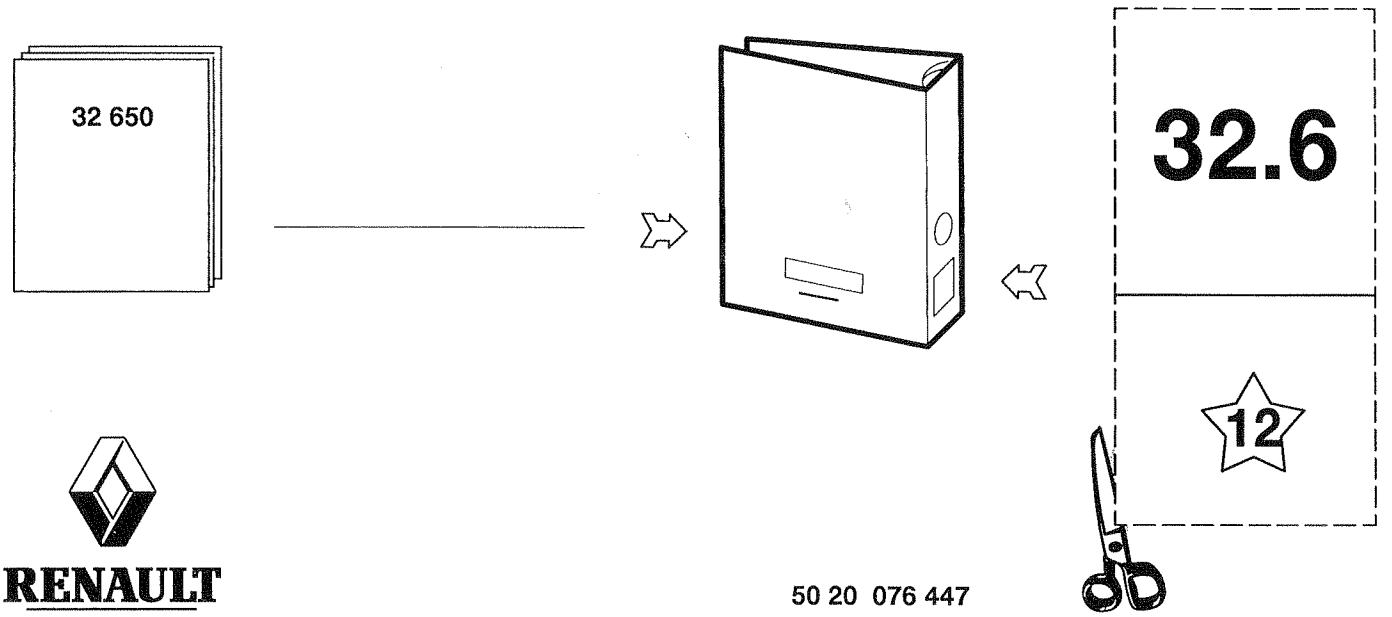
32 650 - AN - 02.1999

GEARBOX ZF 16 S 109

GEARBOX	VEHICLE
ZF 16 S 109	PREMIUM KERAX

NOTE
The above information may change in the course of time.
Only the "Consult" section of the workshop manuals repertory in standard N° 10320 serves as reference.



RENAULT

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TRANSMISSION DESCRIPTION AND FUNCTION

ZF-Ecomid 16 S 109 synchromesh transmissions have been especially developed for use in upper mid-range commercial vehicles.

16 S 109 transmissions mainly comprise:
- a fully-synchromesh four-gear section
- an integrated reverse gear
- a rear-mounted planetary range-change mechanism
- an integrated front-mounted splitter

In addition ZF Friedrichshafen AG can offer the following optional add-ons for these transmissions
- a ZF engine-dependent PTO
- various ZF clutch-dependent PTOs,
- a drive for an emergency steering pump or dual-circuit steering pump
- or a separate heat exchanger for extreme applications.

REPAIR MANUAL

The Repair Manual shows how to repair ZF-Ecomid 16 S 109 synchromesh transmissions.
Structure of the Repair Manual:

Section 1: adjustment data, tightening torques, spring characteristics and an illustrated list of specified ZF special tools.

Section 2: description of transmission repair procedure, broken down into work steps.

General Work Instructions

Maintain cleanliness in all work, and carry out all work to a proper professional standard. After removing a transmission from the vehicle, clean the outside thoroughly **before opening** the housing.

Always use the tools specified by ZF.

Clean all components after dismantling. Pay particular attention to corners, recesses and angles of housings and covers. Carefully remove all traces of old sealing compound and gaskets.

Check that lube oil feed bores, grooves and pipes are clear. They must be free of deposits, foreign matter and anti-corrosion agents. Take special care to remove anti-corrosion agents from new parts.

All parts which cannot be removed without being damaged must always be replaced with new parts (e.g. shaft seals, O-rings, piston sealing rings, flange packing, protective caps, etc.). Parts such as ball or roller bearings, thrust washers, synchronizer parts, etc., which are subject to wear during normal operation, must be inspected by a competent person, who should decide whether or not they can be re-used.

Fit gaskets dry, i.e. free from oil and grease. Joints without gaskets should be sealed with an oil and heat resistant mastic sealing compound (e.g. WEVO-L 100 A).

During assembly, comply with all adjustment data, checking data and tightening torques.

After completing repairs, fill the transmission with transmission oil. For the procedure and approved oils, see the transmission operating manual and List of Lubricants **TE-ML 02**, which are available from any ZF After-Sales Service point.
After filling the transmission with oil, tighten the oil level check plug and oil drain plug to the specified torques.

⚠ **ENVIRONMENTAL HAZARD !**

Lubricants and cleaning agents must not be allowed to enter the ground, the water table or the sewage system.

- **Request safety information for the products concerned from your local environmental protection authority, and follow any instructions herein at all times.**
- **Always collect used oil in a suitably large container.**
- **Always dispose of used oil, clogged filters, lubricants and cleaning agents in accordance with environmental protection laws.**
- **Always observe manufacturer instructions when dealing with lubricants and cleaning agents.**

Important work safety notice:

Companies who repair ZF units are responsible for their own work safety.

To avoid injury to personnel and damage to products, all safety regulations and legal requirements which apply to repair and maintenance work must be adhered to. Before starting work, mechanics must familiarize themselves with these regulations.

Personnel required to carry out repairs on these ZF products must receive appropriate training in advance. It is the responsibility of each company to ensure that repair staff is properly trained.

The following safety instructions appear in this manual:

NOTE	Refers to special processes, techniques, data, use of auxiliary equipment, etc.
CAUTION	**This is used when incorrect, unprofessional working practices could damage the product.**
⚠ DANGER	**This is used when lack of care could lead to serious injury or death.**

NOTE
Read this manual carefully before starting any tests or repair work.

CAUTION
Pictures, drawings and components do not always represent the original object, but are used to illustrate working procedures.
Pictures, drawings and components are not to scale, and no information about size and weight should be inferred (even within a complete illustration).
Always follow the working steps as described in the text.

NOTE
After completion of repair work and testing, skilled mechanics must satisfy themselves that the product is functioning correctly.

Tightening torques for bolts and nuts from ZFN 148

This Standard applies for bolts to DIN 912, DIN 931, DIN 933, DIN 960, DIN 961 and for nuts to DIN 934.

This Standard contains data on tightening torques (MA) for bolts in strength categories 8.8, 10.9 and 12.9 and nuts in strength categories 8, 10 and 12.

Surface condition of bolts: heat-treated blackened finish and oiled or galvanized and oiled or galvanized, chrome-plated and oiled.

Tighten screws using a calibrated signal or pointer-type torque wrench.

Metric coarse pitch thread

Size	Tightening torque MA (Nm) for		
Bolt	8.8	10.9	12.9
Nut	8	10	12
M 4	2.8	4.1	4.8
M 5	5.5	8.1	9.5
M 6	9.5	14	16.5
M 7	15	23	28
M 8	23	34	40
M 10	46	68	79
M 12	79	115	135
M 14	125	185	215
M 16	195	280	330
M 18	280	390	460
M 20	390	560	650
M 22	530	750	880
M 24	670	960	1100
M 27	1000	1400	1650
M 30	1350	1900	2250

Metric fine pitch thread

Size	Tightening torque MA (Nm) for		
Bolt	8.8	10.9	12.9
Nut	8	10	12
M 8 x 1	24	36	43
M 9 x 1	36	53	62
M 10 x 1	52	76	89
M 10 x 1.25	49	72	84
M 12 x 1.25	87	125	150
M 12 x 1.5	83	122	145
M 14 x 1.5	135	200	235
M 16 x 1.5	205	300	360
M 18 x 1.5	310	440	520
M 18 x 2	290	420	490
M 20 x 1.5	430	620	720
M 22 x 1.5	580	820	960
M 24 x 1.5	760	1100	1250
M 24 x 2	730	1050	1200
M 27 x 1.5	1100	1600	1850
M 27 x 2	1050	1500	1800
M 30 x 1.5	1550	2200	2550
M 30 x 2	1500	2100	2500

Edition: August 1991

Screw plugs DIN 908, 910 and 7604

The screw plug tightening torques M_A were determined according to DIN 7604, for screwing into steel, grey cast, and aluminium alloys.

The values are based on experience, and are intended as reference values for the designer.

The values for the tightening torque M_A shall also be used for screw plugs according to DIN 908 and DIN 910, as the thread geometries are almost identical.

General rule: Screw/bolt class 5, ZFN 148-1
Screw/bolt material: steel acc. to DIN 7604. Surface condition: as manufactured (without surface protection) and lightly oiled or galvanized, chromated and lightly oiled

Union screws DIN 7643

The tightening torques M_A were determined for screwing into steel, grey cast and aluminium alloys.

The values are based on experience and are intended as reference values for the designer .

General rule: screw/bolt class 5, ZFN 148-1
Material 9SMnPb28K n acc. to DIN 1651
Surface conditions: as manufactured (without surface protection) and lightly oiled or galvanized, chromated and lightly oiled

Screw plugs (DIN 908, 910, 7604)

Dimensions	Tightening torque screwed into	
	steel/grey cast	Al alloy
M 8 x 1	20	10
M 10 x 1	25 / 30*	15 / 20*
M 12 x 1.5	35	25
M 14 x 1.5	35	25
M 16 x 1.5	40	30
M 18 x 1.5	50	35
M 20 x 1.5	55	45
M 22 x 1.5	60 / 80*	50 / 65*
M 24 x 1.5	70	60
M 26 x 1.5	80 / 105*	70 / 90*
M 27 x 2	80	70
M 30 x 1.5	100 / 130*	90 / 130*
M 30 x 2	95	85
M 33 x 2	120	110
M 36 x 1.5	130	115
M 38 x 1.5	140	120
M 42 x 1.5	150	130
M 42 x 2	145	125
M 45 x 1.5	160	140
M 45 x 2	150	130
M 48 x 1.5	170	145
M 48 x 2	160	135
M 52 x 1.5	180	150
M 60 x 2	195	165
M 64 x 2	205	175

* DIN 7604 Form C

Union screws (DIN7643)

Pipe outer diameter	Thread	Tightening-torque M_A in Nm
4 - 5	M 8 x 1	30
6	M 10 x 1	35
8	M 12 x 1.5	40
10	M 14 x 1.5	40
12	M 16 x 1.5	45
15	M 18 x 1.5	50
18	M 22 x 1.5	60
22	M 26 x 1.5	90
28	M 30 x 1.5	130
35	M 38 x 1.5	140

Status October 1995

Description	Tolerances	Measuring device	Remarks
01. Axial prestress on layshaft	0.18 to 0.30 mm	Depth gauge	Turn layshaft to centre bearing rollers. Set zero play. Set prestress using suitably thick shim (aim for 0.25mm).
02. Axial prestress on mainshaft and input shaft	0.18 to 0.30 mm	Depth gauge	Turn input shaft and mainshaft to centre bearing rollers. Set zero play. Set prestress using suitably thick shim (aim for 0.25mm)
03. Axial play of deep-groove ball bearing on output (range-change)	0 to 0.10 mm	Depth gauge	Play up to 0.1 mm permitted. Set using shim
04. Shaft seal in bearing cover (installation dimension)	8 + 0.5 mm	Drift 1X56 126 467 & Ring 1X56 137 484	Automatically given if drift and ring are used
05. Axial play of circlip on sun gear	0 to 0.05 mm	Feeler gauge	Set using suitably thick circlip
06. Axial play of snapring on deep-groove ball bearing in ring gear carrier	0 to 0.1 mm	Depth gauge	Set using suitably thick snapring
07. Axial play of circlips on mainshaft, input shaft and layshaft	0 to 0.1 mm	Feeler gauge	Set using suitably thick circlip
08. Axial play on 1st/5th-speed helical gear	0.20 to 0.45 mm	Depth gauge or feeler gauge	Play is automatically given. Check to confirm
09. Axial play on 2nd/6th-speed helical gear	0.20 to 0.45 mm	Depth gauge or feeler gauge	Play is automatically given. Check to confirm
10. Axial play on 3rd/7th-speed helical gear	0.20 to 0.40 mm	Depth gauge or feeler gauge	Play is automatically given. Check to confirm

Description	Tolerances	Mesuring device	Remarks
11. Axial play on 4th/8th-speed helical gear	0.20 to 0.45 mm	Depth gauge or feeler gauge	Play is automatically given. Check to confirm
12. Axial play of helical gear on input shaft	0.20 to 0.45 mm	Depth gauge or feeler gauge	Play is automatically given. Check to confirm
13. Axial play of reverse idler gear on reverse idler pin	0.20 to 0.60 mm	Feeler gauge	Play is automatically given. Check to confirm
14. Permitted axial play on planet gears in planet carrier	0.10 to 0.70 mm	Feeler gauge	Permitted thrust washer wear is included in the tolerances. Minimum thickness per thrust washer = 1.20 mm
15. Wear limit for synchro rings and clutch bodies, measured between flat surfaces of ring and body with cones centred and nested firmly together.	Main transmission and splitter 0.80 mm Range-change 1.20 mm	Feeler gauge	If tolerance is not reached, exchange synchro ring and/or clutch body
16. For information: synchromesh play (axial)	≥ 0.60 mm	Feeler gauge	Upper synchromesh play limit automatically given by the wear limit (0.80/ 1.20 mm)
17. For information: force required to push sliding sleeves onto sychronizers	Transmission 270 - 310 N Range-change 850 - 950 N		Renew all compression springs in synchronizers. This will guarantee the specified force
18. Axial play on speedo pinion shaft	min. 0.10 mm	Depth gauge	Check by hand (can be felt).
19. Backlash on speedo pinion	0.10 to 0.20 mm	Experience	Play is automatically given. Check by hand to confirm
20. Temperature for shrink-fitting gears onto layshaft	Heating tempreature max. 170°C. Difference between temperatures of parts to be joined 150°C	Temperature measuring rod or thermometer	Gear and shaft seats must be free of oil and grease. Do not exceed upper temperature limit and hold for max. 15 mins.

Description	Tolerances	Measuring device	Remarks
21. Temperature for mounting sun gear	max. 170 °C	Temperature measuring rod or thermometer	Do not exceed upper temperature limit and hold for max. 15 mins.
22. Delivery rate of lube oil pump (separate test)	5.15- 6.45 l/min. and 0.155 bar	Measuring beaker and stopwatch	Measured at pump speed n = 725 rpm. Oil grade: Shell Spirax SAE 80W at 100°C
Tightening torques			
01. Breather in transmission housing	10 Nm	Torque wrench	Breather must not be clogged
02. Restrictor in cutoff valve (depending on version)	20 Nm	Torque wrench	Use new seal ring
03. Pressure switches in transmission housing and covers	45 Nm	Torque wrench	Use new seal ring in each case
04. M10x1 lock nuts on reaction linkage and ball joint	46 Nm	Torque wrench	———
05. M12 hex nuts on reaction linkage	50 Nm	Torque wrench	———
06. Detent plunger on transmission and shift housings	50 Nm	Torque wrench	Use new seal ring
07. M24x1.5 screw plug (conical) on transmission housing	50 Nm	Torque wrench	Do not exceed tolerance
08. Impulse sensor	50 Nm	Torque wrench	Do not exceed tolerance
09. Tightening torque for M12 hex bolts on output flange	60 Nm	Torque wrench	Secure using retaining plate
10. Speedo connection piece M30 x1.5	100 Nm	Torque wrench	Use new seal ring

Description	Tolerances	Measuring device	Remarks
11. Pivot bolt on swinging fork in transmission housing (overdrive version only)	130 Nm	Torque wrench	Use sealing compound and spring washer
12. Screw plug with M38x1.5 magnet on transmission housing	120 Nm	Torque wrench	Use new seal ring
13. Pivot bolts on transmission housing	160 Nm	Torque wrench	Use sealing compound and spring washers
14. M16x1.5 lock nuts on pistons for range-change and splitter	150 Nm	Torque wrench	Use new lock nuts
15. Pivot bolts for range-change and splitter	180 Nm	Torque wrench	Use sealing compound and spring washers

Order No.	Installation position	No. of coils	Wire Ø in mm	Spring Ø in mm	Untensioned length in mm
0732 040 765	**Shift mechanism** (on selector shaft depending on version)	6.5	2.8	39.9	81.7
0732 040 728	**Shift mechanism** (on selector shaft depending on version)	6.5	1.8	28.9	80.0
0732 040 630	**Shift mechanism** (on selector shaft depending on version)	6.5	28.9	39.6	89.9
1204 307 334	**Shift mechanism** (on selector shaft depending on version)	5.5	2.0	27.2	45.3
1204 318 011	**Shift mechanism** (on selector shaft depending on version)	5.0	2.1	30.9	38.0
0732 040 237	**Shift mechanism** (on selector shaft depending on version)	7.5	2.5	39.4	76.9
0732 041 499	**Shift mechanism** (on selector shaft depending on version)	6.5	2.25	28.7	55.5
0732 040 986	**Shift mechanism** (on the detent levers depending on version)	5.5	2.25	14.8	21.6
0732 040 985	**Shift mechanism** (on the detent levers depending on version)	6.5	2.0	14.8	23.4
0732 040 819	**Shift mechanism** (on the ball roller for detent segment)	10.5	2.25	$13.55^{+0.2}$	40.4
0732 042 156	**Shift mechanism** (on the ball roller for detent segment)	4.0	2.5	25.3	30.7
0732 040 385	**Synchronizer** Splitter and range-change	18.5	1.25	6.35	34.2

Order No.	Installation	No. of coils	Wire Ø in mm	Spring Ø in mm	Untensioned length in mm
0732 040 386	**Synchronizer** Splitter	35.5	0.7	3.3	34.7
0732 040 409	**Synchronizer** Main transmission	12.5	1.4	6.65	23.7
0732 041 374	**Shift mechanism** (Interlock)	13.5	1.3	10.7	37.8

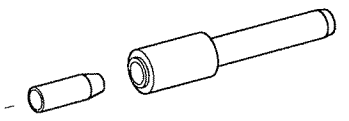
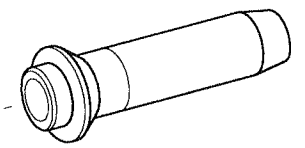
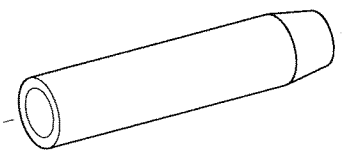
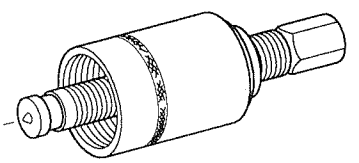
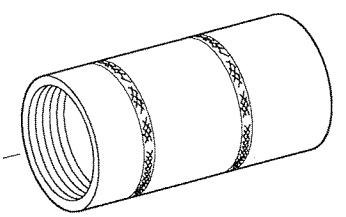
Fig. No.	Illustration	Order No. Application	Quantity	Remarks
1		**1X56 100 632** **Drift** for 10x15x3 shaft seal in speedo connection piece	1	Section 3
2		**1X56 103 768** **Drift** for 48x65x10 shaft seal on output end (1 3/4“)	1	Section 7
3		**1X56 119 916** **Drift** for shaft seal and 25x35x7 wiper in shift housing	1	Section 6
4		**1X56 122 304** **Basic tool** M65x2 used with grippers	1	Sections 11, 12 and 13
5		**1X56 122 310** **Extension** M65x2 for taper roller bearing on input only	1	Section 11

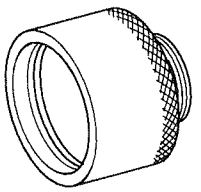
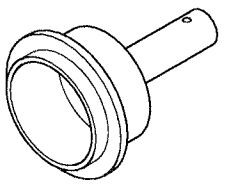
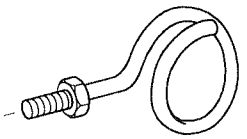
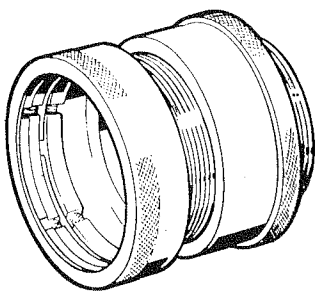
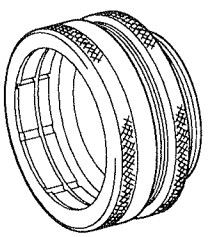
Fig. No.	Illustration	Order No. Application	Quantity	Remarks
6		**1X56 122 317** M95x2 - M65x2 **adapter** used with grippers	1	Section 11
7		**1X56 126 467** **Drift** for 95x115x10 shaft seal on output used with ring 1X56 137 484	1	Section 2
8		**1X56 136 599** M12 **hook** for lifting the layshaft	1	Sections 3 and 10
9		**1X56 136 708** M95x2 **gripper** for taper roller bearing on input end of layshaft	1	Section 13 (only use tools produced after Jan 1991, older versions not suitable)
10		**1X56 136 711** M65x2 **gripper** for taper roller bearing on output end of layshaft	1	Section 11

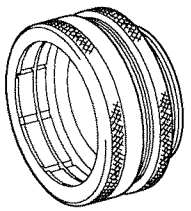
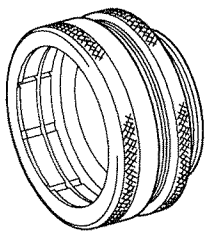
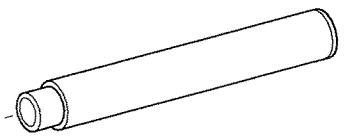
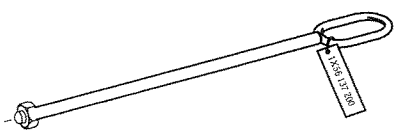
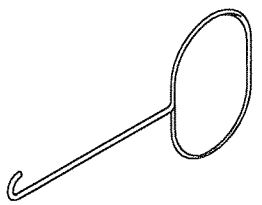
Fig. No.	Illustration	Order No. Application	Quantity	Remarks
11		**1X56 136 719** M95x2 **gripper** for taper roller bearing on input end	1	Section 11
12		**1X56 136 737** M65x2 **gripper** for taper roller bearing on mainshaft bearing journal	1	Section 12
13		**1X56 137 135** **Drift** for 25x32x20 bearing bush in shift housing	1	Section 6
14		**1X56 137 200** **Lifting rod** for mainshaft	1	Section 10
15		**1X56 137 451** **Hook** for guiding shift forks	1	Sections 9 and 10

