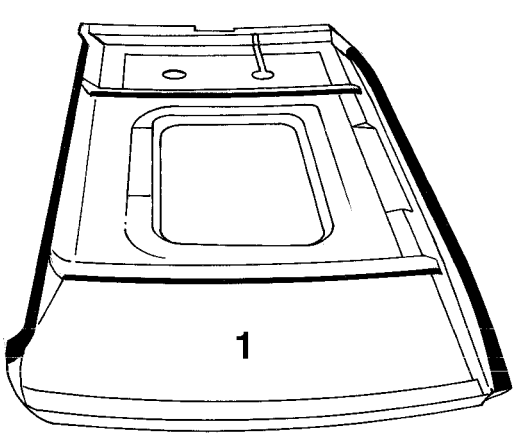
supplier : GURIT-ESSEX
product: BETAMATE 2K - 160 ml cartons

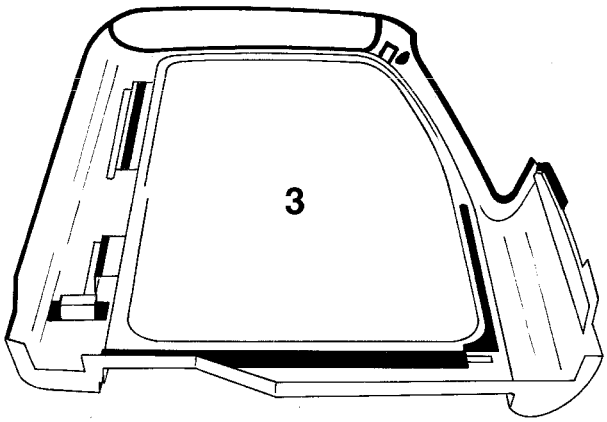
❑ fit the strips in place and keep them in position with suitable tools (clamps, rods, push rods);

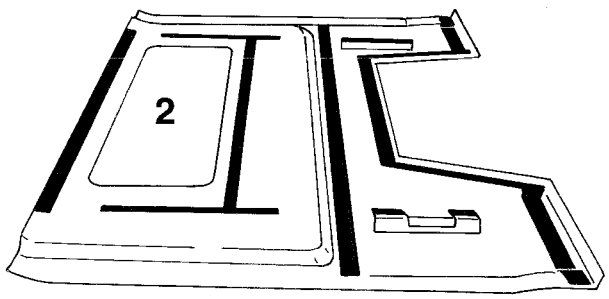
❑ wait until the adhesive has dried completely: it is best to wait 24 hours;

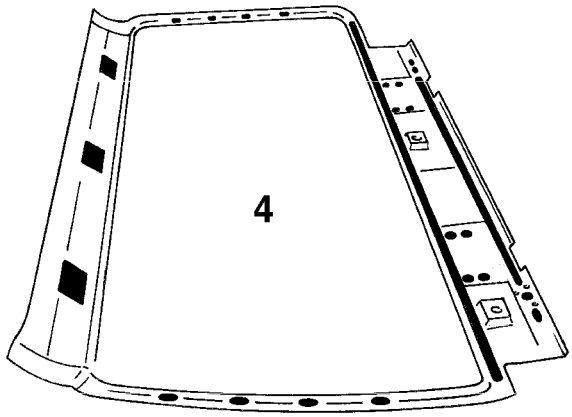
❑ if an entire part of the cab has to be replaced - (1) roof, (2) rear panel, 3) side panel, (4) front panel - the adhesive seam must be applied in the areas shown in the figures below:

Figure 11



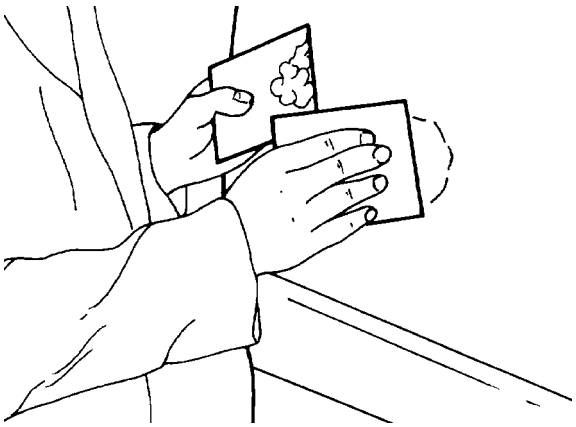






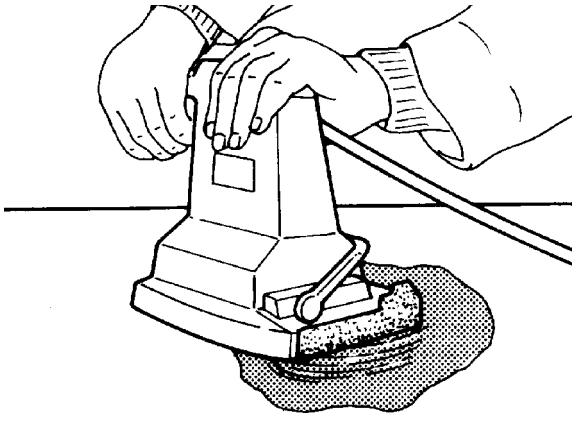
- ❑ when completely dried, remove the supports and tools used to keep the new part in position;
- ❑ prepare the special stopper, mixing with the catalyst in the percentages indicated by the manufacturer;

Figure 12



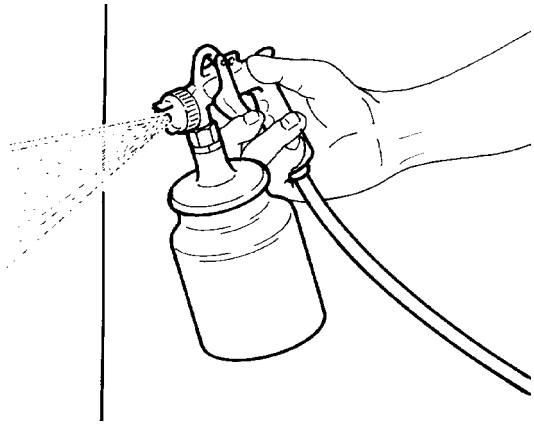
- ❑ apply the stopper, taking care to completely fill the remaining cracks and any imperfections;
- ❑ allow to dry until it is completely hardened;

Figure 13



- ❑ rub down the excess stopper, smooth with emery paper and water to obtain a smooth surface;

Figure 14



- ❑ paint and polish following the usual rules for car bodies.

CHASSIS

SPECIFICATIONS

Chassis

The chassis transmits load weight and component weight to springs and axles. It absorbs the stresses produced during running, e.g. flexure, thrust and torsional force, tensile stress and vibrations.

Chassis conditions are therefore essential for vehicle operation. Inspect the chassis at regular intervals to check that chassis and members thereof are free from cracks or damages, that bolts and rivets are well tightened especially in the areas submitted to stress, i.e. on leaf spring supports, on drive support, on cross members and tow hook.

Every crack or distortion of the chassis seriously impairs chassis resistance to operating stress.

The negative consequences often result in an axial displacement which has negative effects on the driving performances and causes earlier tyre wear.

Any additional hole drilled inadequately in the connection points with other components can be the starting cause of serious damages to the chassis.

This also applies to any interference with other parts or to pits due to rust, since these can increase notch sensitivity and favour crack formation.

Auxiliary chassis

Substructures are connected to the chassis by means of an assembling chassis destined to avoid load being bearing on certain points instead of being distributed uniformly.

The auxiliary chassis is made up in such a way as to not impair chassis twisting capability.

REPAIR OPERATIONS

CHECKS

Visually check the chassis controlling the alignment.
If deformations can be seen, free the relevant part of the chassis for easier measurement.

Before checking, ascertain that all members that could, with their imperfections, influence the exact measurement readings (for example, tyre inflation pressure, weak or broken leaf springs and so forth) are efficient.