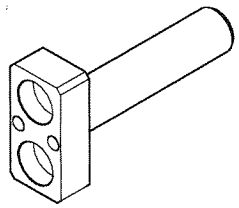
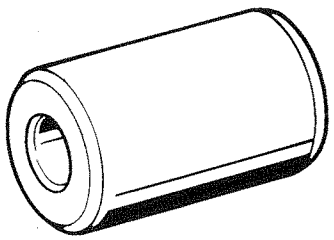
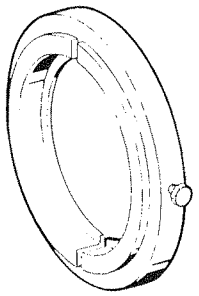
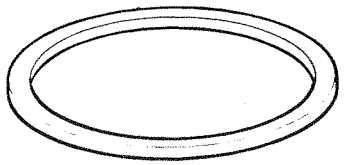
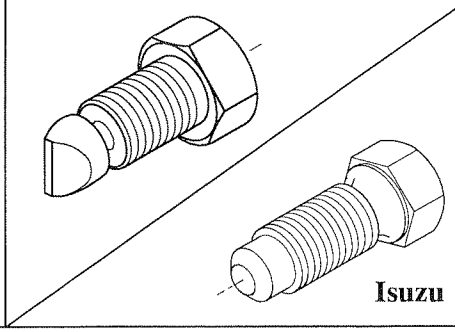
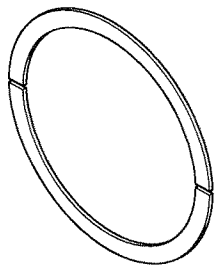
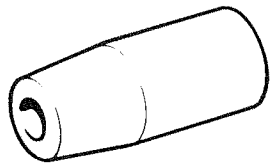
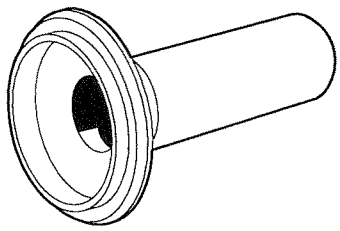
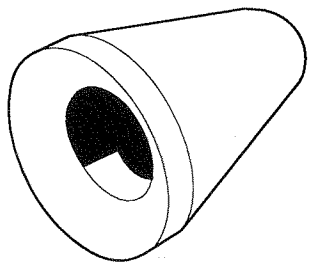
Fig. No.	Illustration	Order No. Application	Quantity	Remarks
16		**1X56 137 452** **Drift** for retaining plate 4132 304 015 on output flange	1	Section 2
17		**1X56 137 456 30.0 mm** **1X56 138 101 40.5 mm** **Drift** for oil pipe, mainshaft and layshaft (output end)	one of each	Section 5
18		**1X56 137 457** **Split puller** for synchronizer hub on mainshaft	1	Section 12
19		**1X56 137 484** **Spacer ring for 95x115x10 shaft seal on output end, used with drift** 1X56 126 467	1	Section 2
20		**1X56 137 579** **Fixing device** for radially fixing the range-change shift rail **1X56 138 100** ISUZU version	1	Section 3

Fig. No.	Illustration	Order No. Application	Quantity	Remarks
21		**1X56 137 648** **Split ring** for pulling off output end clutch body from range-change	1	Section 3
22		**1X56 137 134** **Protective sleeve** Assembly aid for mounting shift cover onto selector shaft	1	Section 6
23		**1X56 138 026** **Drift** for fitting baffle plate into input shaft	1	Section 11
24		**1X56 138 064** **Protective sleeve** Assembly aid for fitting connection plate	1	Section 7

Reference ZF	Reference RENAULT V.I.
1X56 100 632	Not necessary
1X56 103 768	50 00 26 **9052**
1X56 119 916	50 00 26 **2363** + 50 00 26 **3016**
1X56 122 304	50 00 26 **0827** + Hydraulic press
1X56 122 310	50 00 26 **0827** + Hydraulic press
1X56 122 317	50 00 26 **0827** + Hydraulic press
1X56 126 467	50 00 26 **2351** + 50 00 26 **3016**
1X56 136 599	**FL 3253**
1X56 136 708	50 00 26 **0827** + Hydraulic press
1X56 136 711	50 00 26 **0827** + Hydraulic press
1X56 136 719	50 00 26 **0827** + Hydraulic press
1X56 136 737	50 00 26 **0827** + Hydraulic press
1X56 137 134	Adhesive tape type protection
1X56 137 135	50 00 26 **2363** + 50 00 26 **3016**
1X56 137 200	**FL 2388**
1X56 137 451	**FL 3247**
1X56 137 452	50 00 26 **3251**
1X56 137 456	50 00 26 **2379**
1X56 137 457	50 00 26 **0827** + Hydraulic press
1X56 137 484	50 00 26 **2351** + 50 00 26 **3016**
1X56 137 579	**FL 2384**
1X56 137 648	**FL 3248**
1X56 138 026	50 00 26 **2351** + 50 00 26 **3016**
1X 56 138 064	Adhesive tape type protection

TOOLS

RENAULT V.I. divide tools into 3 categories :

– **General–purpose tools :** Commercially available tools.
  . **50 00 26 .... reference number** (possibility of purchasing through the Renault V.I. Spare Parts department).
  . **4–figure reference number** (tools with Renault V.I. reference number, but available from the supplier).

– **Special tools :** Specially created tools, distributed by the RENAULT V.I. spare parts division.

– **Locally manufactured tools :** these tools are classified differently according to their degree of sophistication :

  . **4–figure reference number** (represented by a drawing) : tools that are simple to make without need for special qualification.

  . **50 00 26 .... reference number** (possibility of purchasing through the Renault V.I. Spare Parts department) : a certain skill is needed to make these tools.

Three levels (or echelons) determine their assignment :

– **LEVEL1 :** Tools for servicing and minor tasks.

– **LEVEL 2 :** Tools for major repairs.

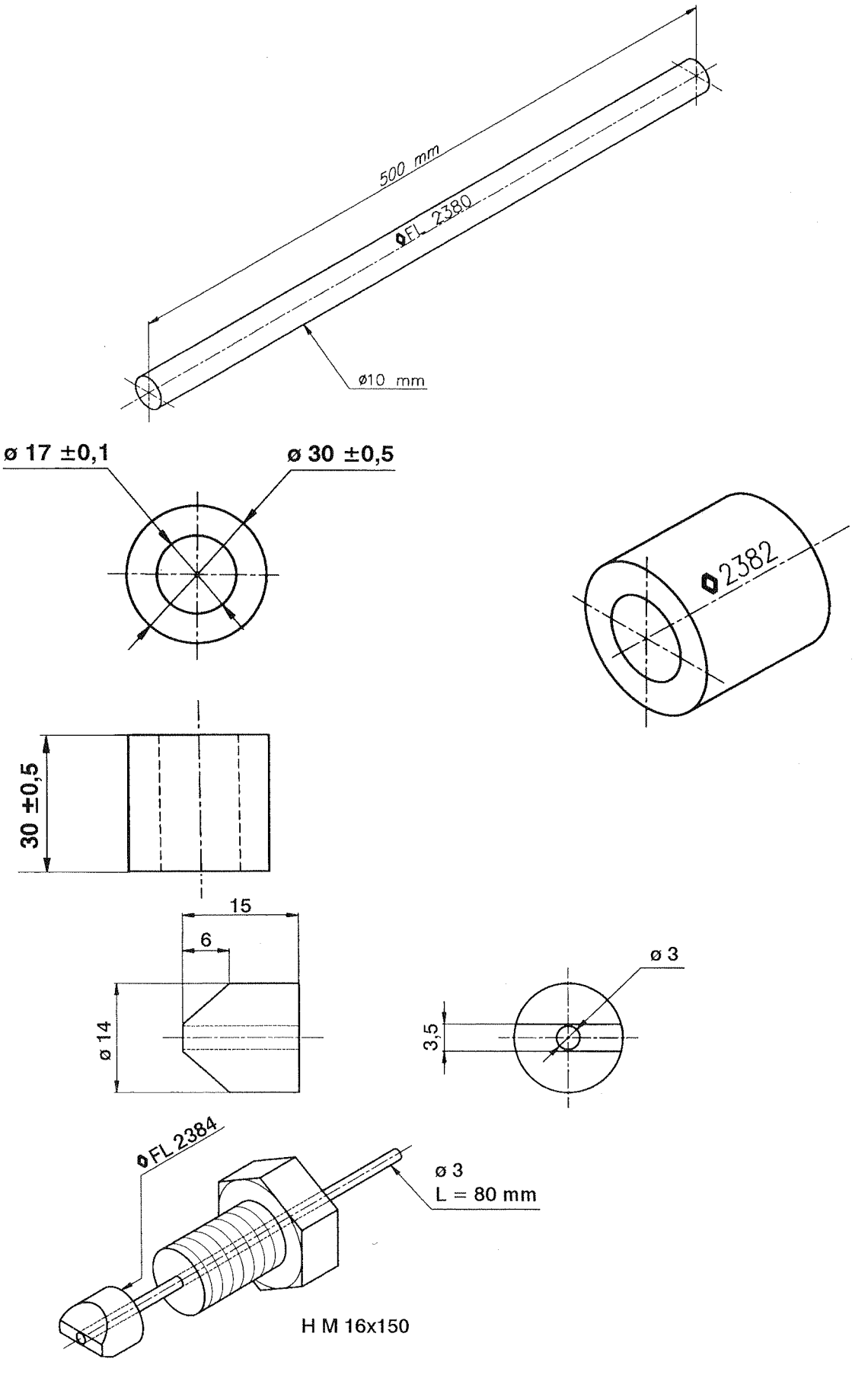
– **LEVEL 3 :** Tools for refurbishment.

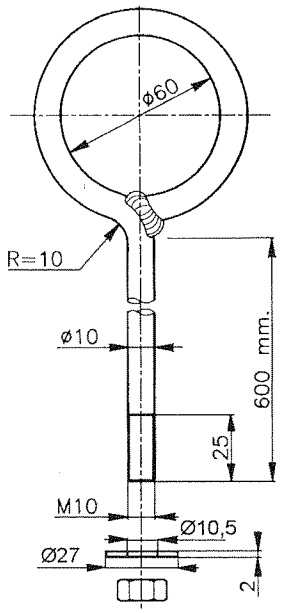
General–purpose tools				
Ref. Renault V.I.	**Description**	**Category**	**Quantity**	**Pages**
50 00 26 **0827**	Puller	2	1	11–1
50 00 26 **0833**	Puller	1	1	2–1
50 00 26 **1000**	Universal frame	2	1	1–0
50 00 26 **2351**	Pusher set	1	1	2–3
50 00 26 **2363**	Pusher set	2	1	6–5

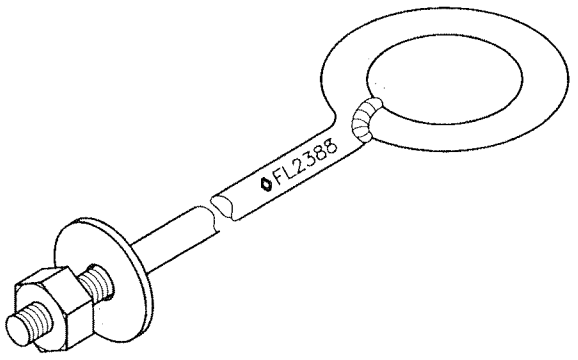
Special tools				
Ref. Renault V.I.	**Description**	**Category**	**Quantity**	**Pages**
50 00 26 **2203**	Support	2	1	1–0
50 00 26 **2379**	Protector	2	1	5–1
50 00 26 **2381**	Extension	2	1	2–1
50 00 26 **3016**	Handle	1	1	2–3
50 00 26 **3251**	Rivet snap	1	1	2–4
50 00 26 **9052**	Pusher	1	1	7–5

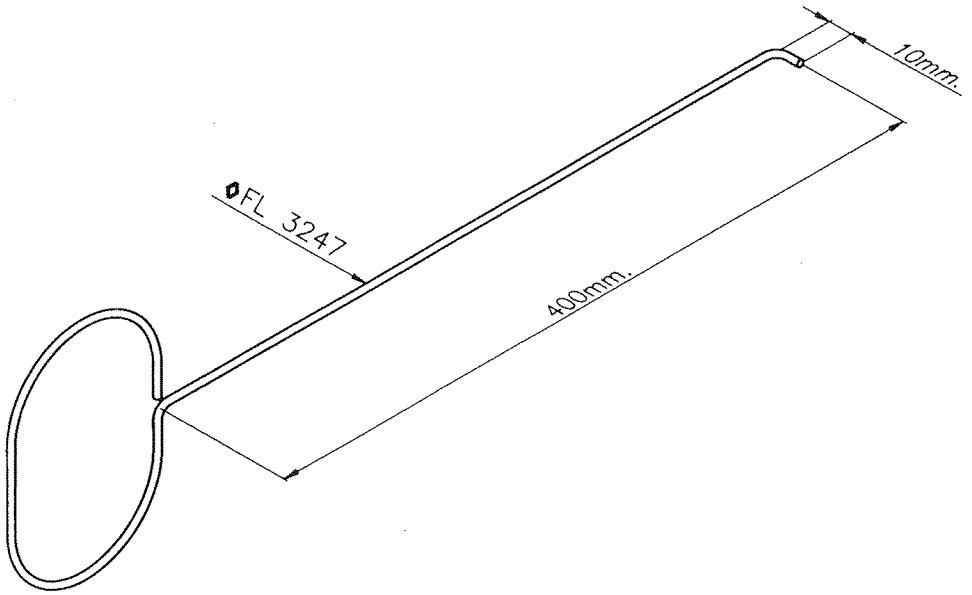
Locally manufactured tools				
Ref. Renault V.I.	**Description**	**Category**	**Quantity**	**Pages**
2380	Puller	2	1	9–5
2382	Pedestal	2	2	1–0
2384	Immobilizer	2	1	3–1
2388	Hook	2	1	10–3
3247	Hook	2	1	9–6
3248	Demi–shell	2	2	4–1
3253	Hook	2	1	3–2

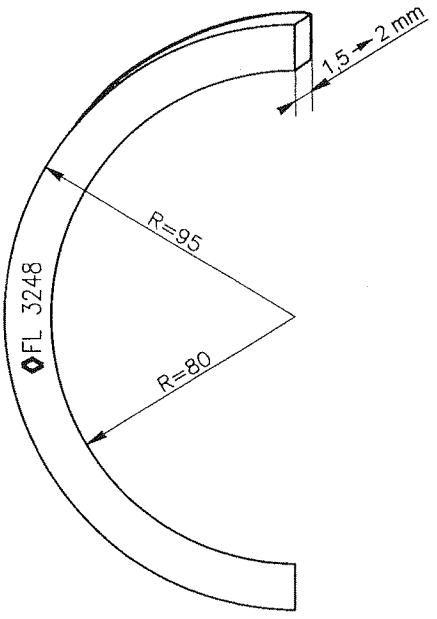
Locally manufactured tools

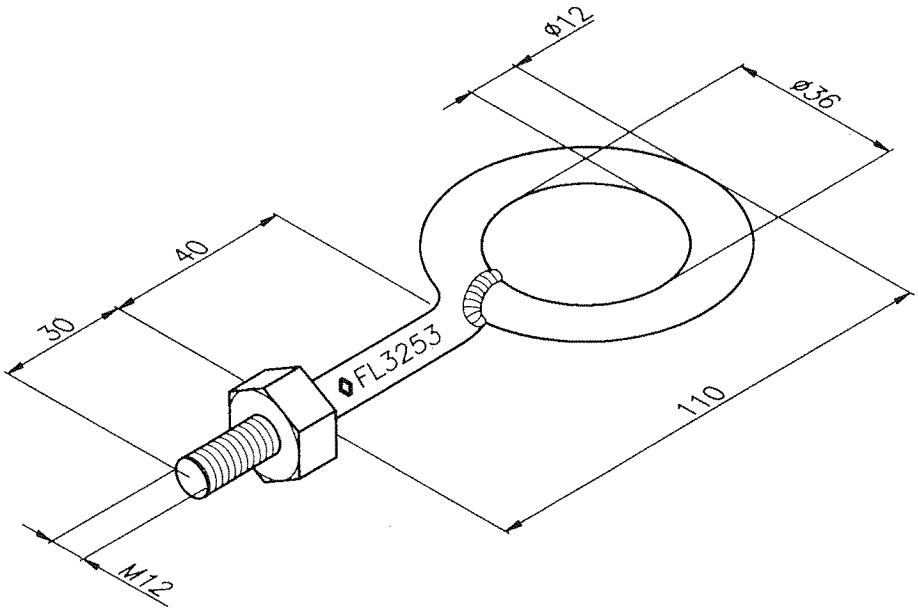



ø60
R=10
ø10
600 mm.
25
M10
Ø10,5
Ø27
2

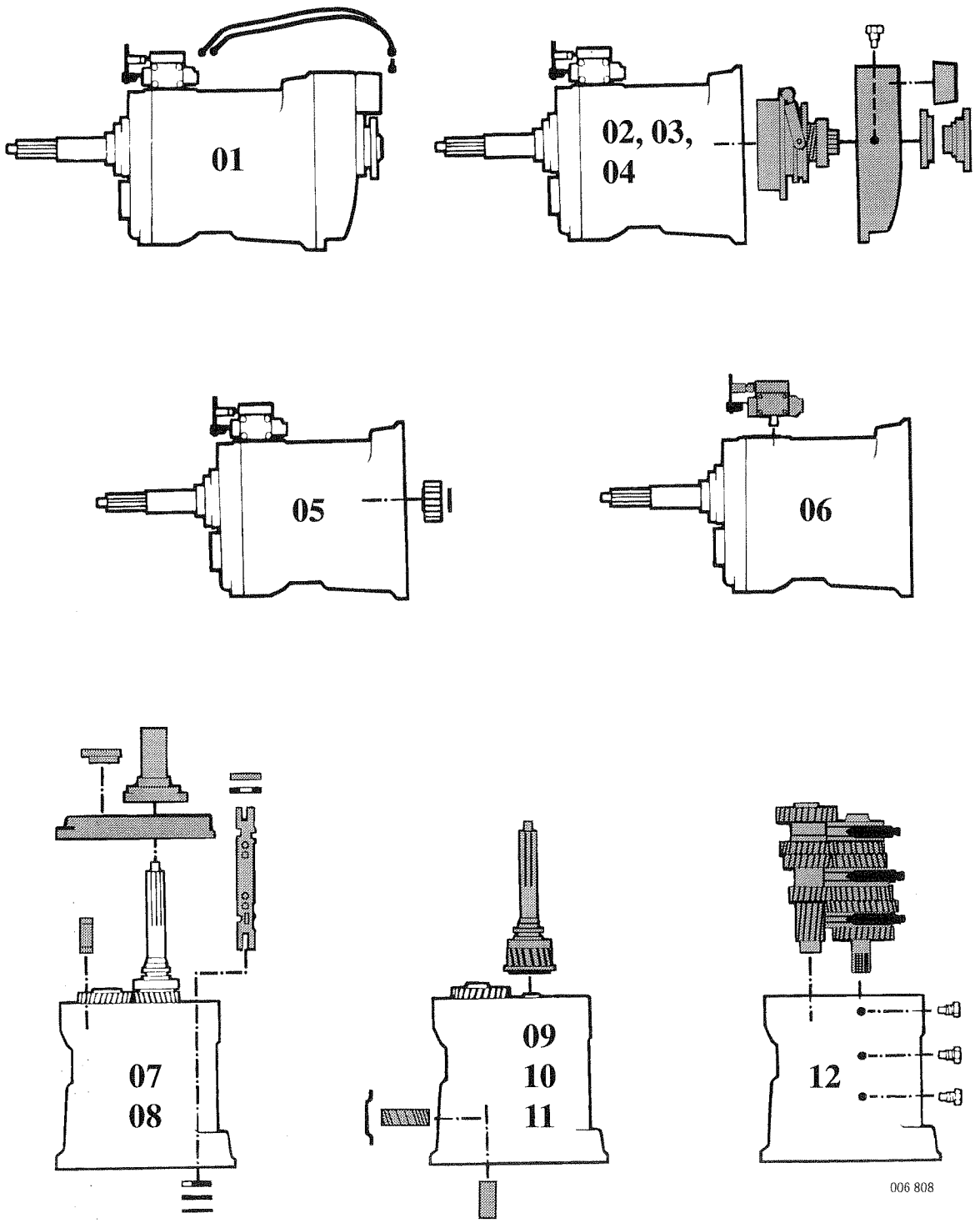

FL2388


10mm.
FL 3247
400mm.


1,5 → 2 mm
R=95
FL 3248
R=80


ø12
ø36
40
30
FL3253
110
M12

For basic overhauls, follow removal sequence 01 to 12 and installation sequence 12 - 01, as shown below.



01 *Tecalan pipes*

02, 03, 04 *Range-change with both shift cylinders*

05 *Sun gear*

06 *Shift mechanism*

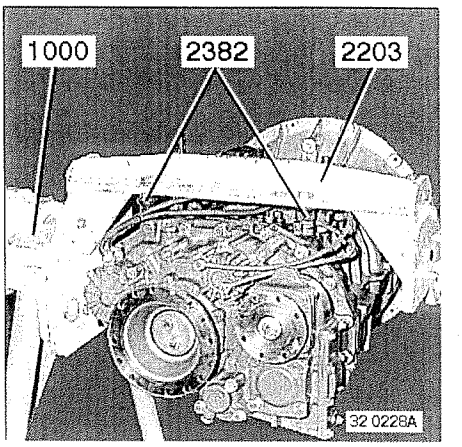
07, 08 *Connection plate, housing, shift rails and oil screen*

09, 10, 11 *Input shaft, reverse idler gear and pivot bolts*

12 *Shafts with shift clamps*

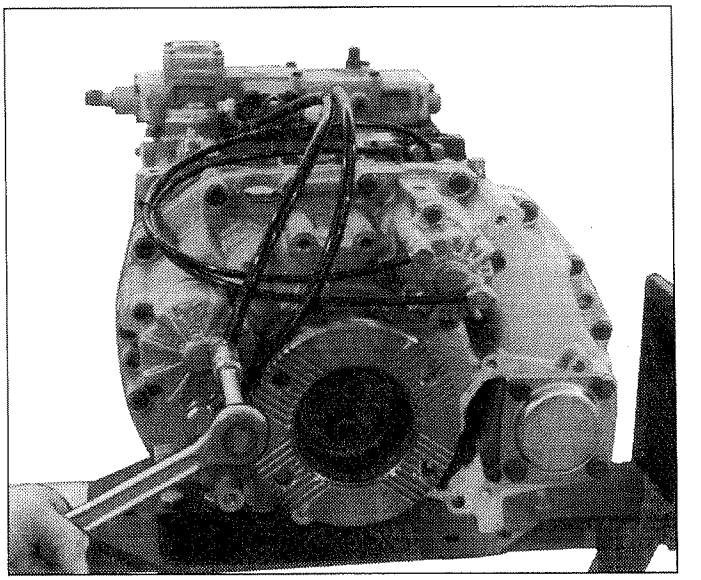
Installation on support frame n° 1000

Fix the box to the **1000** frame.
Use tool(s) **(2203 + 2382)**.



1. Pneumatic range-change and splitter shift mechanism

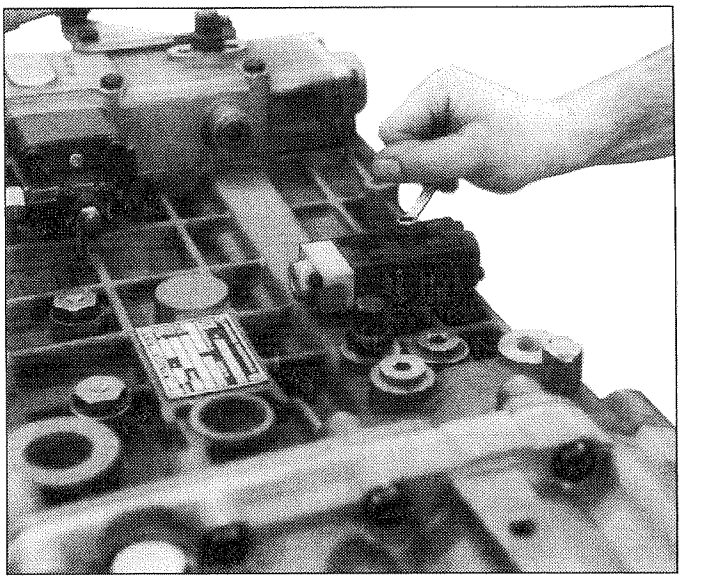
NOTE
Mark the Tecalan pipes and their respective connection positions before removing.