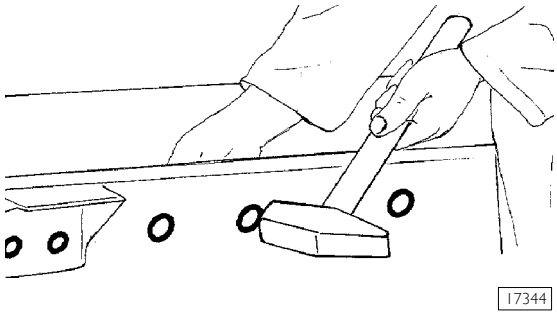
Modifying the chassis

The following modifications can be performed only after written consent by our plant:

- ❑ wheel base modification;
- ❑ chassis cantilever extension;
- ❑ driving-steering system modification;
- ❑ leaf springs modification or addition of auxiliary supporting elements;
- ❑ holes or welding on the chassis;
- ❑ power unit or driving parts modifications;
- ❑ exhaust gas system modification;
- ❑ steering axles or driving axles assembling.

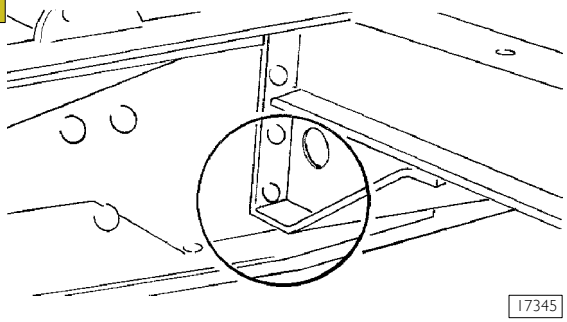
The above mentioned modifications can impair vehicle soundness and can also be dangerous for the driver, it is therefore recommended to observe strictly our directions.

Figure 15



Check the tightness of rivets by hammering the rivet heads and touching the opposite side with the fingers.
Mark any loose rivets with paint in order to find them easily when making the repair operations.

Figure 16



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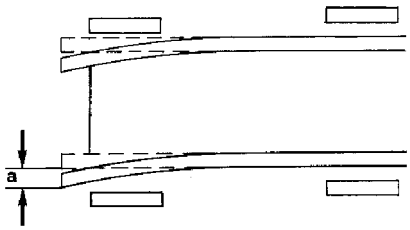
Carefully check the entire chassis for cracks paying special attention to highly stressed coupling points between chassis cross members, brackets, leaf spring supports and chassis side members.
Mark immediately any cracked spots.
Mark immediately any cracked spots.

Figure 17



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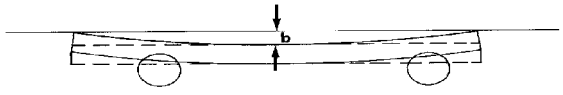
Chassis lateral bending check.
Chassis lateral bending admitted
"a" = 3 mm/m

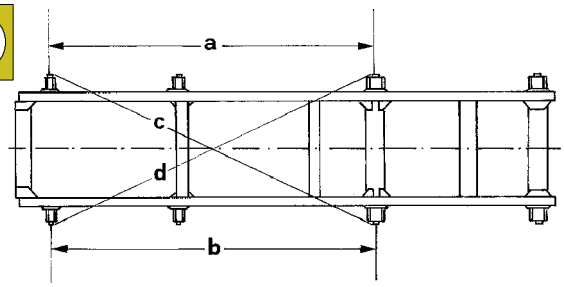
Figure 18



17348

Chassis bending check.
Chassis bending admitted
"b" = 1 mm/m
Maximum 10 mm

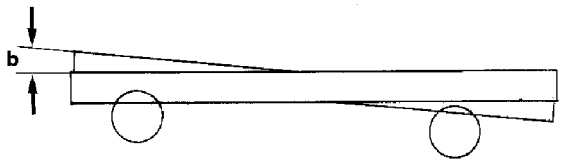
Figure 19



17349

Chassis alignment check.
Admitted difference between "a" and "b" = 3mm
With diagonal measurement from "c" and "d" = 6 mm