009 302

1.1 Disassembly

1 Unscrew union screws from range-change cylinder, splitter cylinder, cutoff valve and 4/2-way valve. Remove Tecalan pipes. Remove cable clips if necessary.

2 Unscrew hex bolts from 4/2-way valve for splitter and remove.


009 303

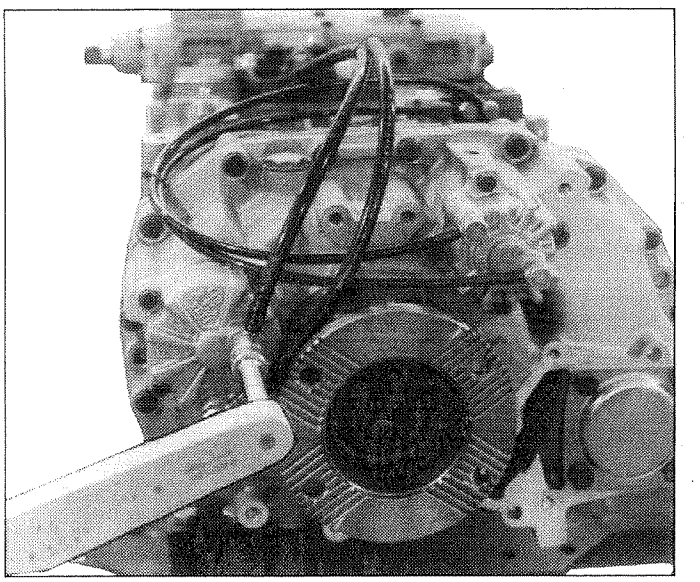
1.2 Assembly

Place 4/2-way valve for splitter onto housing. Insert hex bolts together with spring washers.

- M5 Tightening torque = 5.5 Nm

Using union screws, attach Tecalan pipes to cutoff valve, to splitter and range-change cylinders and to 4/2-way valve. Use new seal rings with the union screws. Ensure that the Tecalan pipes are in correct position and attach to the correct points.
Union screw tightening torques:

- M10x1 = 15 Nm
- M14x1.5 = 35 Nm


009 304

CAUTION

Do not mix up the Tecalan pipe connections. Fit range-change as described below.

Pull out selector shaft to end position (e.g. reverse gear – see arrow).

Charge compressed air connection (item 1) on main cutoff valve using compressed air (no higher than operating pressure).

Air will escape from one of the Tecalan pipes (item 2 or 3).

Attach Tecalan pipe from which air is escaping to range-change cylinder (connection for low range, item 4). Connect second Tecalan pipe.

The ratio determines connection of the Tecalan pipes for the splitter. Check the following before connecting the Tecalan pipes:

Read off the top gear ratio from the transmission type plate:

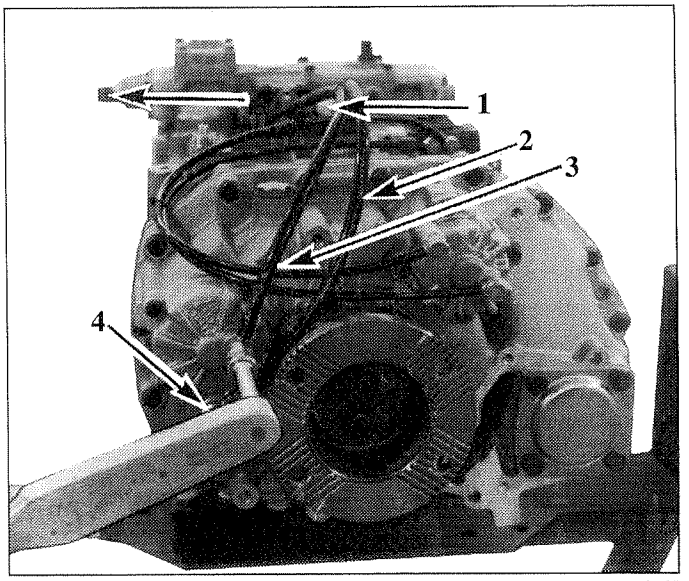
e.g. 1.0 = direct drive ratio or less than 1.0

e.g. 0.85 = overdrive ratio

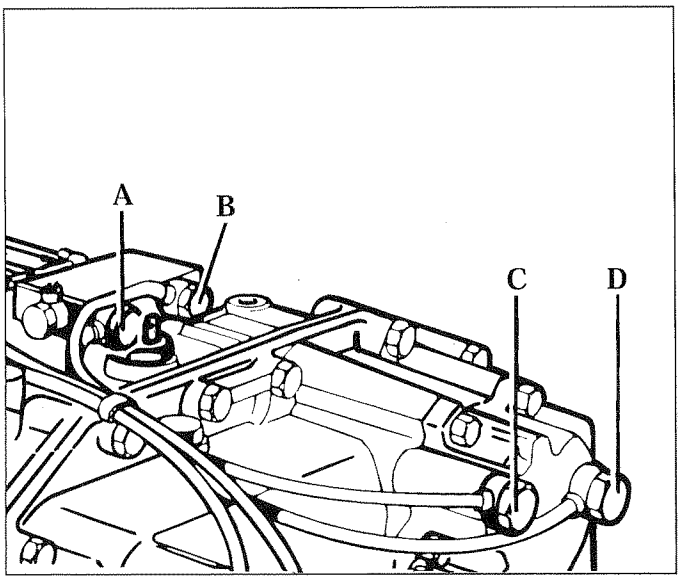
For direct drive ratio, connect A to C and B to D. For overdrive ratio, connect A to D and B to C.

NOTE

Ensure there is at least a 5 mm gap between the Tecalan pipe and the housing.



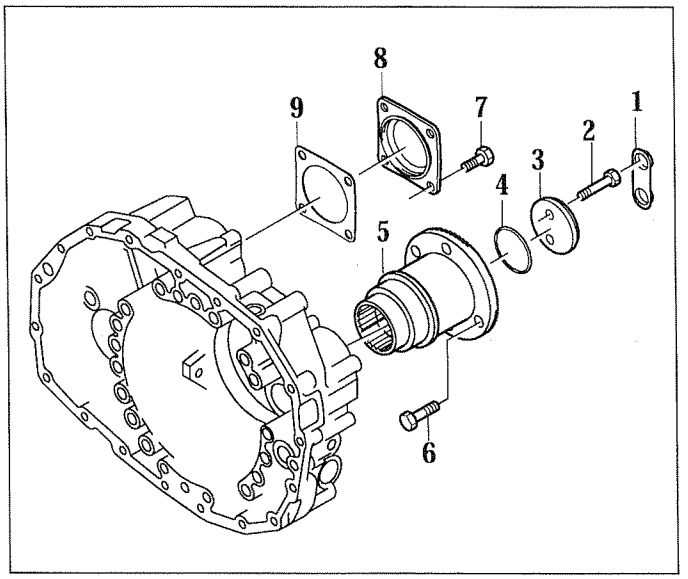
009 305



009 306

2. Ouput

2.1 Removing output flange and cover



008 002

1 Remove retaining plate (**1**).

2 Secure output flange using standard flange holder to prevent it from rotating.

3 Remove hex bolts (**2**) and clamping disc (**3**).

4 Pull off output flange (**5**) using standard two- or three-leg puller.
Use tool(s) 50 00 26 0833 + 50 00 26 2381.

5 Remove flange bolts (**6**) if necessary.

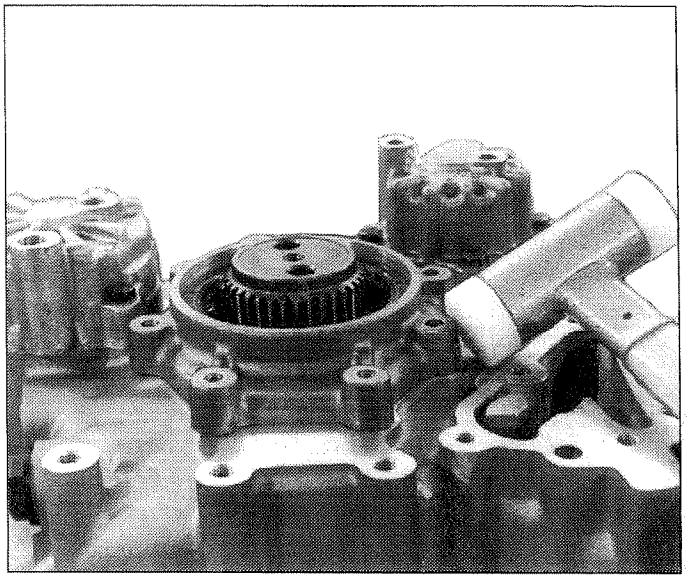
6 Remove O-ring (**4**).

7 Remove hex bolts (**7**). Remove cover (**8**) together with gasket (**9**).

2.2 Removing bearing cover

1 Unscrew hex bolts from bearing cover.

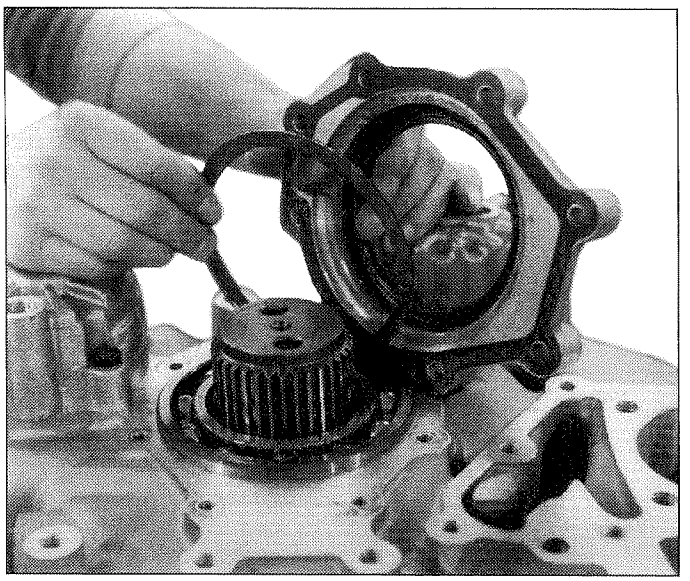
2 Loosen bearing cover by lightly tapping with a plastic hammer.



009 309

3 Remove bearing cover together with gasket and shim.

4 Drive out shaft seal from bearing cover using plastic drift.



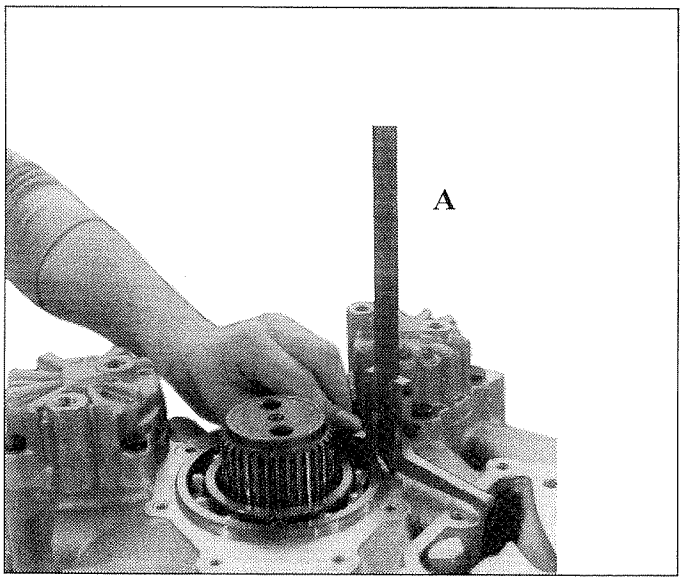
009 310

2.3 Fitting bearing cover

NOTE
To avoid measuring errors, position ball bearing so that it is flush against the collar on housing III by lightly tapping with a plastic drift and hammer.

1 Set axial play on ball bearing using shim. Aim for 0.0 mm play.
- Permitted axial play: 0.0 - 0.1 mm

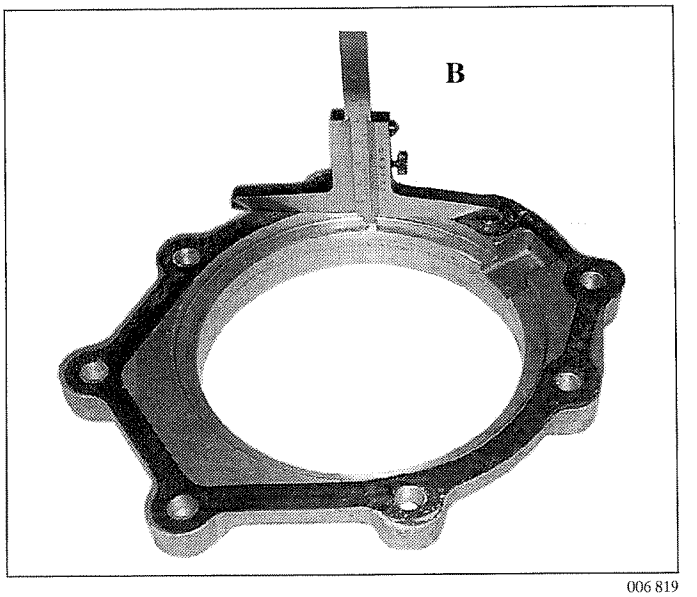
2 Measure **distance "A"** between ball bearing face and housing sealing face.



009 311

3 Measure **distance "B"** between bearing cover with gasket **affixed** and ball bearing contact face.

4 Determine shim thickness "C"
C = B – A
C = Shim thickness for zero axial play

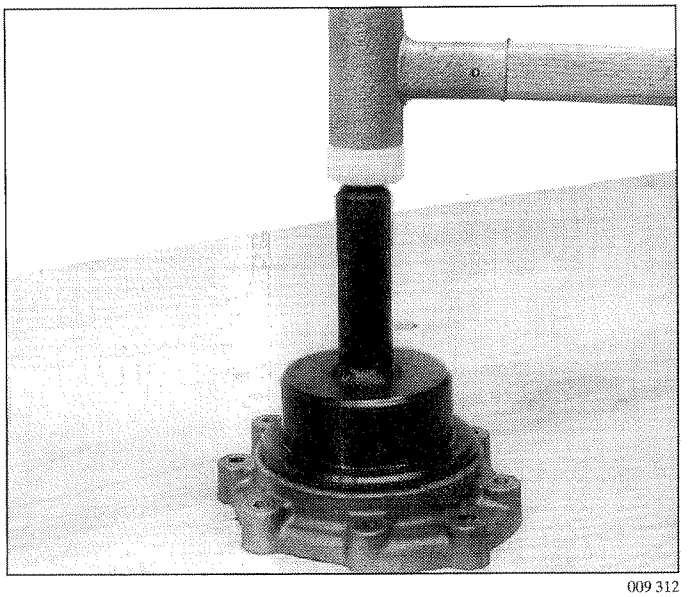


006 819

5 Coat outside of shaft seal with lubricant, e.g. liquid soap.

6 Drive shaft seal into bearing cover unit using drift **1X56 126 467** and ring **1X56 137 484**. This automatically gives the required installation dimension of $8.0^{+0.5}$ mm.

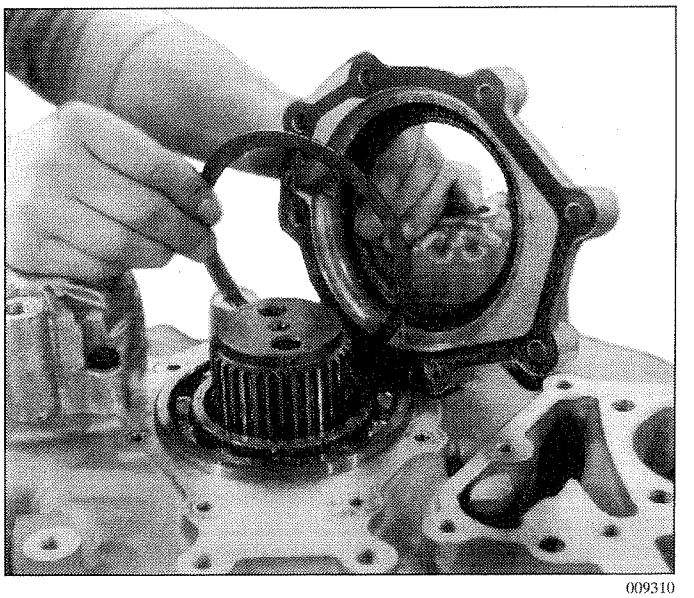
NOTE
Lightly coat sealing lip of shaft seal with grease.


009 312

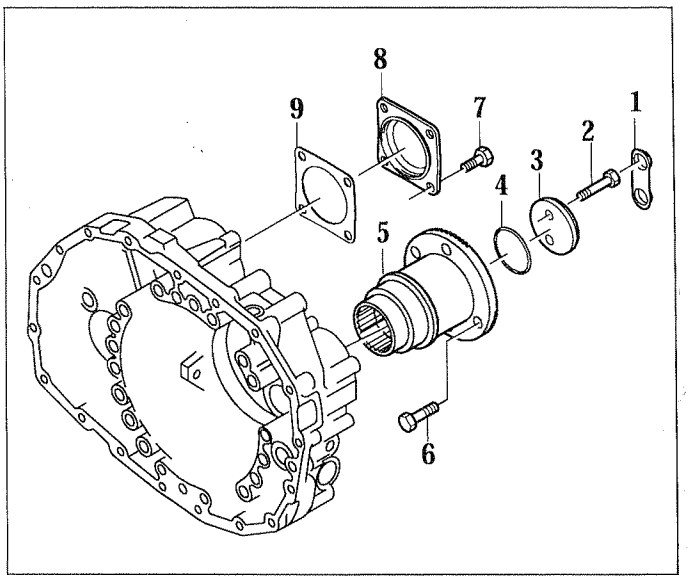
7 Place selected shim into bearing cover groove.

8 Fit bearing cover together with new gasket.

9 Insert M8 hex bolts together with spring washers - tightening torque = 23 Nm


009310

2.4 Fitting output flange and cover



008 002

1 Fit cover (**8**) together with new gasket (**9**). Insert M12 hex bolts (**7**).
- Tightening torque = 79 Nm

2 If necessary, insert or press in flange bolts (**6**).

3 Fit output flange so that it is flush on the planet carrier shaft.

4 Pull on input shaft until flush using disc (**3**) and two assembly aid screws.

5 Remove disc and assembly aid screws.

6 Lightly coat new O-ring (**4**) with oil and insert into gap between output flange and planet carrier shaft.

7 Insert disc (**3**) into output flange (**5**) and affix to planet carrier using bolts (**2**).
Tightening torque: = 60 Nm.
If necessary, use flange holder to prevent output flange from rotating.

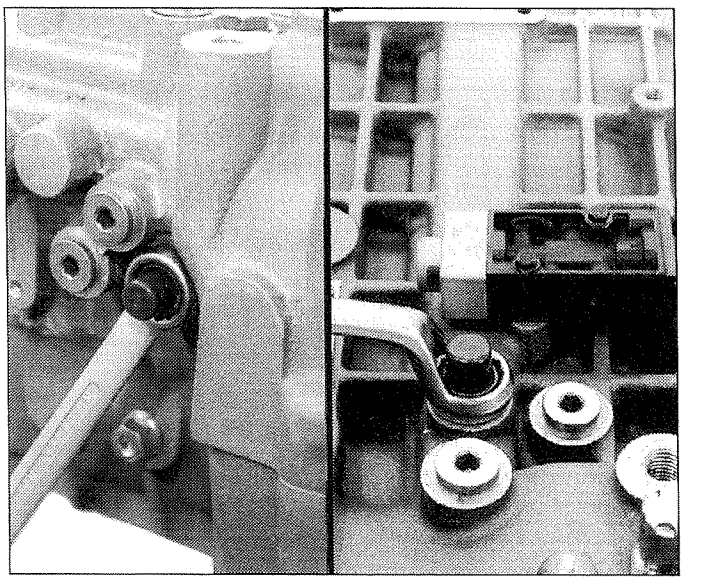
8 Drive new retaining plate (**1**) flush onto bolt heads using special tool **1X56 137 452.**

3. Range-change

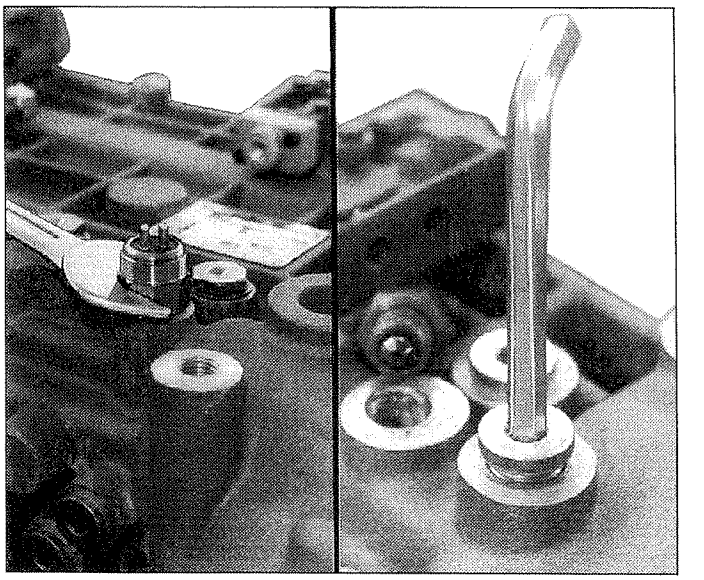
3.1 Removing range-change / splitter operating cylinder

1 Unscrew detent plunger for range-change and splitter.

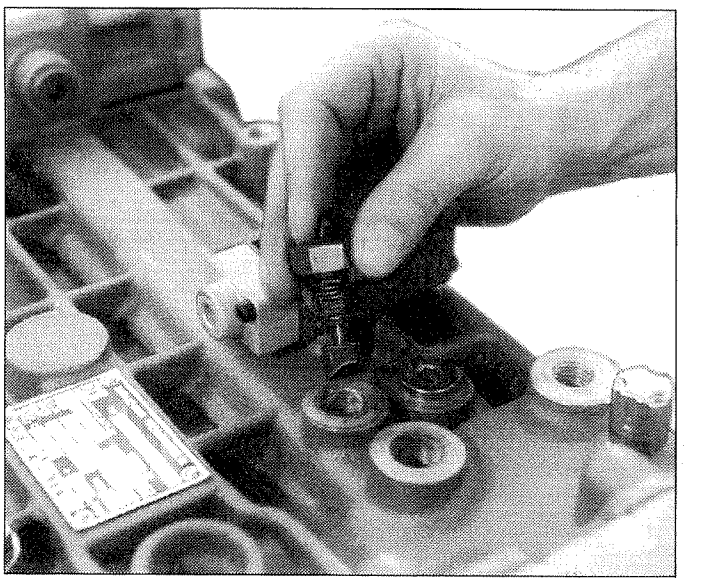
NOTE
If the range-change is not dismantled and the range-change and splitter cylinders only require new flange packing and/or pistons, proceed as follows: insert fixing device **1X56 137 579** into corresponding threaded bore for detent plunger and tighten to 50 Nm. While doing this, position the device so that the shift rail is radially fixed. Remove cylinder. Remove lock nut from piston, take off piston and remove grooved rings from piston. Press out flange packing from housing, e.g. using screwdriver.