Figure 20

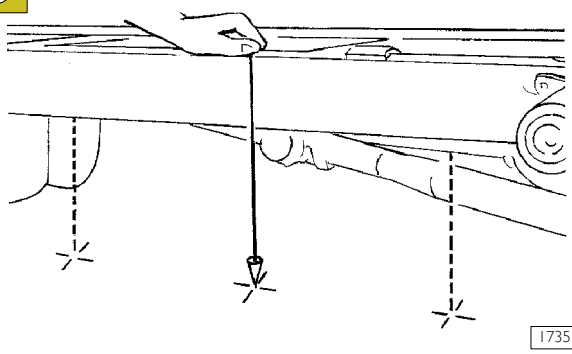


17350

Chassis twist check.
Chassis twist admitted
"b" = each side 1 mm

Finding chassis lateral bending

Figure 21

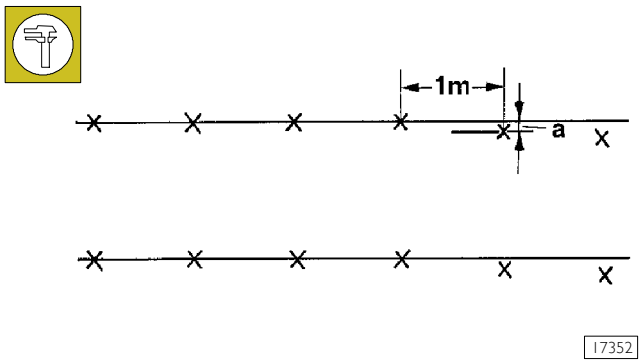


17351

To find the chassis lateral bending plumb the bearing surfaces starting from the two side members at intervals of approx. 1 m.

The points obtained must be carefully marked on the floor.

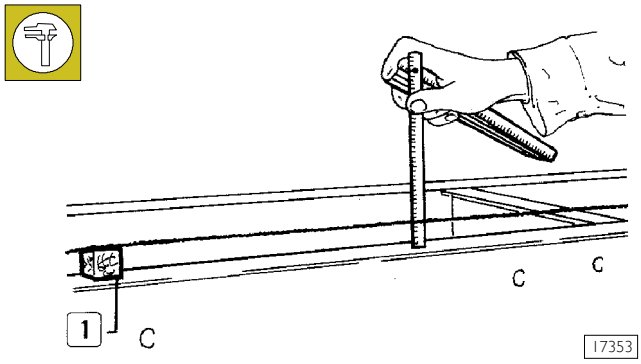
Figure 22



In order to use the plumbed points, stretch a cord through the aligned points marked.
The points that are not aligned indicate the beginning and the entity of the actual strain (a, Figure 22).

Finding chassis bending up and down

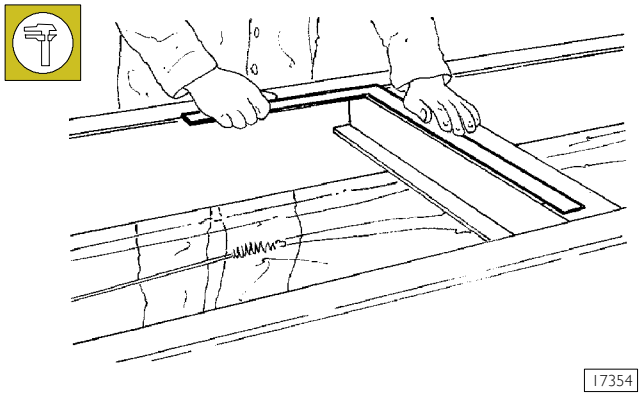
Figure 23



Use two shims (1, Figure 23) of the same thickness and of a size that permits a cord to be stretched throught the straight length of the lower or upper edge plate of the side member.
Measure the distance of the side member from the cord at 1 metre intervals. Different cord distance shows position and entity of actual side member bending.