009 314

2 Unscrew reverse gear indicator switch and/or screw plug for splitter. Then, remove ball and magnet from bore.


009 315

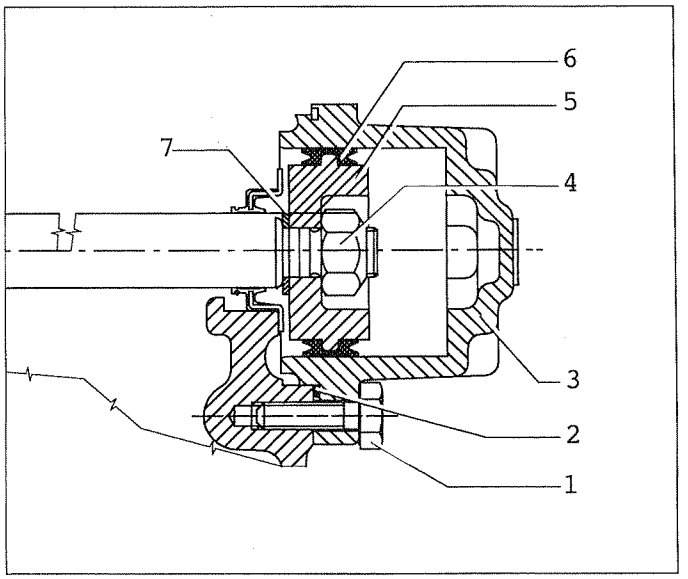
3 Insert fixing device **1X56 137 579** into threaded bore for splitter detent plunger. While doing this, position the fixing device so that the shift rail is radially fixed.
- tightening torque = 50 Nm


009 316

4 Remove hex bolts (**1**) from splitter cylinder (**3**).

5 Carefully take off cylinder together with O-ring (**2**) and remove double-grooved ring (**6**) from piston.

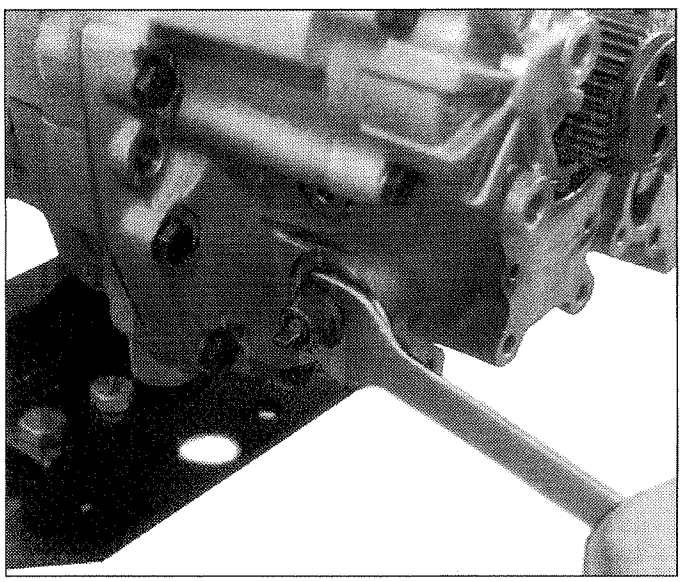
6 Remove lock nut (**4**), piston (**5**) and shim (**7**).



008 136

7 Unscrew speedo drive / impulse sensor.

NOTE
Speedo drive is a complete component and is not dismantled.

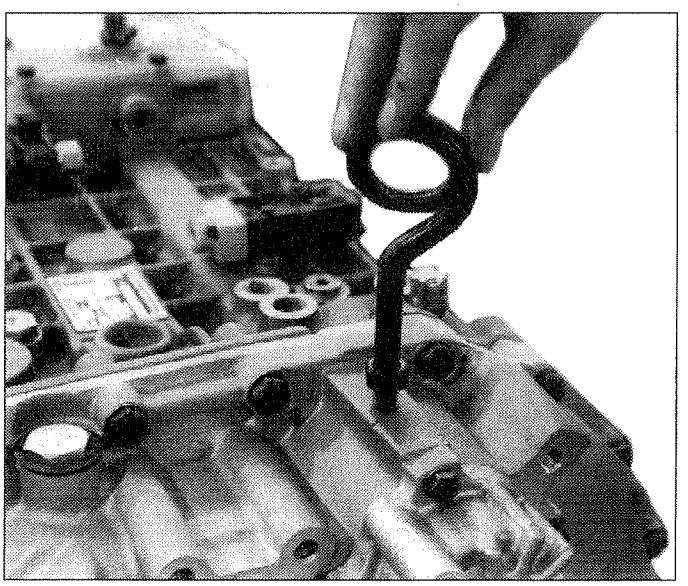

009 318

8 Insert hook **1X56 136 599** into housing.

9 Attach range-change to crane.

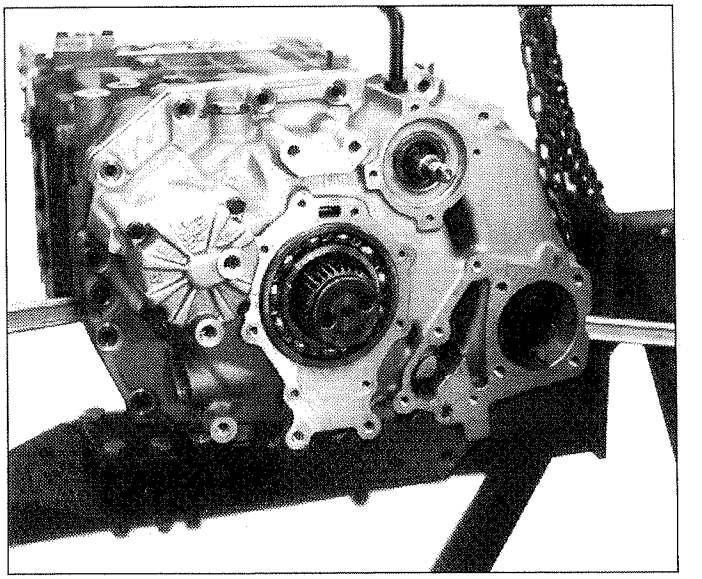
CAUTION
If output flange removed, secure planet carrier in housing. To do this, place suitable bush on planet carrier shaft. Secure bush using the previously removed shim and two hex bolts.

10 Remove hex bolts from around the housing.


009 319

11 Separate the two housing sections using prybars.

12 Remove gasket and clean sealing faces.



009 321

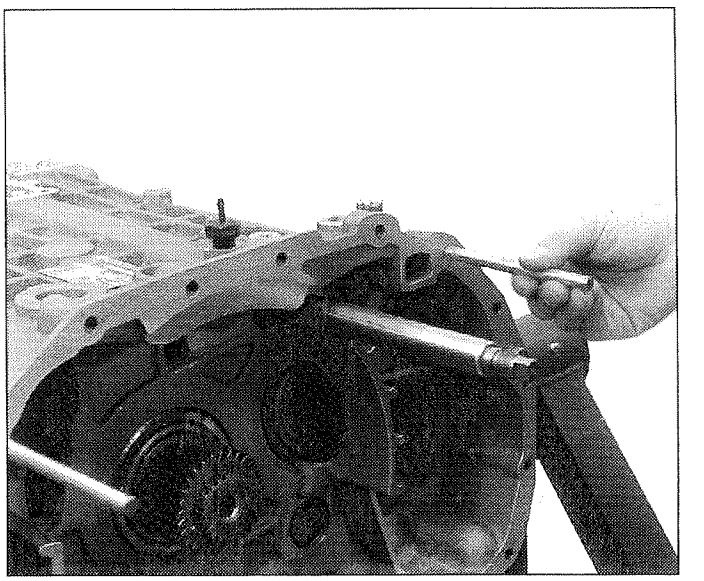
3.2 Fitting range-change / splitter operating cylinder

CAUTION
If output flange removed, secure planet carrier in housing. To do this, place suitable bush onto planet carrier shaft. Secure bush with the previously removed shim and two hex bolts.

1 Insert standard M10 guide pins into housing.

2 Slide new gasket over guide pins and place against housing.

3 Attach range-change to crane and carefully lift towards transmission housing.



009 322

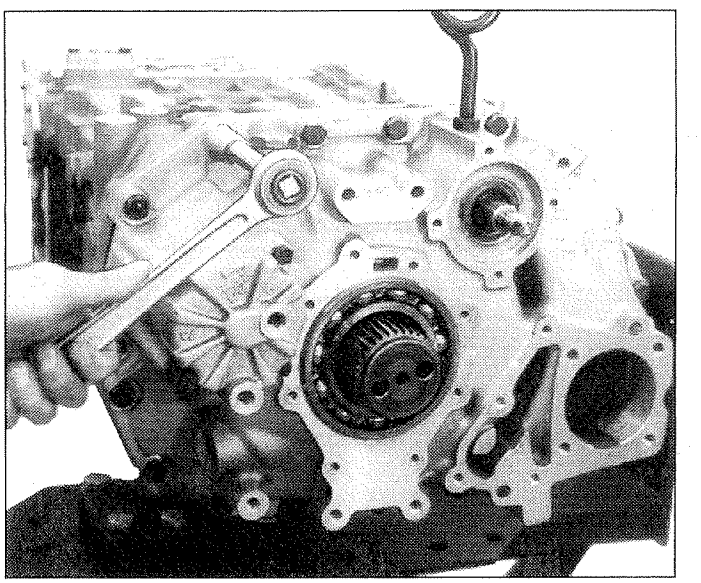
NOTE
Guide shift rail into bearing plate opening for shift interlock.

4 Place range-change onto guide pins and bring into position.

NOTE
Bring sun gear and planet gear teeth into mesh.

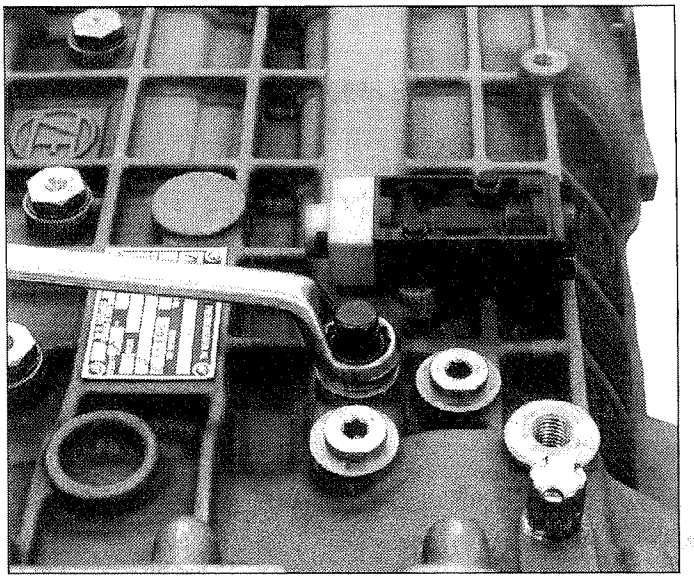
5 Insert hex bolts specified on parts list.
- M10 tightening torque = 50 Nm

NOTE
Insert hex bolt with transverse bore in head into speedo drive threaded bore (safety wire).



009 320

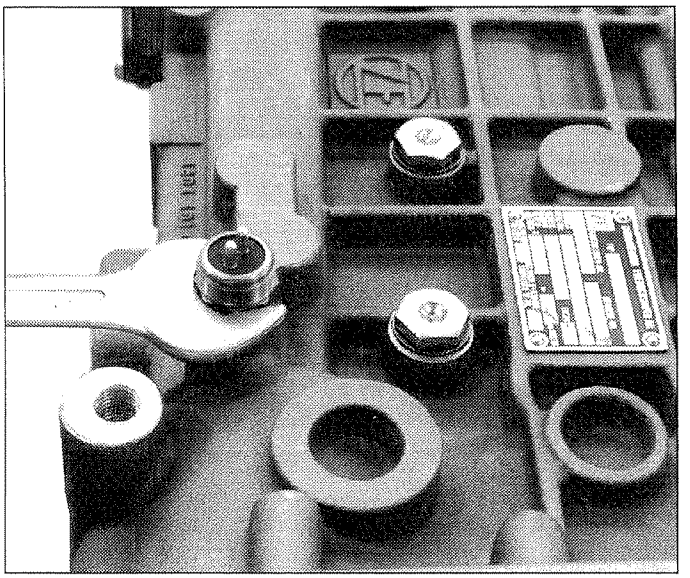
6 Insert detent plunger for range-change together with new seal ring
- M16x1.5 tightening torque = 50 Nm



009 323

7 Insert ball into housing bore. Use ohmmeter to check that reverse gear indicator switch functions correctly and insert together with new seal ring.
- tightening torque = 45 Nm

NOTE
If range-change has not been dismantled and only flange packing and/or piston, lock nut and cylinder have to be fitted, proceed as follows before inserting the detent plunger: insert fixing device* into detent plunger threaded bore and tighten to 50 Nm. While doing this, position the fixing device so that the shift rail is radially fixed. Coat outside of new flange packing with white spirit. Slide flange packing over shift rail with sealing lip facing housing and place against housing bore. Use suitable tool to ensure flange packing is fully flush. Mount shim, piston and lock nut. Mount double-grooved ring, O-ring and cylinder (1). Unscrew fixing device*.



009 324

** depending on version, 1X56 137 579 or 1X56 138 100.*

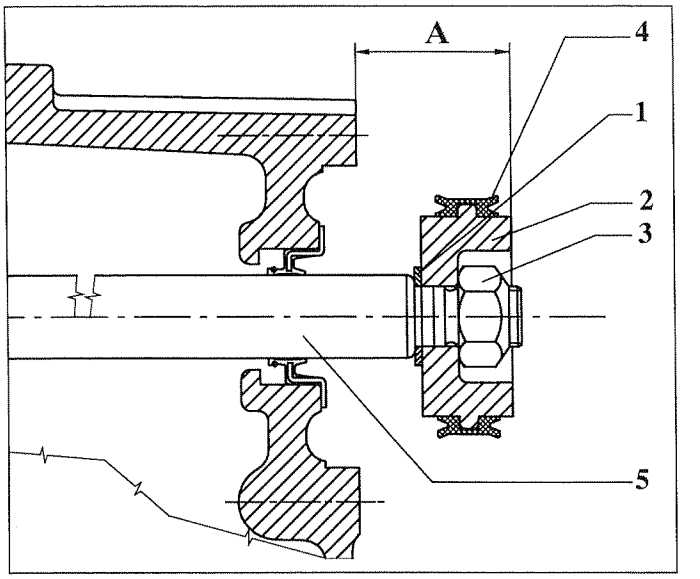
Range-change dismantled.

8 Insert fixing device* into threaded bore for splitter detent plunger and tighten to 50 Nm. This means the following positions are fixed:

a) High **splitter** in overdrive transmission

b) Low **splitter** in direct drive transmission.

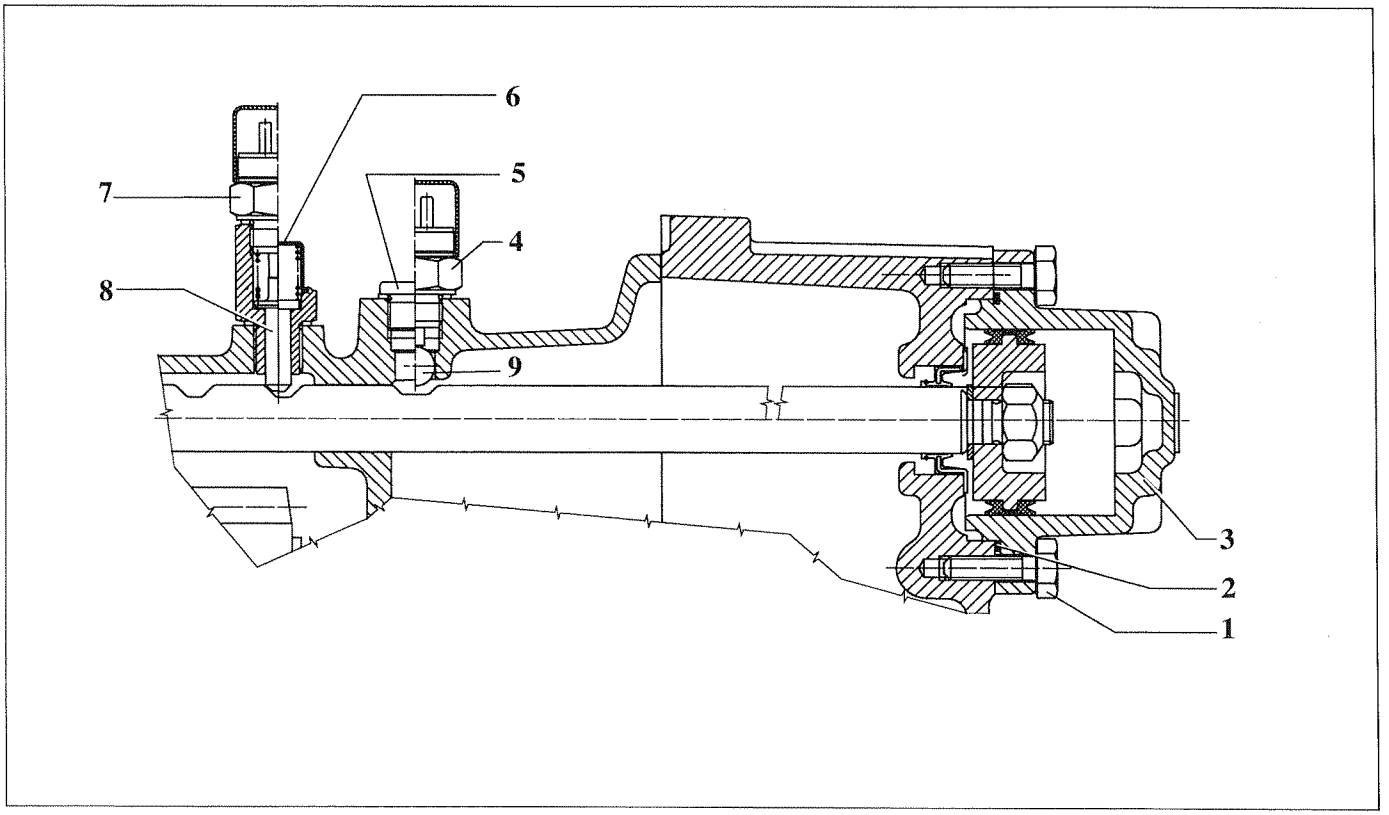
Measure **distance "A"** between piston face and housing sealing face. In the first version (sand cast), dimension "A" = $40.6^{\pm 0.2}$ mm.
In the second version (pressure die-cast), dimesion "A" = $41.6^{\pm 0.2}$ mm.



008137

9 Select suitable shim **(1)** from spare parts catalogue. Mount shim **(1)**, piston **(2)** and lock nut **(3)** onto shift rail **(5).**
M16x1.5 lock nut
- tightening torque = 150 Nm

**Depending on version, 1X56 137 579 or 1X56 138 100.*



008 138

10 Coat new O-ring (**2**) with grease and place into annular groove in cylinder (**3**).

11 Lightly coat inside of cylinder with grease (**AERO GREASE 22 C – MIL G 81322**).

12 Carefully slide cylinder over piston.

13 Rotate cylinder into position.

14 Insert hex bolts (**1**) together with spring washers.
- M8 tightening torque = 23 Nm

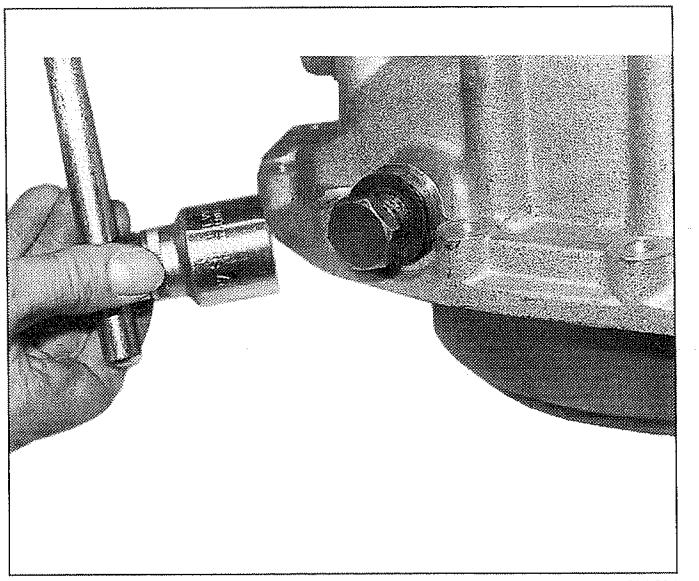
15 *Depending on version*
Insert dentent plunger (**6**) for splitter together with new seal ring.
- tightening torque = 50 Nm

or insert threaded bush (**8**) together with switch (7)
- tightening torque 50 Nm in each case

16 *Depending on version*
Insert ball (**9**) into housing bore and screw in switch (**4**) together with new seal ring, using ohmeter to check for correct functioning, or insert screw plug (**5**) together with seal ring.
Switch tightening torque = 50 Nm
Screw plug tightening torque = 35 Nm

3.3 Dismantling range-change

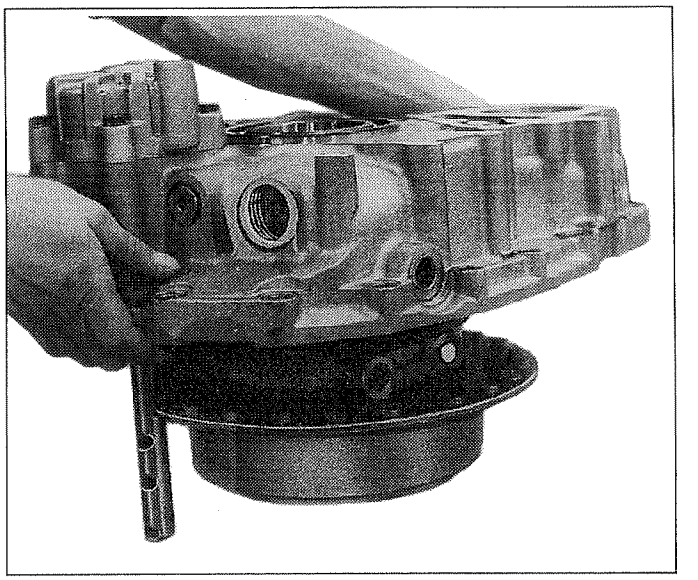
1 Remove both pivot bolts from housing.



006 834

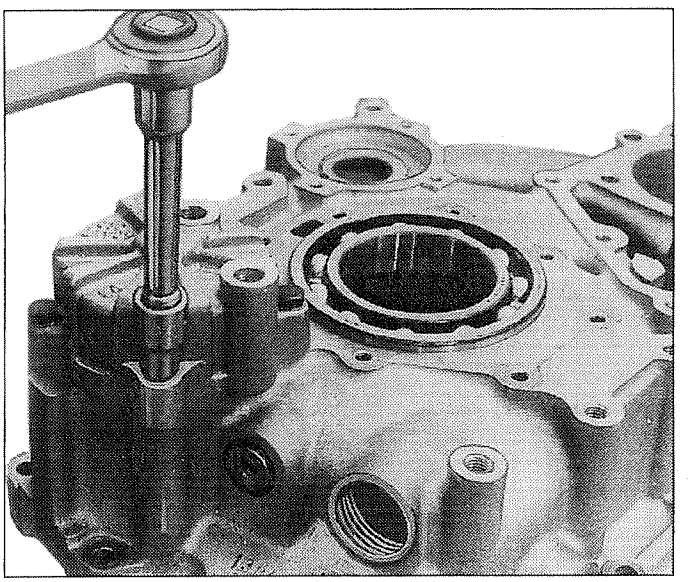
2 Lift off housing from planet carrier.