Finding chassis displacement

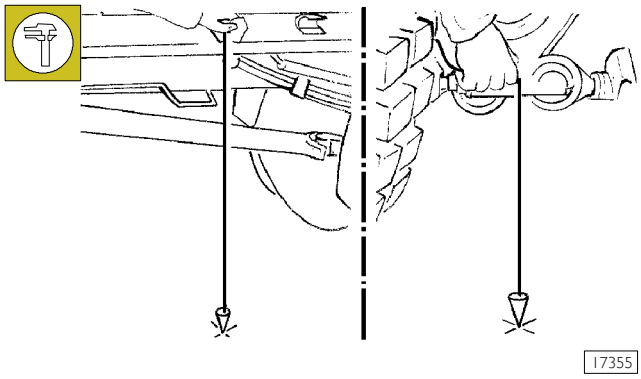
Figure 24



Chassis displacement may be found by using a square.
To this purpose set the square at 90° to the chassis side member and check the orthogonality of chassis cross members.

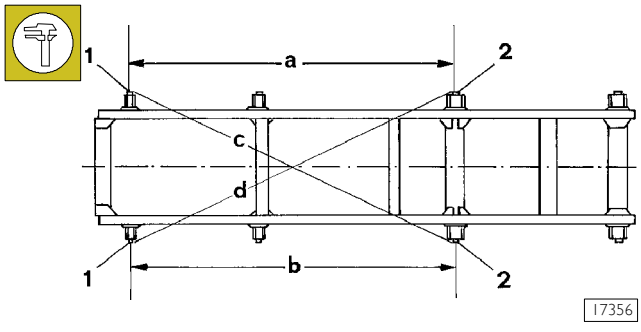
Axle position

Figure 25



A displacement of the axle positions may be checked by diagonal measuring. To this purpose plumb to the flat bearing surface, on both sides, the centre of the front suspension front support and the centre of the rear leaf spring front support.

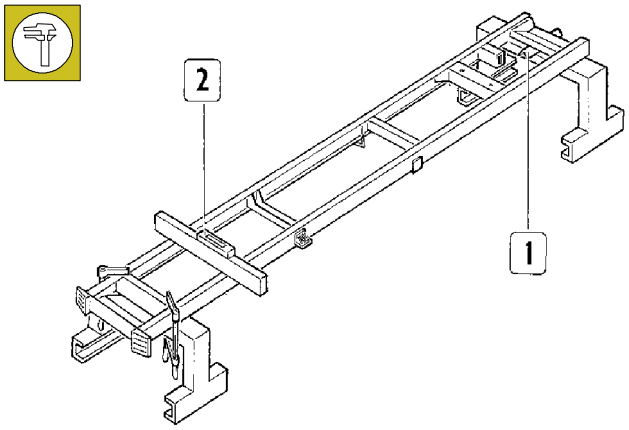
Figure 26



First compare the distance of points "a" and "b". Then carry out diagonal measuring (distance "c" and "d") from point (2, Figure 26) on the front to the right and point (1, Figure 26) on the rear to the left and in the opposite directions.

Finding chassis twist

Figure 27



17357

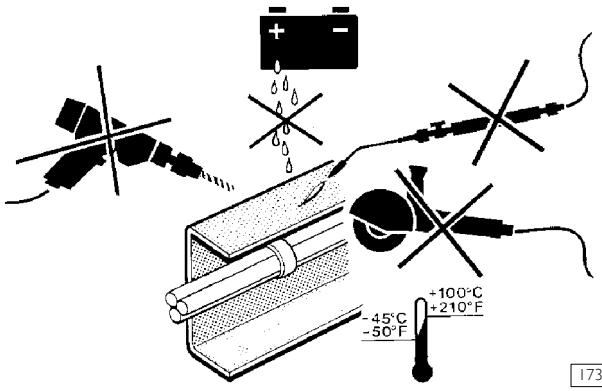
Slight torsion may only be detected with the cab and mechanical units removed. To make the check, proceed as follows:

- ❑ place the chassis on two stands;
- ❑ fasten one side of the chassis to the stand with two clamps;
- ❑ set the other side of the chassis on the knee of an "L" iron (1, Figure 27) in central position under the rear cross member;
- ❑ place a ruler in cross position and a spirit level (2, Figure 27) on the ruler and check the readings.