NOTES
If the range-change is not dismantled, the cylinder, lock nut, piston with grooved rings, guide ring and flange packing are disassembled in section **3.1.**



006 835

3 Remove hex bolts from cylinder.



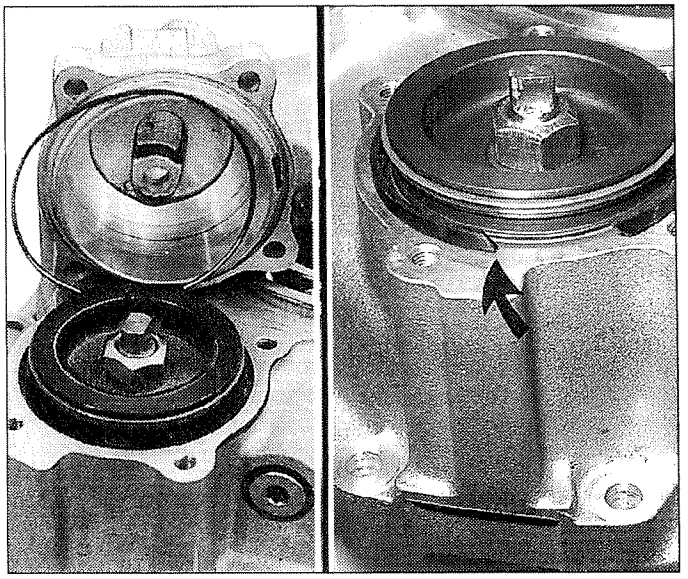
006 836

4 Carefully lift off cylinder together with O-ring.

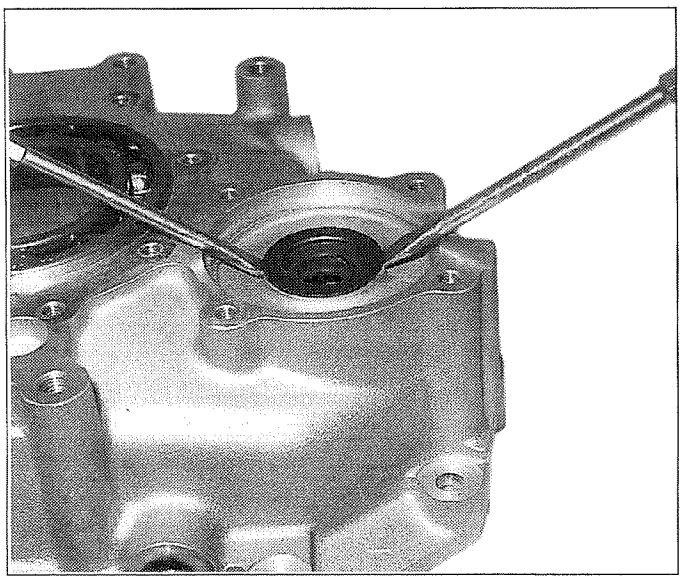
5 Remove guide ring from piston groove (see arrow).

6 Pull out shift rail together with piston.

CAUTION
The flange packing may be damaged; therefore, it must ALWAYS be renewed.

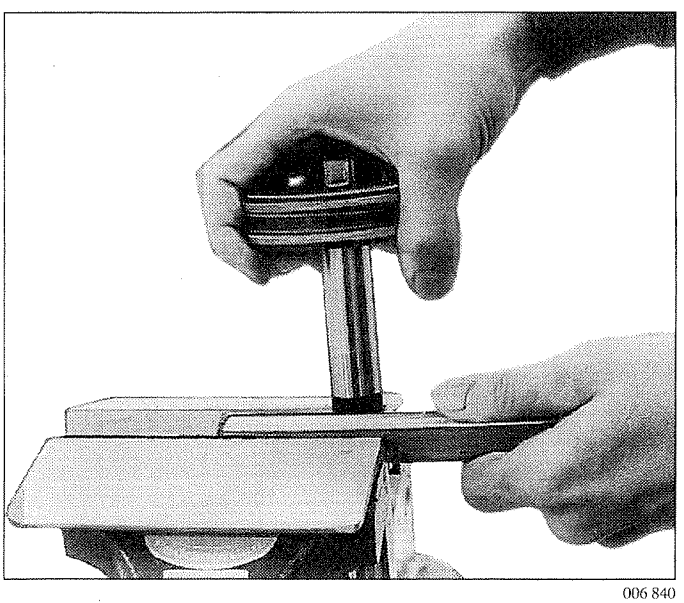

006 837

7 Press out flange packing from housing, e.g. using screwdriver.


006 838

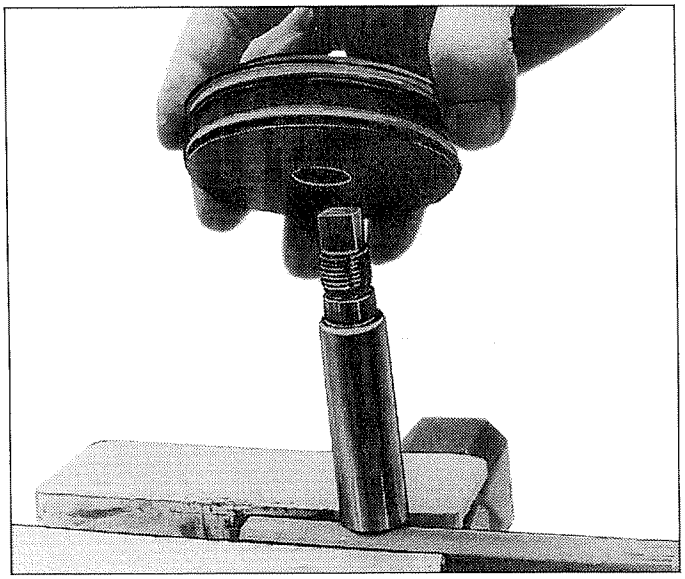
8 Clamp shift rail in vice, placing rectangular bar against recess.

CAUTION
Use aluminium jaws in vice to protect shift rail.


006 840

9 Unscrew lock nut and remove piston.

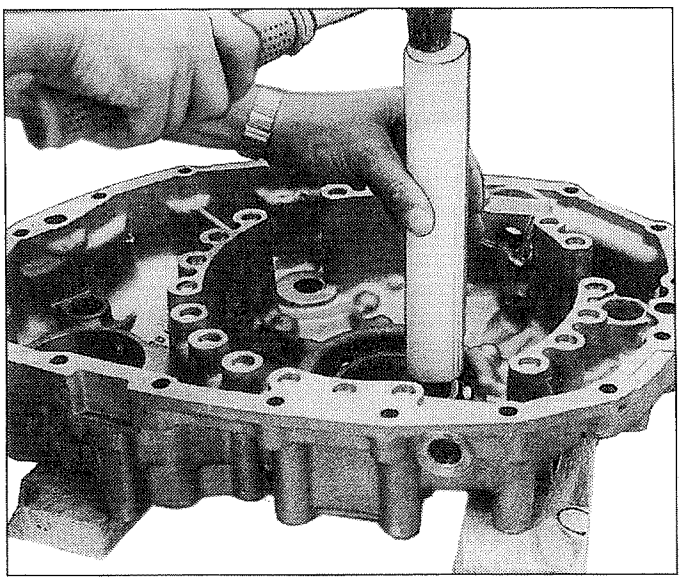
10 Remove both grooved rings from piston grooves.



006 839

11 Use drift to drive out ball bearing from housing. Before doing this, place housing onto wooden blocks.

12 Remove screw plugs from housing.



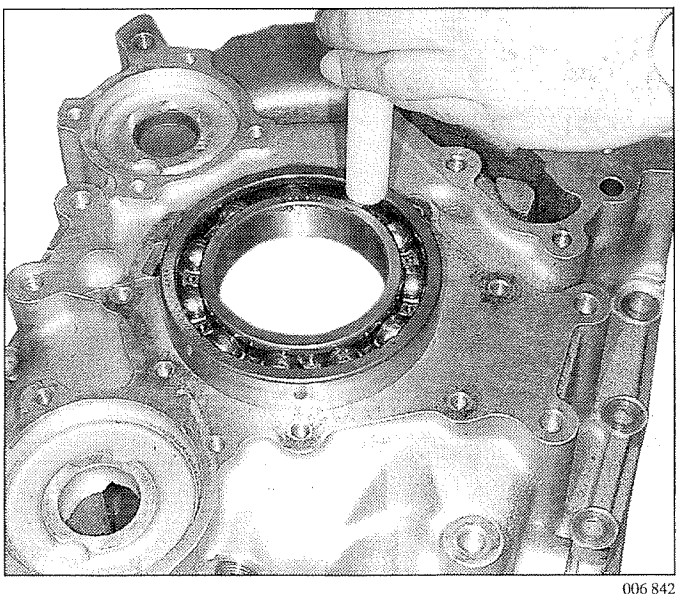
006 841

3.4 Assembling range-change

1 Insert screw plugs into housing together with new seal rings.
- M18x1.5 tightening torque = 35 Nm

NOTE
Heat bearing seat in housing to max. 70°C using hot air blower.

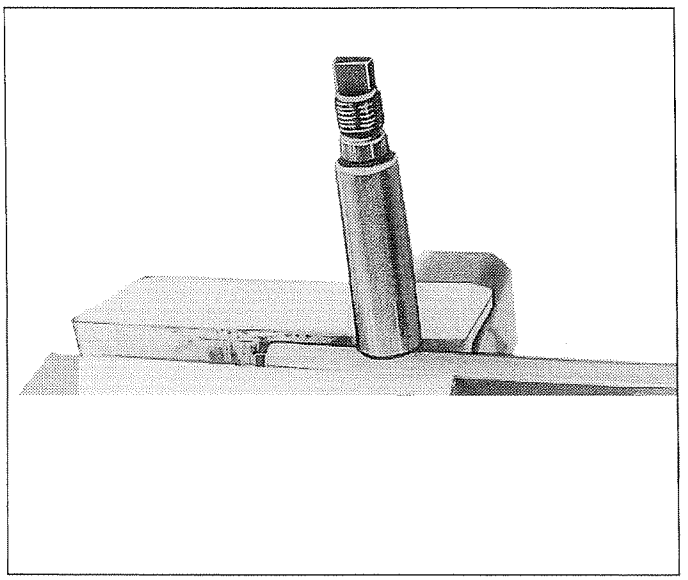
2 Using plastic drift, drive ball bearing into housing ensuring it is fully flush.



006 842

3 Clamp shift rail in vice, placing rectangular bar against recess.

CAUTION
Use aluminium jaws in vice to protect shift rail.

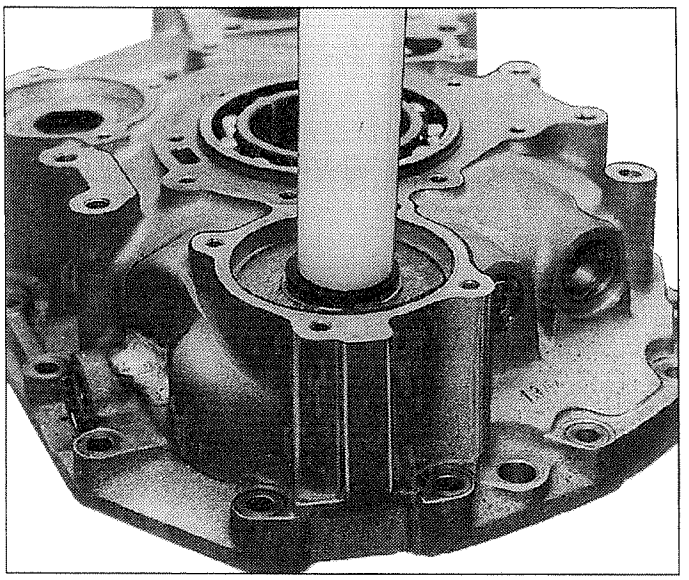


006 843

NOTE
If the range-change has not been dismantled, flange packing, piston with grooved rings and guide ring, lock nut and cylinder are mounted in section **3.2.**

NOTE
Coat outside of flange packing with white spirit.

4 Drive new flange packing into housing using suitable tool.

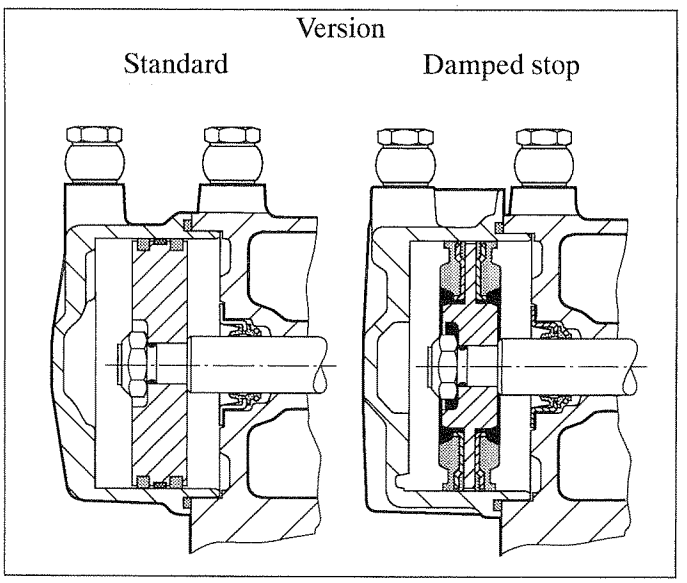


006 844

5 Insert new grooved rings into piston.

CAUTION
The grooved sides of the rings must face outwards.

6 Lightly coat sealing lips of grooved rings with grease, ZF No. **0750 199 001 (e.g. ARALUB HL2)**.



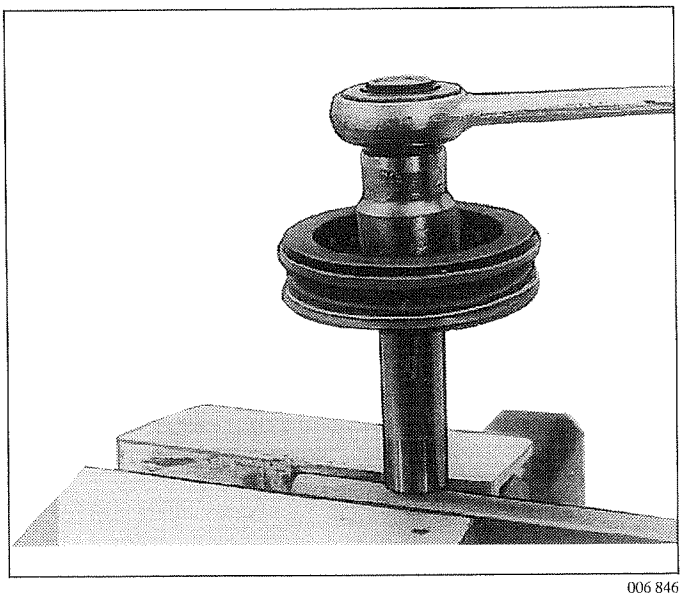
009 767

7 Place piston onto shift rail.

NOTE
The recess in the piston must face upwards.

8 Screw on new lock nut.
- M16x1.5 tightening torque = 150 Nm

9 Insert shift rail into housing bore together with piston. Rotate shift rail while doing this.

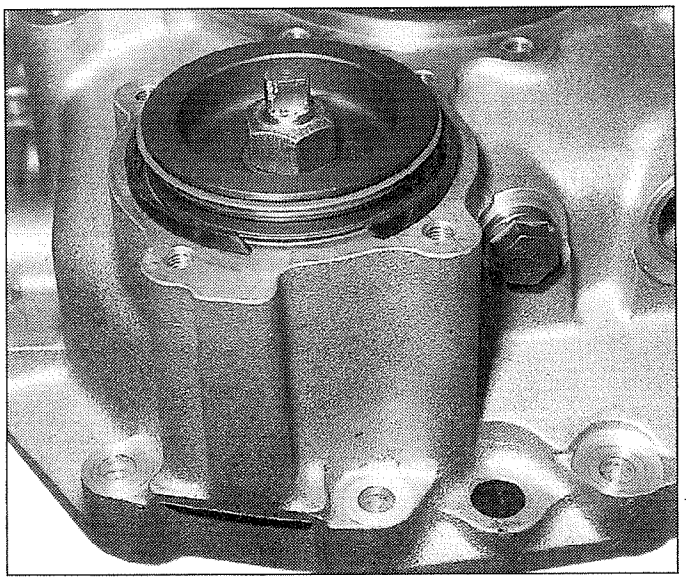


006 846

10 Insert guide ring into middle annular groove in piston.

11 Lightly coat inside of cylinder with grease ZF No. **0750 199 001 (e.g ARALUB HL2)**.

12 Coat new O-ring with grease, and insert into annular groove in cylinder.

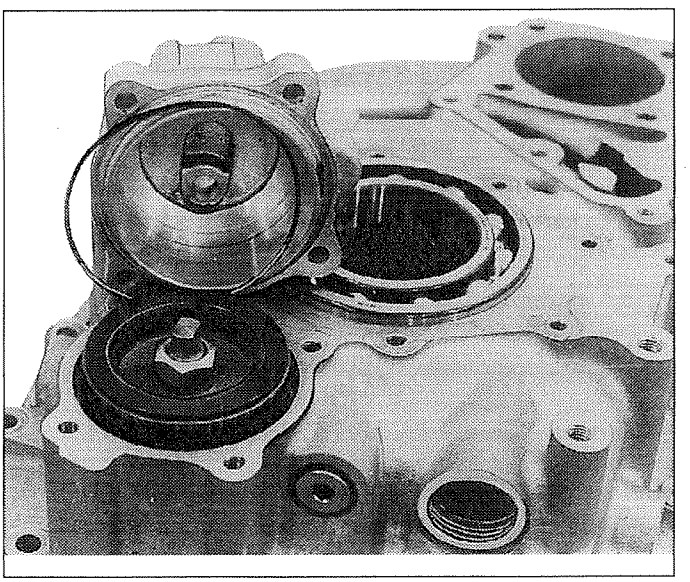


006 847

13 Carefully slide cylinder over piston.

NOTE
While doing this, the guide ring must rest against the base of the annular groove in the piston.

CAUTION
Take care not to damage grooved rings and guide rings.

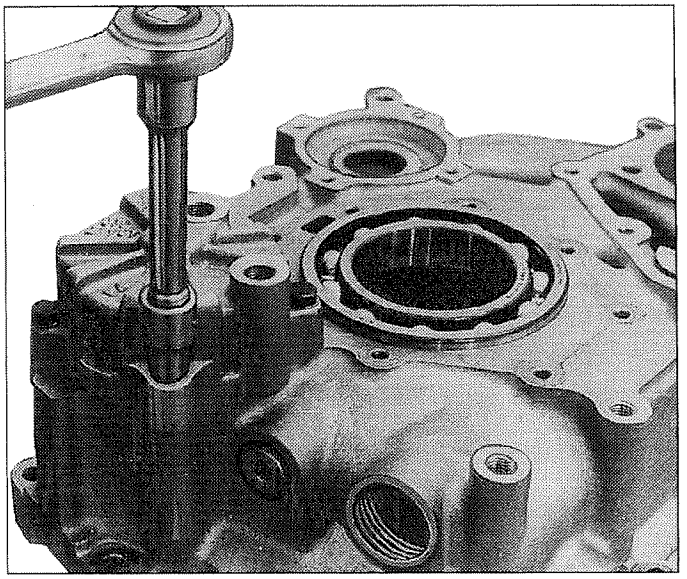


006 848

14 Rotate cylinder into position.

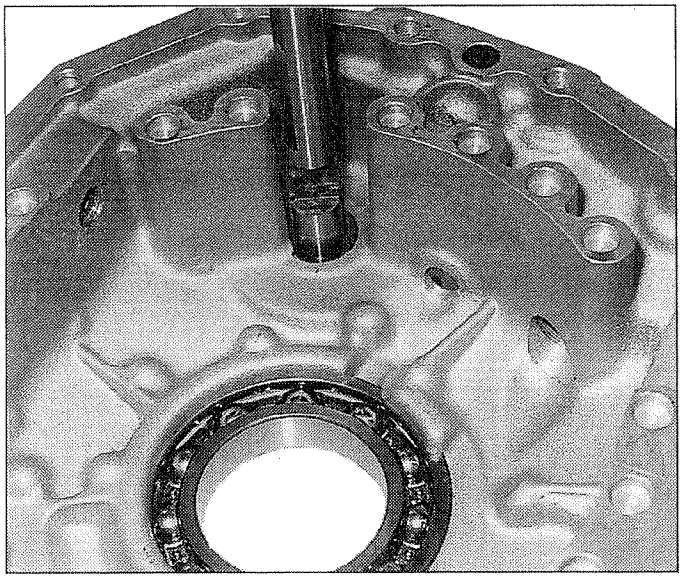
15 Insert hex bolts together with spring washers.
- M8 tightening torque = 25 Nm

16 Radially position shift rail so that both detents for attaching the range-change (**3.2**) face outwards.



006 849

NOTE
The shift rail recesses for shift fork engagement are in installation position.



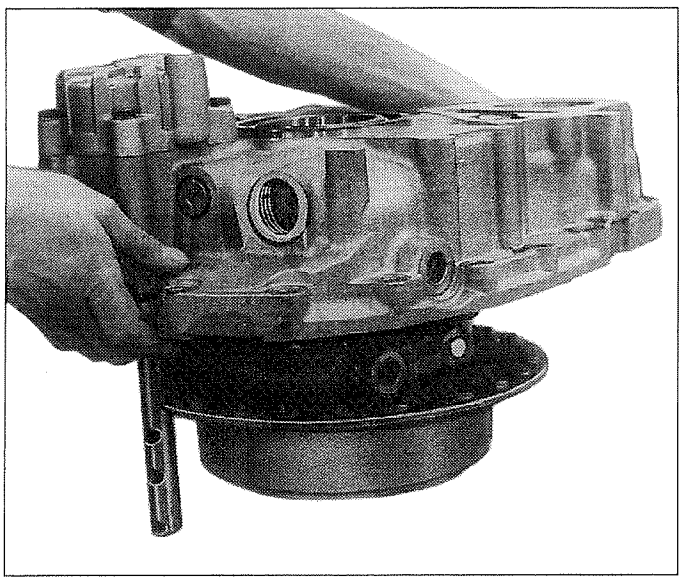
006 850

17 Place range-change housing onto planet carrier together with synchronizer and bring into position.

NOTE
One of the two recesses in the clutch body must be next to the shift rail, while the second recess must be beneath the second shift cylinder attachment point.

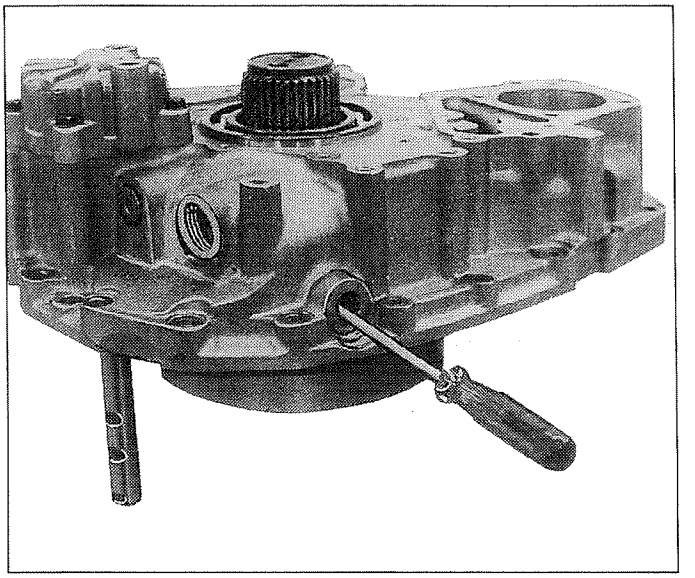
18 Insert the shift fork lug into the shift rail recess.

NOTE
Journals on clutch body must engage in housing recesses.



006 835

19 Line up shift fork with threaded bores in housing so that shift fork guide bores are aligned with threaded bores in housing.