The same value should result at each check point, otherwise the chassis is deformed.

PRECAUTIONS

Figure 28

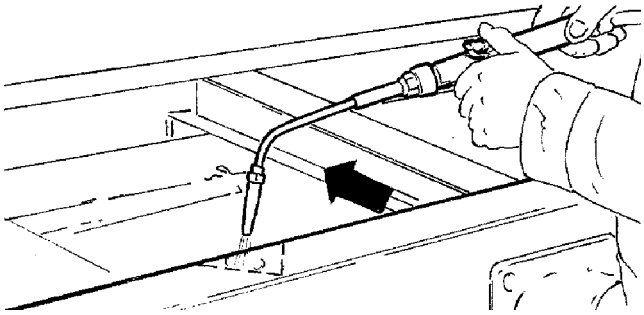


17358

When welding, drilling, grinding or cutting near the pipes of the braking system, especially near plastic parts or electrical wiring, take adequate precautions to protect them, and if necessary, remove them. All parts of the chassis that are reconditioned are to be protected from oxidation and corrosion.

Protection and painting operations are to be carried out accurately on all the parts involved, following any instructions, methods, and preventive precautions indicated by the paint manufacturers.

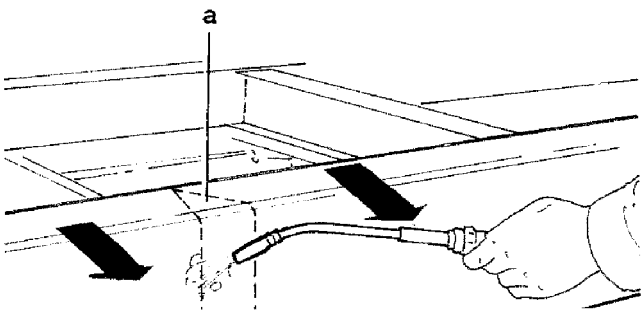
Figure 29



17359

The chassis reconditioning is obtained by wedge heating the part concerned with a torch.
During this operation the metal must become cherry red coinciding with a temperature ranging between 600 and 680°C.
The points already heated must not be re-heated.
Let the heated points cool slowly without using water, compressed air or other cooling agents.

Figure 30

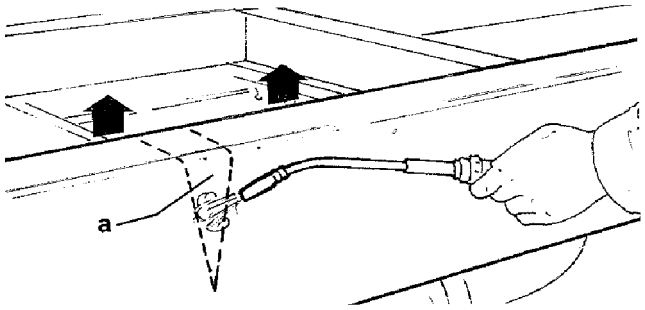


17360

Straighten chassis lateral bending by wedge heating the upper and lower edge of the chassis length concerned.
The wedge point must in the desired bending direction.

If the base (a, Figure 30) of the two wedges is on the upper edge plate of the side member, the plate must also be heated, but last.