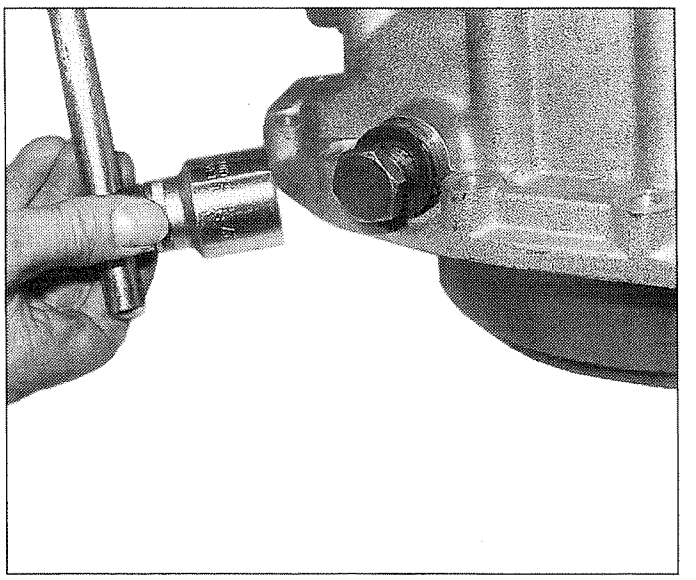


006 851

NOTE
- Threads must be clean and free of oil and grease.
- Coat thread of pivot bolts with **Loctite No. 241.**

20 Insert pivot bolts together with spring washers.

Depending on version:
- M20x1.5 tightening torque= 180 Nm
- M24x1.5 tightening torque = 250 Nm



006 834

21 Fit cover as described in section **2.3**

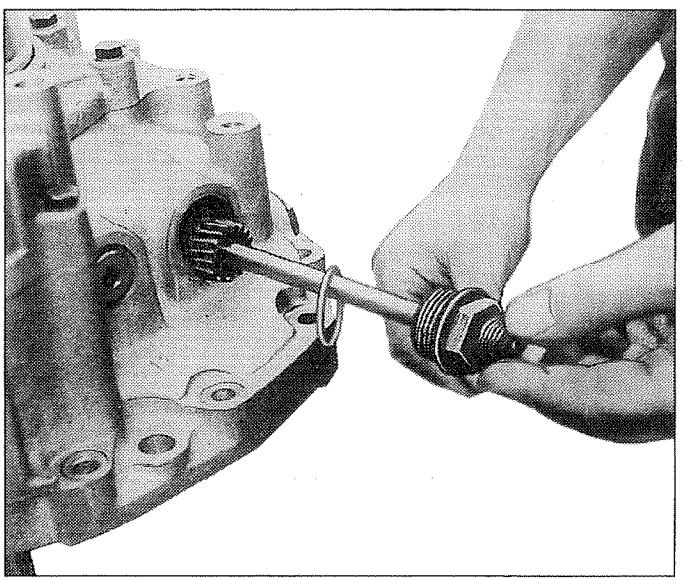
22 Fit output flange as described in section **2.4.**

23 Insert speedo shaft together with new seal ring
- tightening torque = 100 Nm

24 Check axial play and backlash on speedo shaft by hand (can be felt).
- Axial play = min. 0.1 mm
- Backlash = min. 0.1 to 0.2 mm

NOTE
If shaft seal is defective, do not remove. Instead, drive in new shaft seal using drift **1X56 100 632.**

NOTE
Depending on parts list version, impulse sensor may be fitted
- tightening torque = 50 Nm



006 852

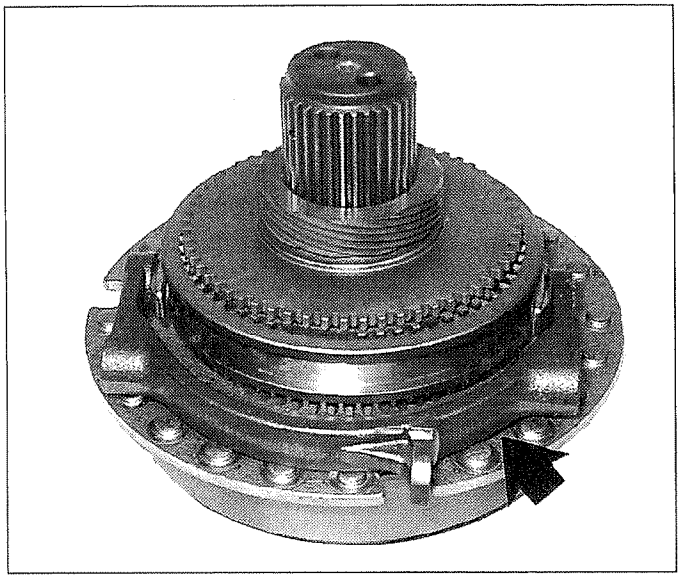
4 Planetary mechanism with synchronizer

4.1 Dismantling synchronizer

1 Remove shift fork (see arrrow).

2 Remove fulcrum pads from shift fork.

3 Place adapter onto planet carrier.



006 856

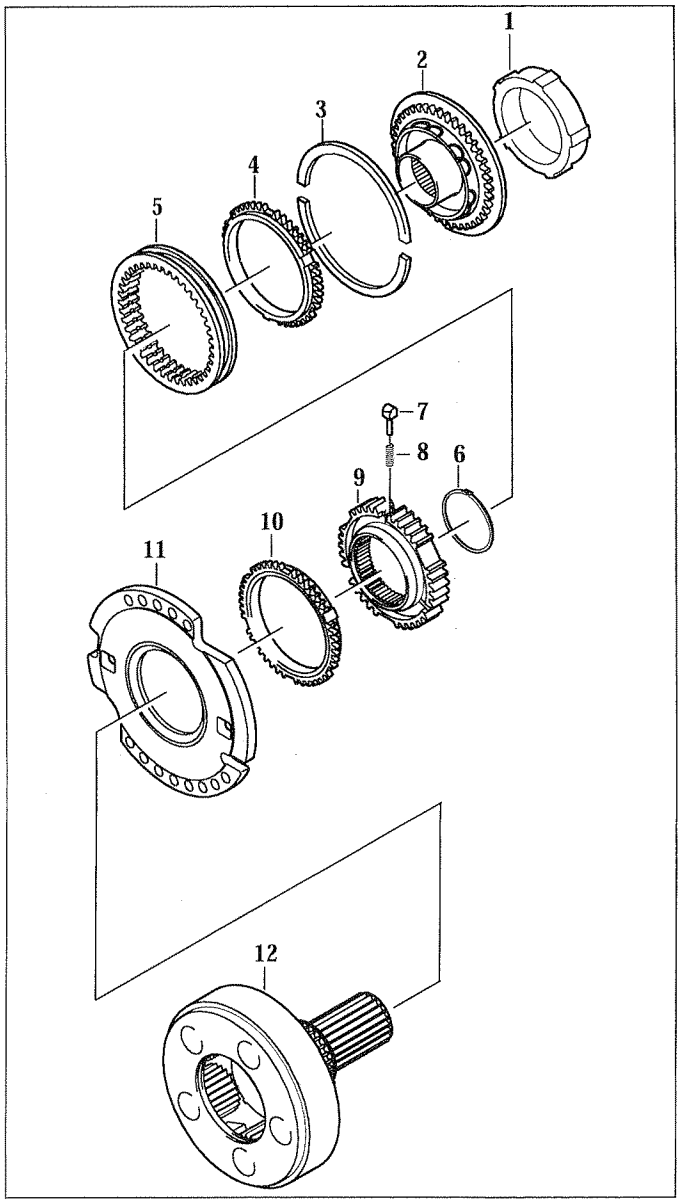
4 Insert split ring (3) **1X56 137 648** between clutch body (2) and synchronizer ring (4). Attach two- or three-leg puller underneath sliding sleeve (5) and pull off synchronizer ring (4), clutch body (2) and impulse disc (1)/speedo worm. The pressure pieces (7) and compression springs (8) which are held by the sliding sleeve can be caught in a cloth.

⚠ DANGER
Pressure pieces are under spring pressure. Secure them to prevent them from flying out.

5 Detach circlip (6).

6 Attach two-leg puller beneath synchronizer hub (9) and pull off.

7 Remove synchronizer ring (10) and clutch body (11) from planet carrier (12).



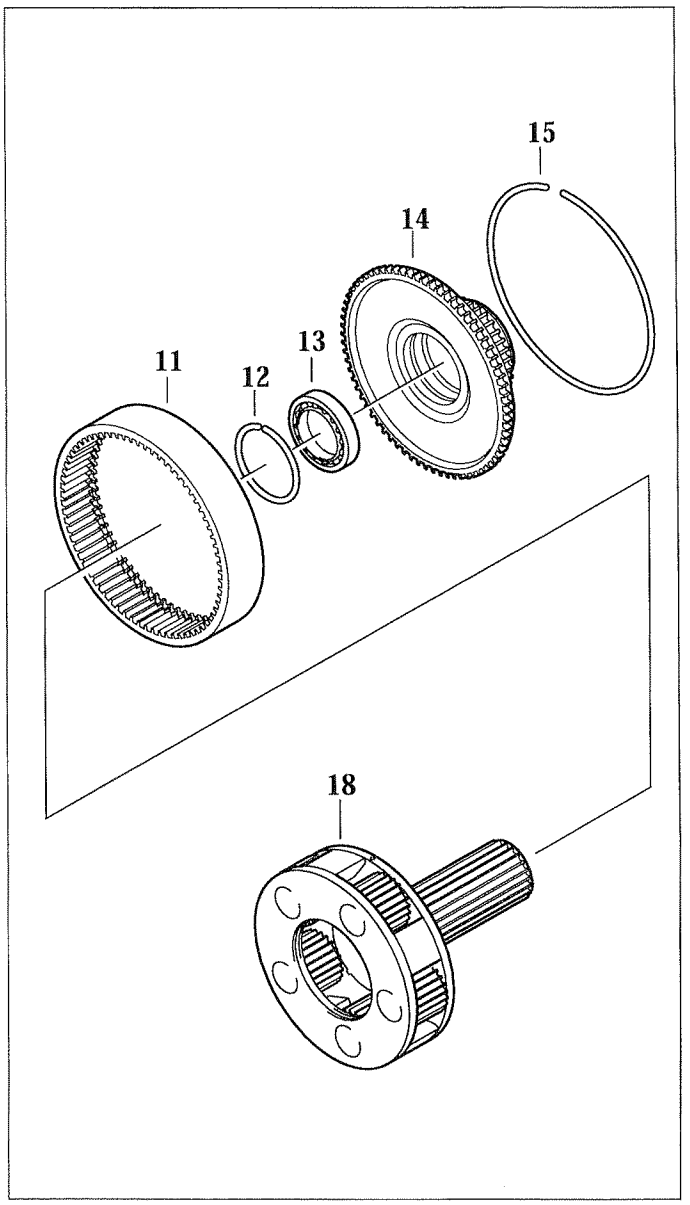
007 998

4.2 Dismantling ring gear

1 Pull off complete ring gear from planet carrier **(18).**

2 Detach circlip **(12)** from annular groove in ring gear carrier **(14)** and remove ball bearing **(13).**

3 Detach safety wire **(15)** from annular groove in ring gear **(11)** and drive out ring gear carrier **(14)** from ring gear using plastic hammer.



007 999

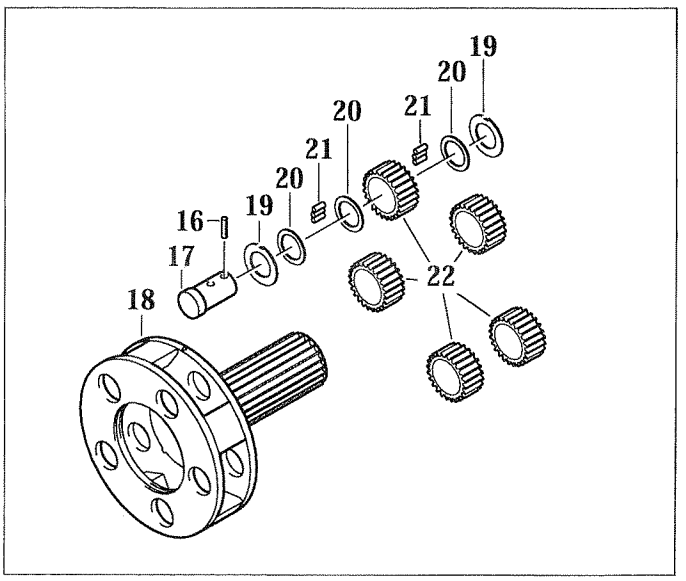
4.3 Dismantling planet carrier

1 Fully drive dowel **(16)** into planet pin **(17).**

2 Drive out planet pin **(17)** from planet carrier **(18)** (towards input end) using hammer and plastic drift.

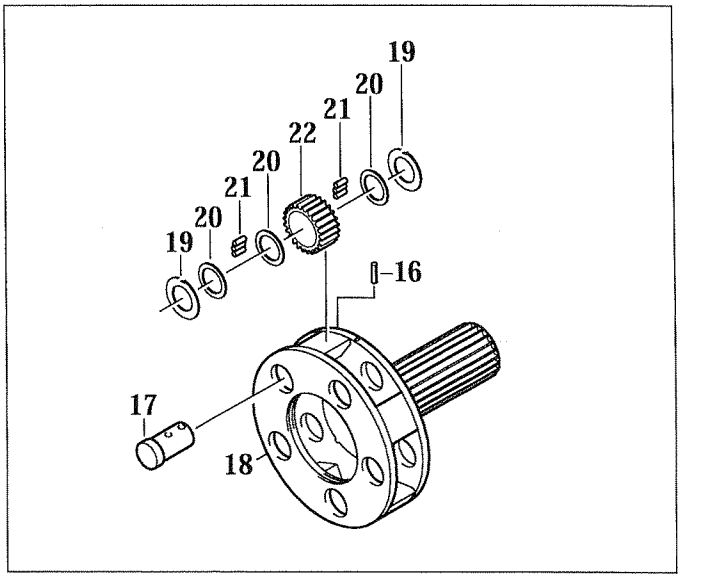
3 Remove planet gears **(22)**, washers **(20)**, thrust washers **(19)** and needle rollers **(21)** from planet carrier.

4 Drive out dowel **(16)** from planet pins **(17).**



008 003

4.4 Assembling planet carrier



008 001

CAUTION
Planet gears must always be replaced in sets, never individually.

1 Lightly coat planet gear (**22**) face and cylinder roller raceway with oil.

2 Position planet pin (**17**) with collar facing downwards.

3 Slide thrust washer (**19**) over planet pin, ensuring that marked side is facing towards planet carrier.

4 Slide one washer (**20**) over the planet pin.

5 Place planet gear (**22**) onto planet pin.

6 Insert 20 needle rollers (**21**) into planet gear and slide washer (**20**) over planet pin.

NOTE
Only use needle rollers of the same dimensions.

7 Insert remaining 20 needle rollers, lightly coat with oil and fit washer (**20**).

8 Slide thrust washer (**19**) over planet pin, ensuring marked side is facing towards planet carrier.

9 Place planet carrier (**18**) onto shaft end.

10 Carefully remove planet gear (**22**) from planet pin (**17**) together with thrust washers (**19**) and insert into planet carrier.

11 Align planet gear (**22**) and thrust washers (**19**) with bearing bore.

NOTE
The "0" marking on the end of the planet pin must face towards the outer radius of the planet carrier (oil bore must face towards inner radius of planet carrier).

12 Radially align planet pin (**17**) and insert into bearing bore.

13 Drive in planet pin using plastic hammer. Check that dowel bore is aligned.

14 Drive new dowel (**16**) into planet carrier.

15 Check planet gear axial play (0.1 to 0.7 mm).

16 Repeat steps 1 to 15 for the other four planet gears.

4.5 Assembling ring gear

1 Drive ring gear carrier (**14**) flush into ring gear (**11**).

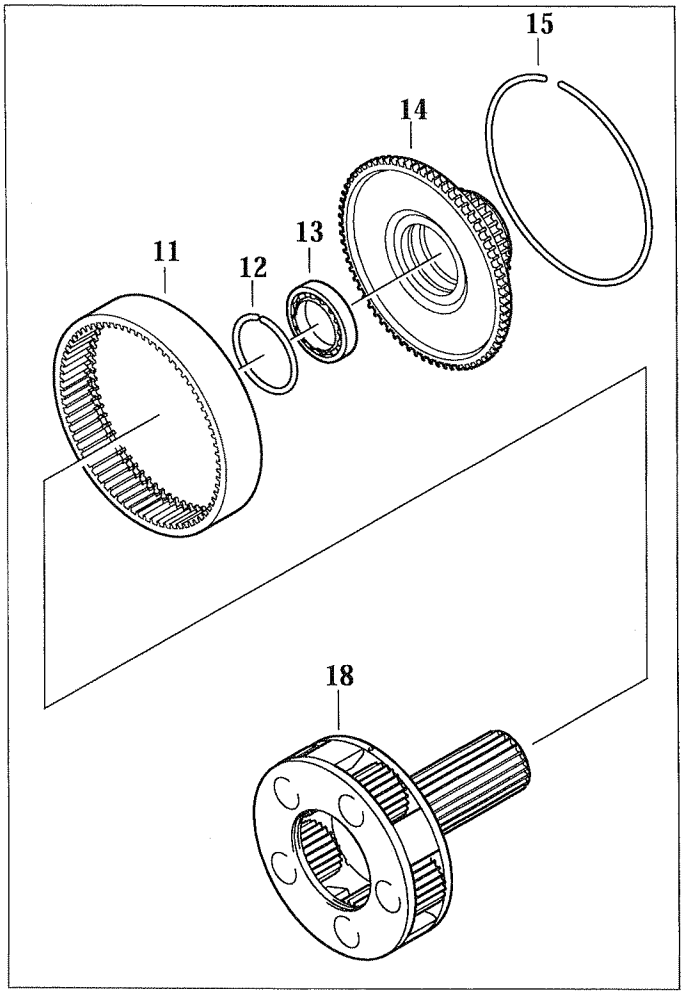
2 Attach safety wire (**15**) into annular groove in ring gear.

NOTE
The safety wire must lie in the base of the groove.

3 Insert ball bearing (**13**) into ring gear carrier and attach snapring (**12**). Set ball bearing axial play to between 0 and 0.1mm using suitable snapring.

4 Heat ball bearing (**13**) to approx. 60 °C and place onto planet carrier together with ring gear. While doing this, rotate ring gear and bring teeth into mesh. Ball bearing must be flush against planet carrier.

⚠ **DANGER**
Always wear protective gloves when handling heated parts.



007 999

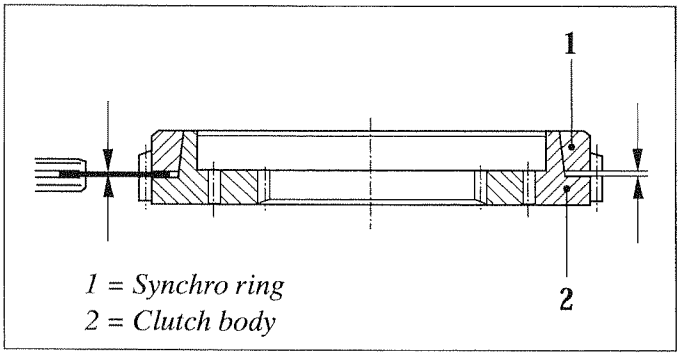
4.6 Assembling synchronizer

NOTE
Use synchromesh parts as specified in brochure 1297 754 001 "Inspection ZF lock synchronizer components".

CAUTION
Check, mark and store parts in PAIRS. Do not mix up parts.

1 Place synchronizer ring centrally onto clutch body. Bring cones into contact by rotating the parts.

2 Measure distance between clutch body and synchronizer ring using feeler gauge.



006 867

NOTE
Compare measured distance with permitted wear limits. These are:
- main transmission = 0.8 mm
- range-change = 1.2 mm

NOTE
If the wear limit is exceeded, install new synchro nizer ring and/or clutch body.

3 Place clutch body (**11**) and synchronizer ring (**10**) onto planet carrier.

4 Slide on synchronizer hub (**9**) ensuring that long hub side is facing towards planet carrier. The lugs on the synchronizer ring must engage into the recesses in the synchronizer hub.

5 Attach circlip (**6**) into annular groove, ensuring axial play is between 0 and 0.1 mm.

NOTE
Select suitably thick circlip from spare parts catalogue.

6 Place sliding sleeve (**5**) onto synchronizer hub (**9**) and bring into correct position.

NOTE
Recesses in sliding sleeve must be aligned with recesses in synchronizer hub.

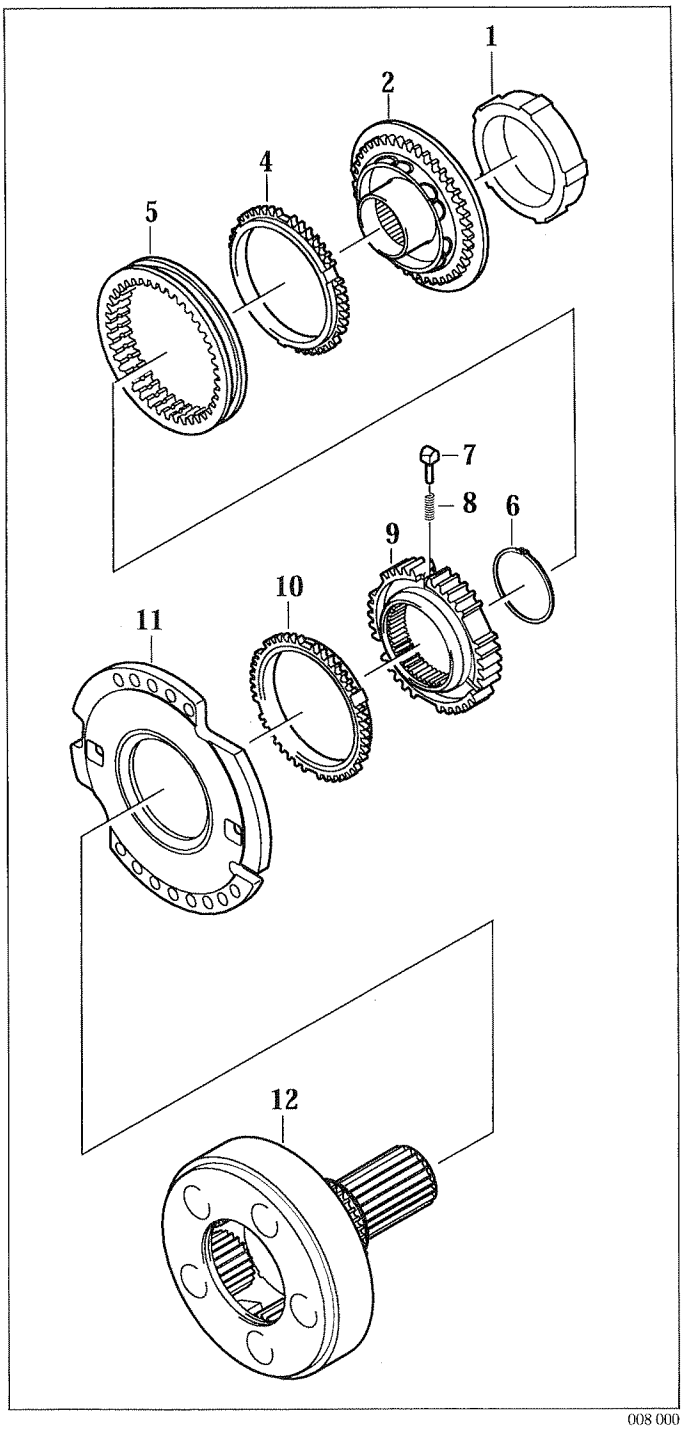
7 Insert new compression springs (**8**) into synchronizer hub together with pressure pieces (**7**) and guide into sliding sleeve using suitable tool.

8 Place synchronizer ring (**4**) onto synchronizer hub.

NOTE
Lugs on synchronizer rings (**10** and **4**) must engage into the recesses in the synchronizer hub (**9**).

9 Apply pressure to synchronizer ring (**4**) and bring sliding sleeve into centre position. Engagement of the pressure pieces can be clearly heard.

10 Heat clutch body (**1**) to approx. 120 °C and slide onto planet carrier.



008 000

⚠ **DANGER**
Always wear protective gloves when handling heated clutch body.

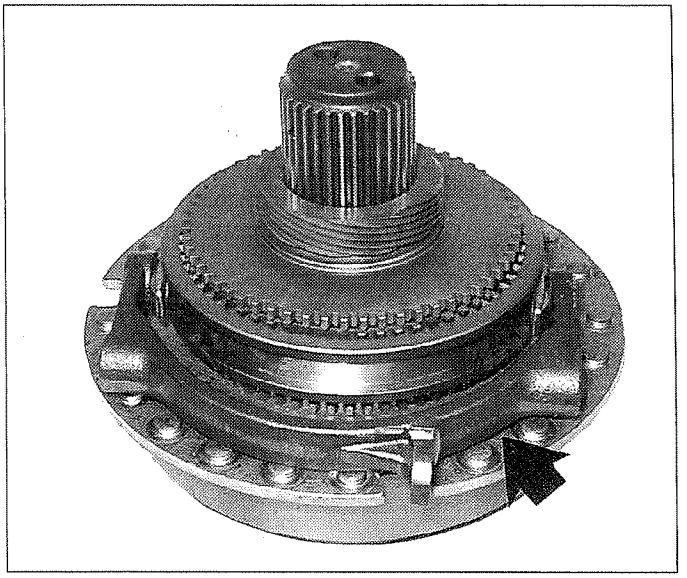
11 Heat speedo worm* or impulse disc* and slide onto planet carrier.