Figure 31

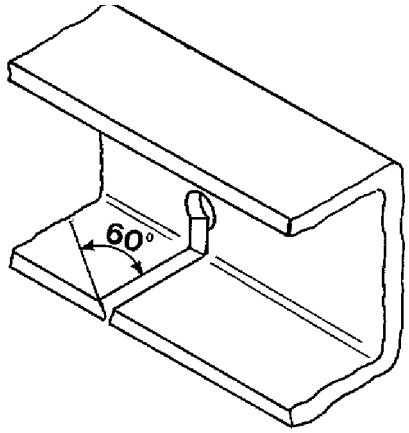


17361

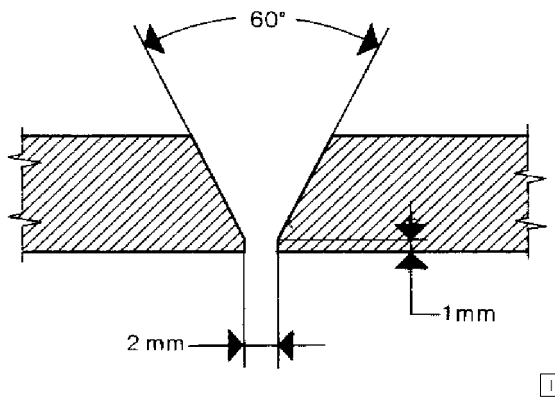
Straighten the chassis up or down bending by wedge heating the upper edge plate of the side member. When bending down, the base of the wedge (a) is down, for up bending the base is up.
The relevant lower or upper edge plate of the side member is to be heated last in the area where the wedge base lays.

Welds on the chassis

Figure 32



17362

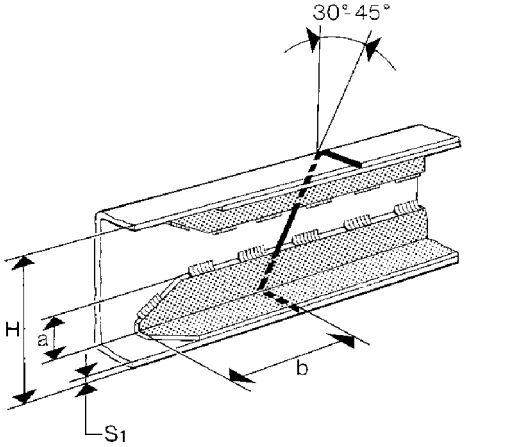


17363

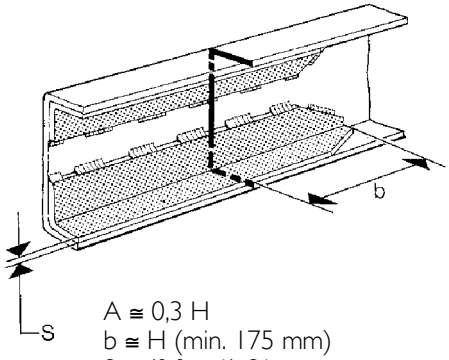
Before starting to weld, remove the negative battery terminal and connect the welding machine earth directly on the part to be welded. Plastic hoses must be protected or removed.
Excellent workmanship is essential and welding shall only be carried out by skilled and trained operators using suitable equipment.
Strip off the paint and remove rust from the parts to be welded.
Make a V chamfer of 60° on the broken point in the inner part of the side member along the entire length concerned.

No cuts are admitted on the side members in areas where the profile changes or in the points subject to heavy stress, moreover, the parting line is not to involve any holes on the side member.

Figure 33



17364



A ≅ 0,3 H
b ≅ H (min. 175 mm)
S ≅ (0,8 ÷ 1) S1

17365

A ≅ 0,3 H
b ≅ H (min. 175 mm)
S ≅ (0,8 ÷ 1) S1

The operating instructions for correct welding are given here below:

a) heat the areas to be welded (except material QST E 420); arc weld with several passes using basic electrodes suitably dried, or MIG-MAG weld with proper welding material. Avoid current overloads; welding must have no marginal indentation or slags;

b) re-weld on the back, as specified in point (a, Figure 33);

c) allow to cool slowly and evenly. Cooling with air jets or other means is not allowed;

d) grind surface to remove excess material;

e) apply steel stiffening angle irons having the same characteristics as the chassis; minimum suggested dimensions are indicated in the figures above. They are only to be fixed to the vertical length of the side member, and welding seams, false spots, nails or screws may be used. Welding seam section and length, number and distribution of false spots, screws or nails must be suitable to transmit moments of flexure and shearing stress of the section. When the job has been completed the welded part must be protected with rust preventer paint.