⚠ DANGER
Always wear protective gloves when handling heated clutch body.

12 Insert fulcrum pads into shift fork.

13 Insert shift fork (see arrow) into sliding sleeve.

NOTE
Lug on shift fork is next to the corresponding recess in the clutch body.



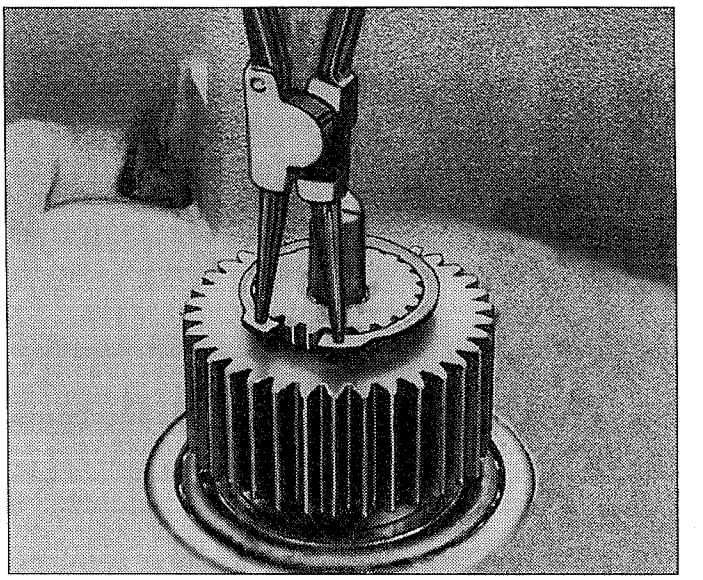
008835

* *Depending on parts list version*

5. Sun gear

5.1 Removing sun gear

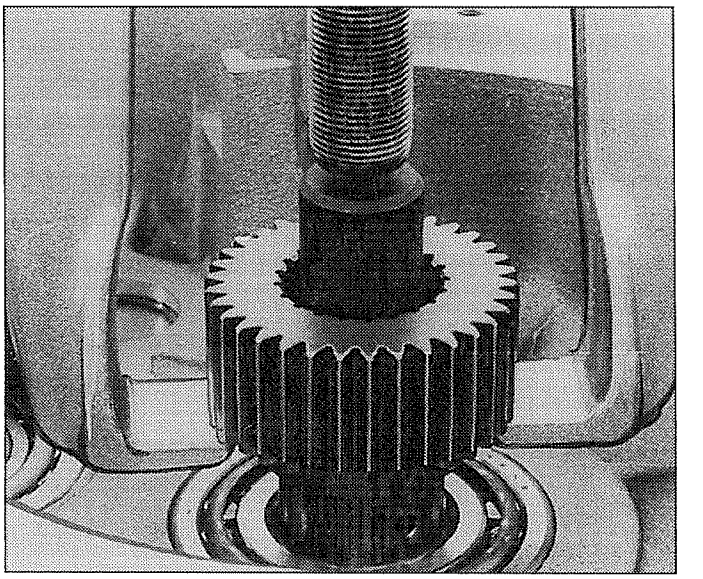
1 Remove circlip from sun gear.



009402

2 Slide drift **1X56 137 456** over pipe for pressure oil lubrication.

3 Pull off sun gear from mainshaft using standard two-leg puller.



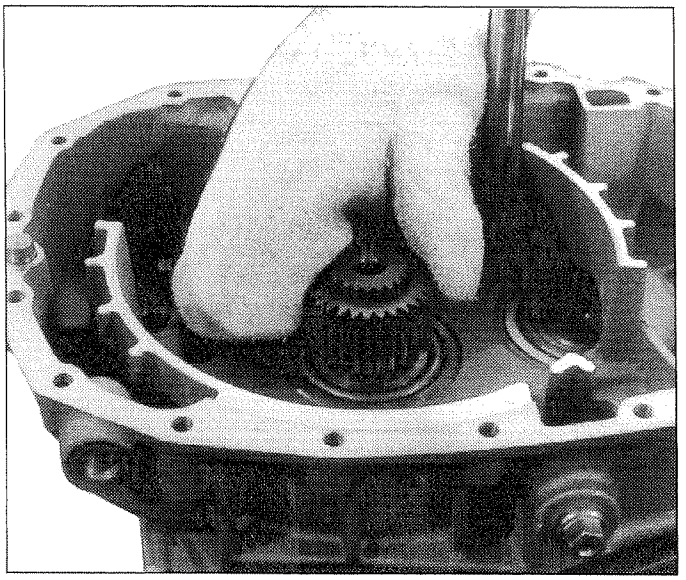
006886

5.2 Fitting sun gear

1 Evenly heat sun gear to max. 170°C so that it can be slid on **by hand** in a single action.

CAUTION
Do not exceeed upper temperature limit of 170°C and only heat for max. 15 mins.

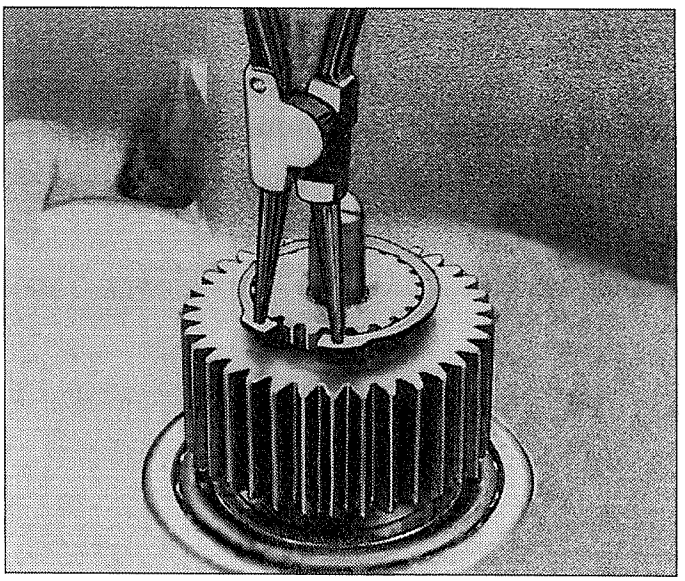
⚠ DANGER
Always wear protective gloves when handling heated sun gear.


009326

2 Slide sun gear flush onto mainshaft.

CAUTION
Always heat sun gear before mounting. Never drive sun gear onto main shaft since impacts and shocks can destroy or damage the taper roller bearing on the mainshaft bearing journal.

NOTE
Collar with bore must face towards input shaft.


009402

3 Attach circlip.

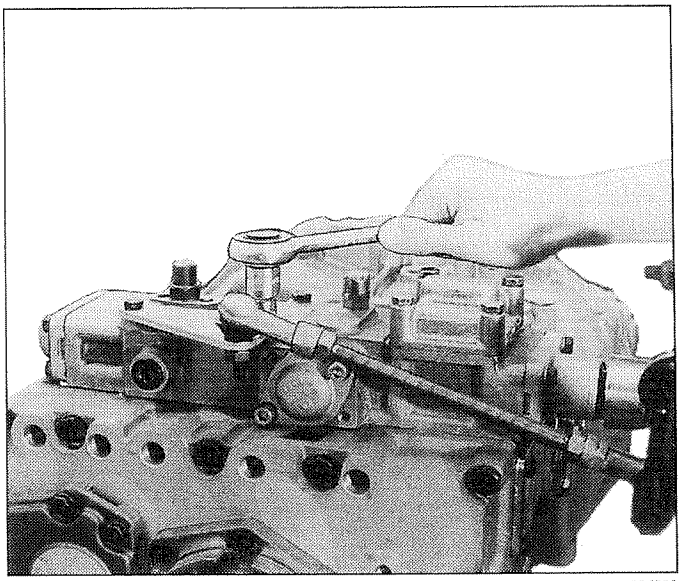
NOTE
Circlip must have axial play of between 0 and 0.05 mm. Select suitable circlip from spare parts catalogue.

4 Drive oil pipe flush into bore using drift **1X56 137 456.**

6 Shift mechanism

6.1 Removing shift mechanism

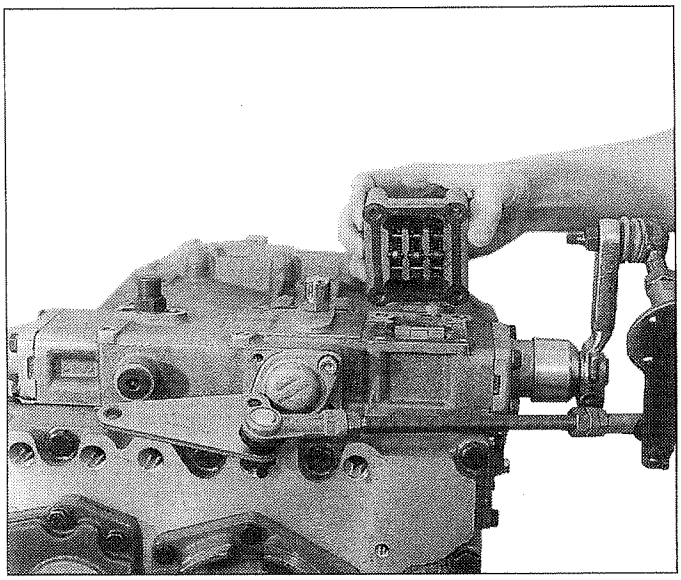
1 Remove hex bolts and spring washers from shift housing and detent cover.



006889

2 Remove detent cover.

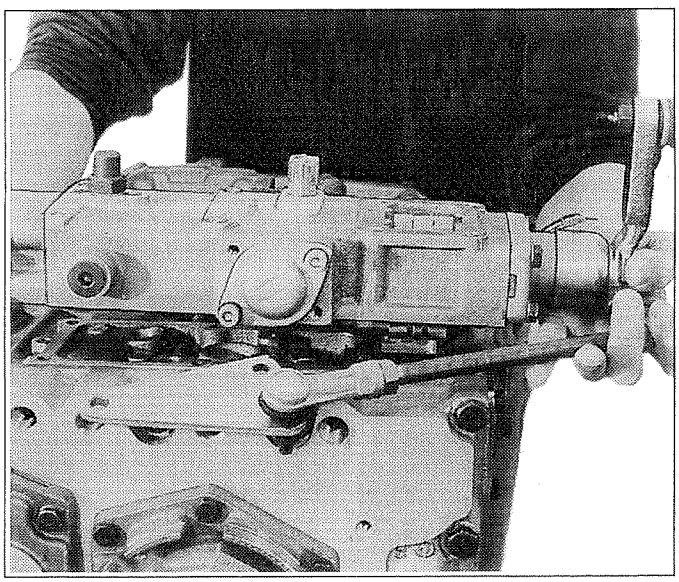
NOTE
Detent cover is a complete part and is not dismantled.



006890

3 Remove shift mechanism.

4 Remove gasket.

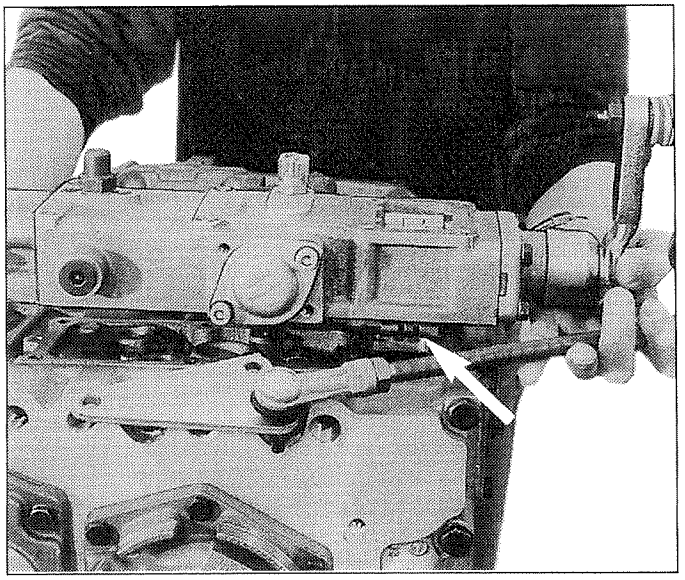


006891

6.2 Fitting shift mechanism

1 Move shift mechanism into "neutral" and place new gasket onto housing sealing face.

2 Fit shift mechanism and engage drivers (see arrow).



006891

3 Place new gasket onto shift housing and fit detent cover.

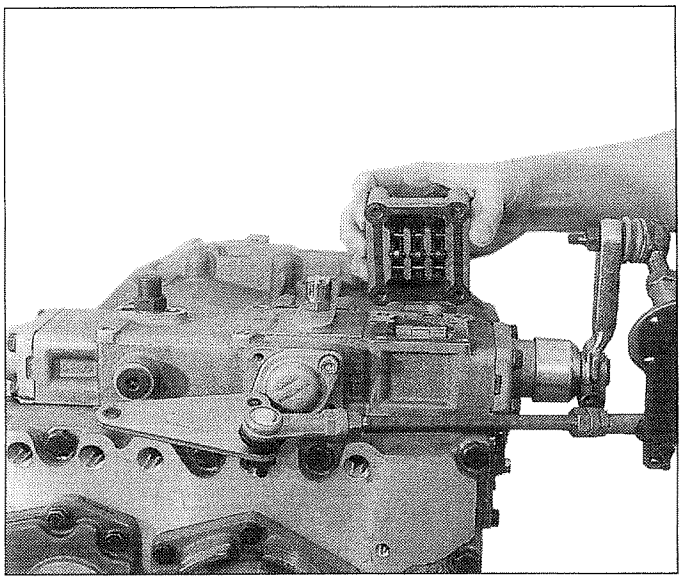
4 Insert all hex bolts together with spring washers and pre-tighten only slightly at first.

NOTE
The shift housing must be aligned with the shift components in the transmission. To ensure that this is the case, proceed as follows:

5 Engage a gear by actuating the shift lever.

6 Engage opposite facing gear.

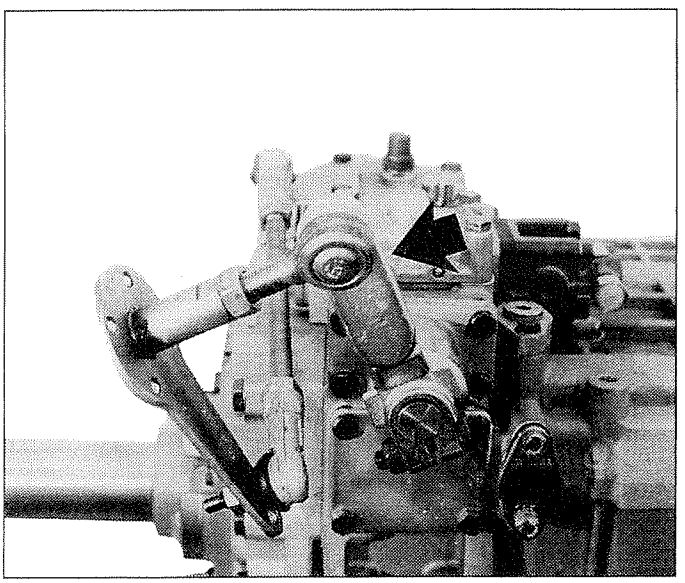
7 Compare shift travel / excess shift travel in relation to centre position.



006890

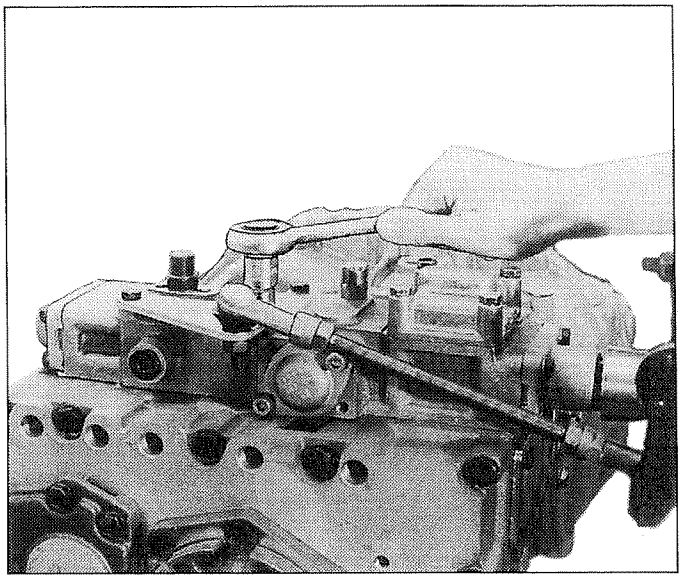
8 If the shift travel/excess shift travel is not the same, loosen hex bolts slightly and move shift housing by lightly tapping with plastic hammer.

NOTE
Repeat procedure until shift travel / excess shift travel is the same.



006892

9 Tighten all hex bolts on the shift mechanism
- M8 tightening torque = 23 Nm



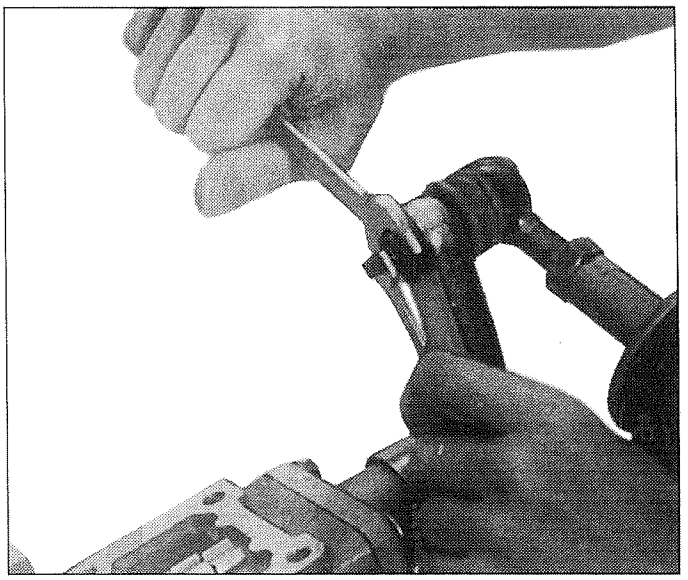
006889

6.3 Dismantling shift mechanism

NOTE
The following illustrations depict the "horizontal left" shift mechanism version. Section **6.4** contains details of the shift component and compression spring arrangements for each shift mechanism type.

1 Clamp shift mechanism in vice.

CAUTION
Use aluminium jaws in vice to protect shift housing.

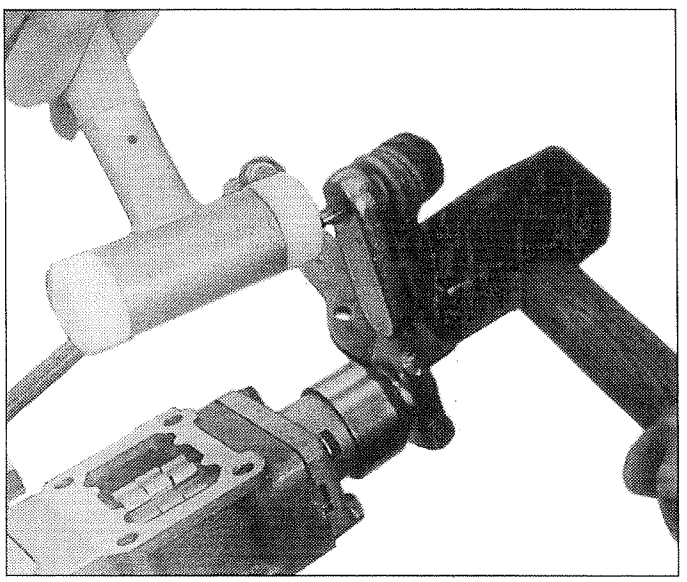

006896

NOTE
Depending on transmission version, a shift reaction linkage may be installed.

2 Unscrew lock nut from ball joint.

3 Drive out ball joint from shift lever and remove reaction linkage.

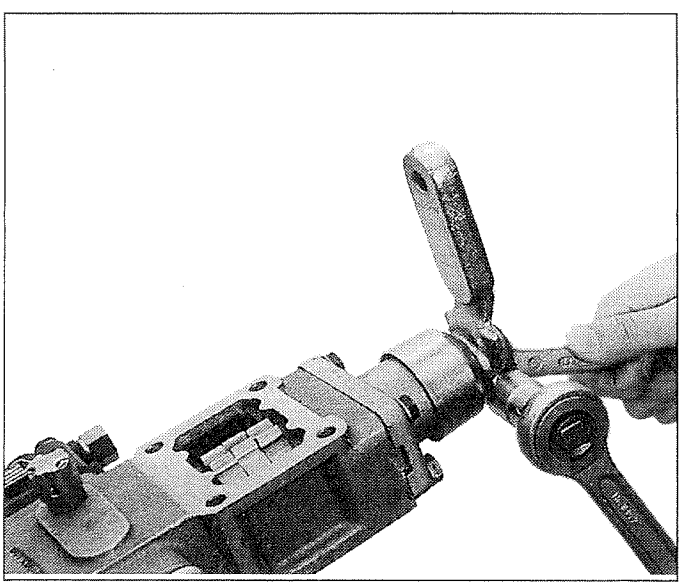
NOTE
Do not dismantle reaction linkage since it needs to be subsequently reset to suit the vehicle.


006897

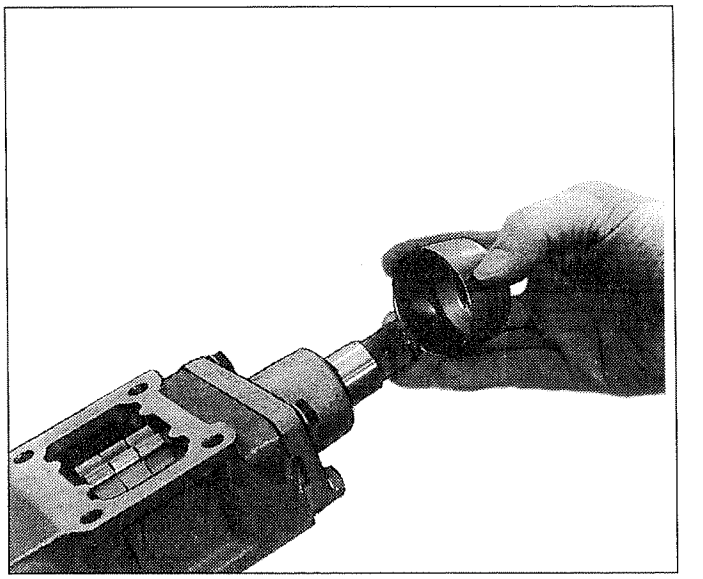
4 Remove hex nut and hex bolt from shift lever.

5 Mark position of shift lever on selector shaft.

6 Pull off shift lever from selector shaft, using standard two-leg puller if necessary.


006898

7 Remove protective cap from selector shaft.

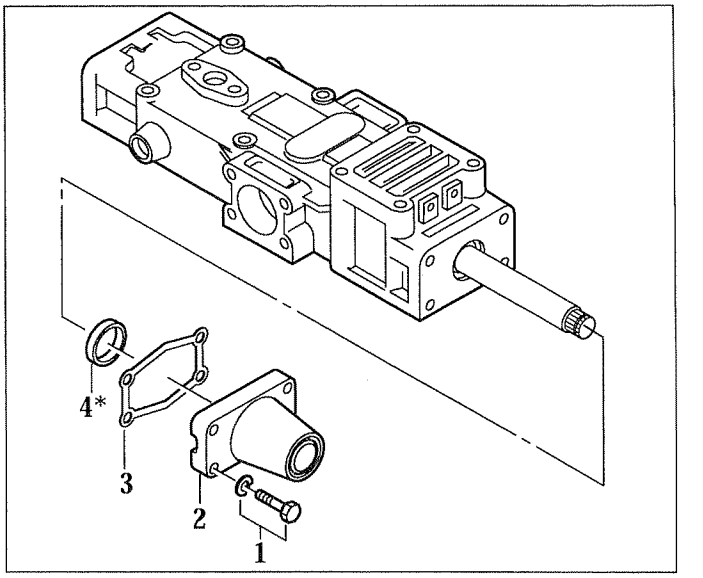


006900

8 Remove hex bolts (**1**) from shift cover (**2**).

9 Remove shift cover from selector shaft.

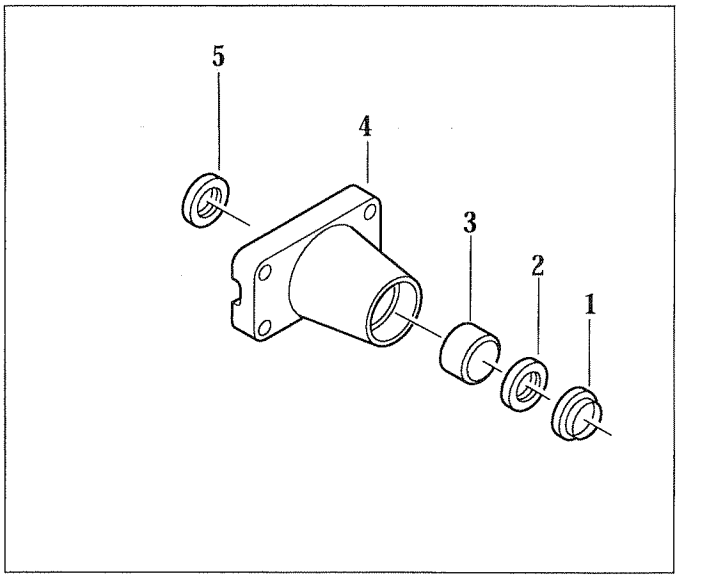
10 Remove gasket (**3**) and bushing* (**4**).



007993

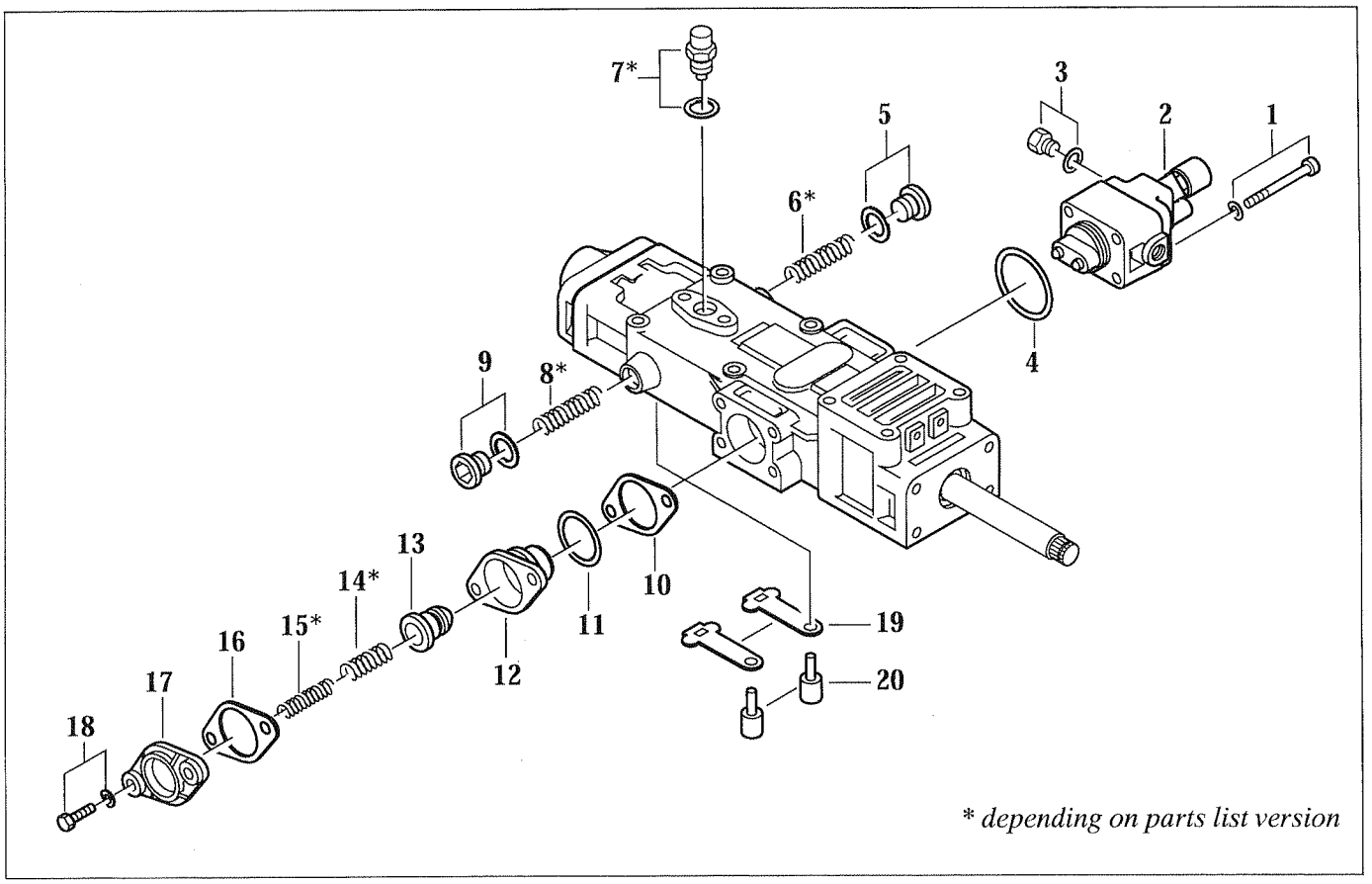
11 Remove wiper (**1**) and shaft seals (**2** and **5**) from shift cover (**4**).

12 Drive bearing bush (**3**) out of shift cover using drift **1X56 137 135.**



007997

* *depending on parts list version*



007996

13 Remove cylinder screws (**1**) together with spring washers.

14 Remove cutoff valve (**2**) and O-ring (**4**).

NOTE
Cutoff valve is a complete part and is not dismantled.

NOTE
Unscrew restrictor (**3**) from cutoff valve.

15 Remove screw (**18**) and spring washer from cover (**17**) for insert.

⚠ DANGER
Cover (17) is under spring pressure.

16 Remove cover (**17**) together with compression spring(s) (**15/14**) and gasket (**16**).

17 Remove insert (**12**) together with O-ring (**11**), gasket (**10**) and taper roller (**13**).

18 Remove detent plunger (**7**) for reverse gear.

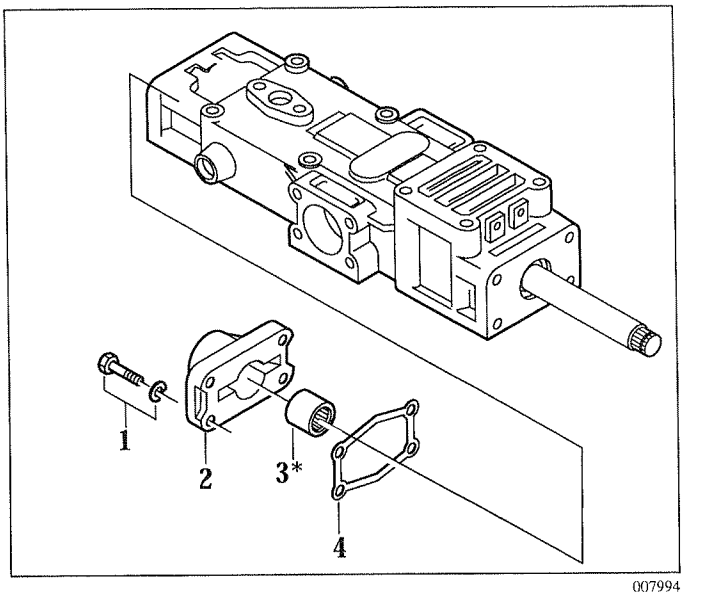
19 Remove screw plugs (**5/9**) and compression springs (**6/8**) from both sides of shift housing.

⚠ DANGER
Screw plugs are under spring pressure.

20 Remove pins (**20**) and detent levers (**19**) from shift housing.

21 Remove hex bolts (1).

22 Remove cover (2) and gasket (4).
Depending on version, check needle bearing (3) in cover (2) and renew if necessary.

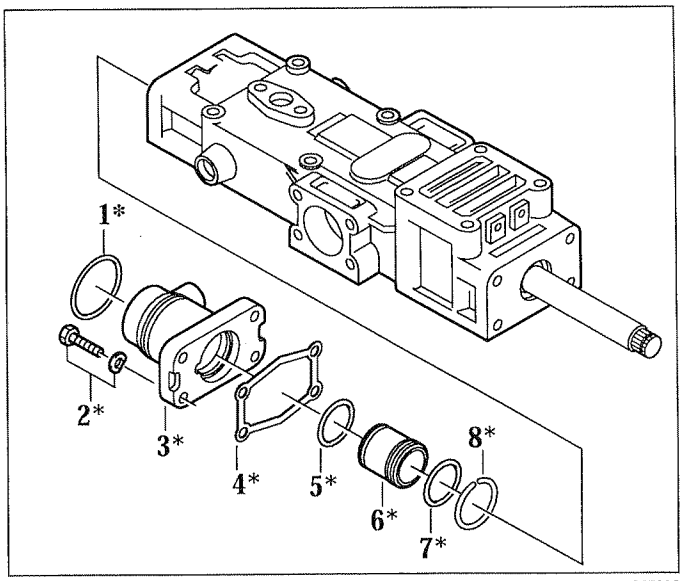


007994

23 In version with gate interlock, remove O-ring **(1)**, hex bolts **(2)**, cover **(3)** and gasket **(4)**.

24 Remove snapring **(8)** from cover **(3)** and take out piston **(6)** together with O-ring **(7/5)**.

NOTE
Parts marked * depending on parts list.

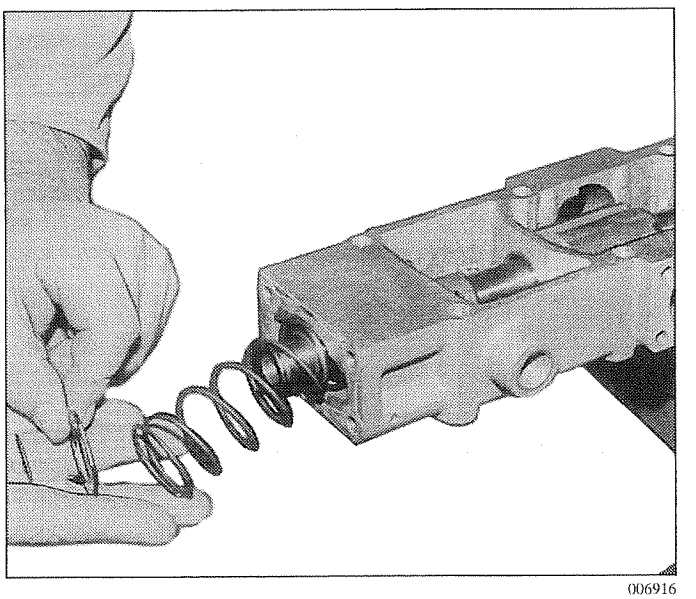


007995

NOTE
Mark the position of the circlips and washers to make assembly easier.

25 Detach circlip from annular groove in selector shaft.

⚠ DANGER
Circlip is under spring pressure.
Hold back washer on circlip against spring pressure.

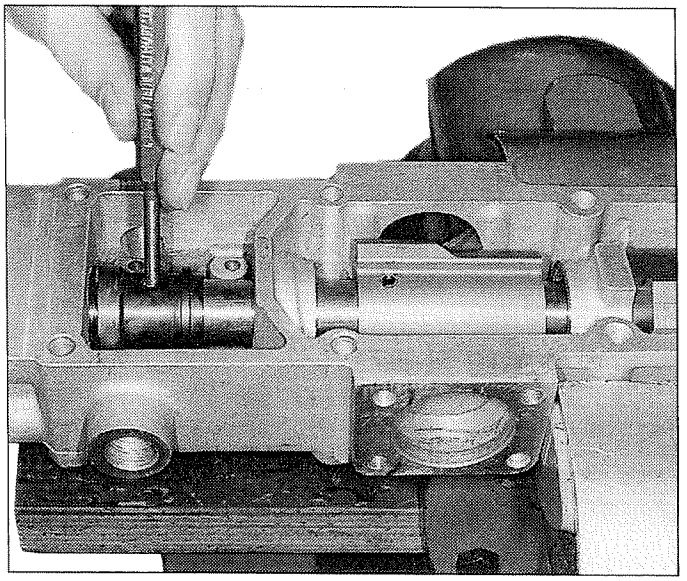

006916

26 Remove washer and compression spring(s) from selector shaft.

27 Depending on shift mechanism version and compression spring arrangement, remove circlip, washer and second compression spring.

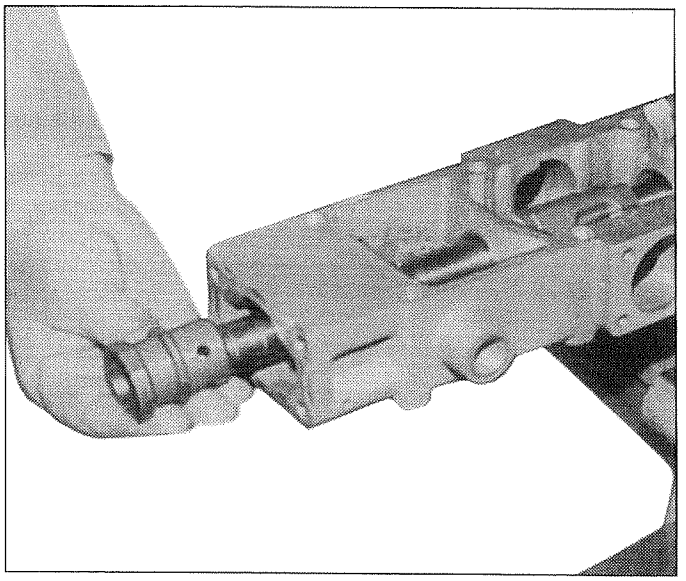
28 Drive out double dowel from detent bush by placing drift into open threaded bore in top of shift housing.

NOTE
Ensure selector shaft is in correct position while doing this.



006919

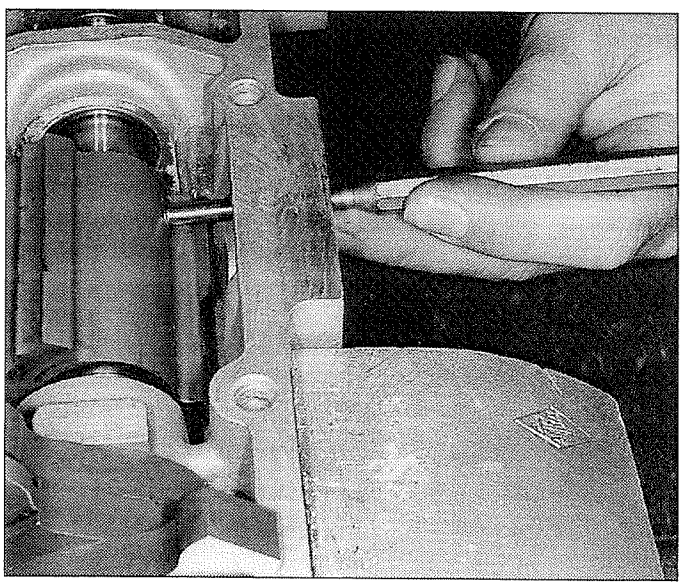
29 Mark position of detent bush. Pull off detent bush from selector shaft.



006920

30 Drive out dowels from detent piece by placing suitable drift in insert opening.

NOTE
While doing this, ensure selector shaft is in correct position.

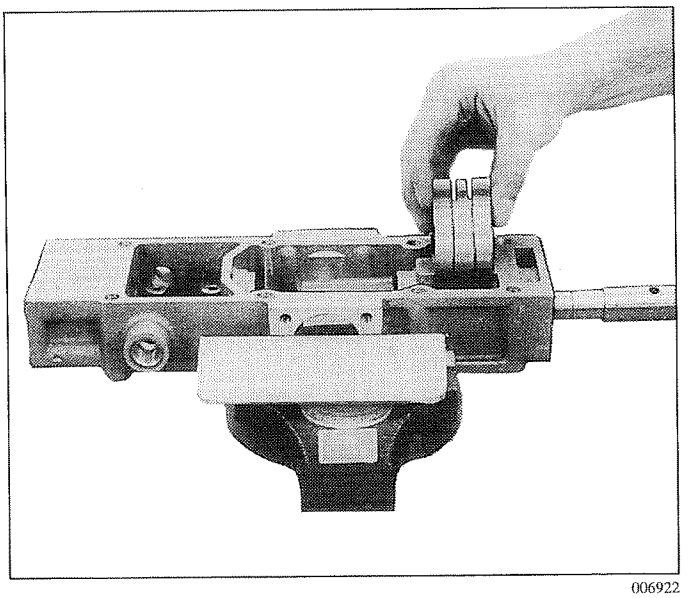


006921

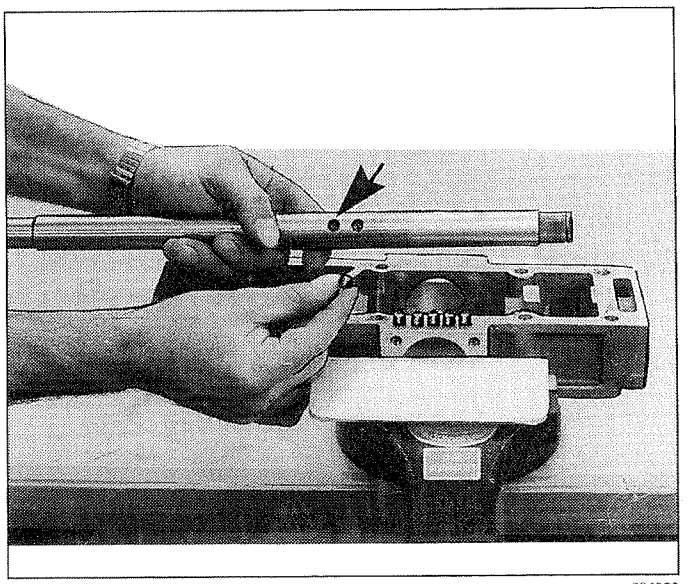
31 Pull out selector shaft from shift housing.

32 Remove detent piece and drivers from shift housing.

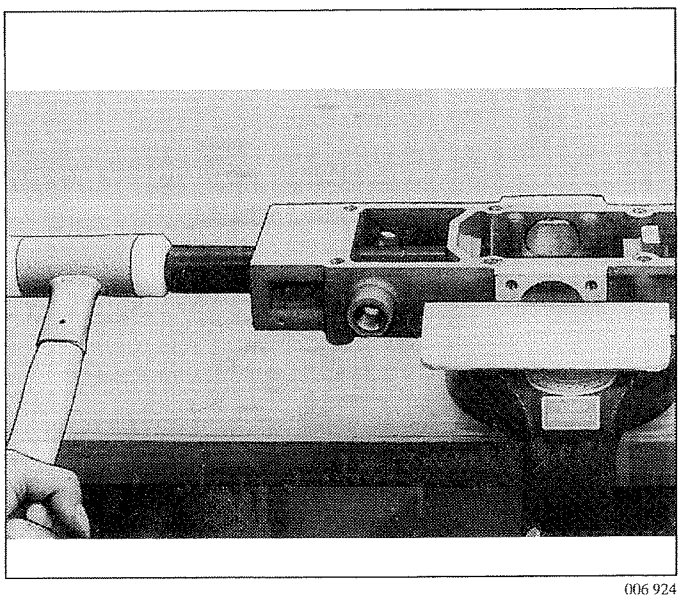
NOTE
Drivers are liable to fall out. Secure accordingly.


006922

33 Remove rollers from selector shaft (see arrow).

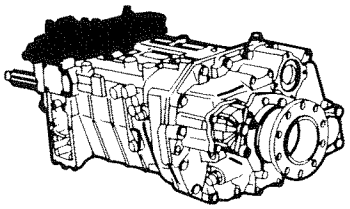
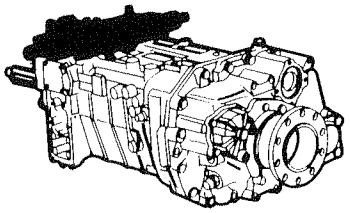
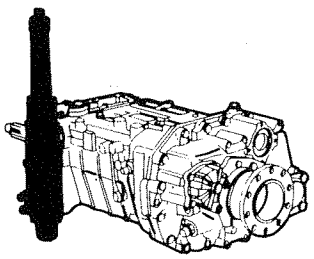
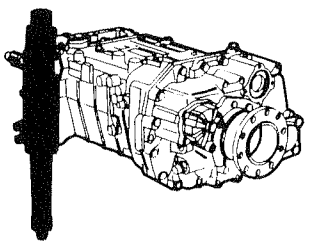
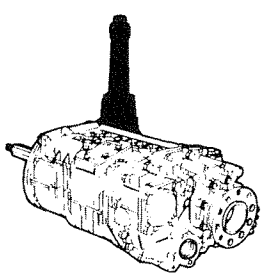

006923

34 Drive out needle sleeve from shift housing using drift **1X56 137 135**.


006 924

6.4 Assembling shift mechanism

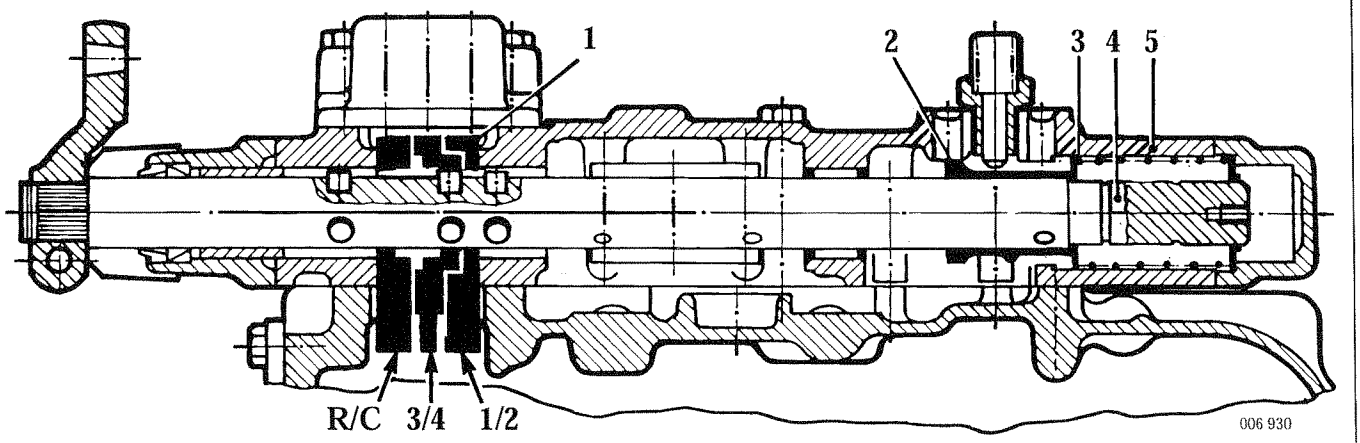
Summary of shift mechanism types; see parts list for selector pattern and spring arrangement

Transmission installation position horizontal left	Mechanism type	Shift output	Driver arrangment	Spring pack arrangement Q1 to Q7
			Select. pattern I & II	
 006925	horizontal	left	Section 6.4.1	Section 6.4.2
 006926	horizontal	right	Section 6.4.1	Section 6.4.2
 006927	vertical	top	Section 6.4.1	Section 6.4.2
 006928	vertical	bottom	Section 6.4.1	Section 6.4.2
Transmission installation position horizontal right				
 006929	vertical	top	Section 6.4.1	Section 6.4.2

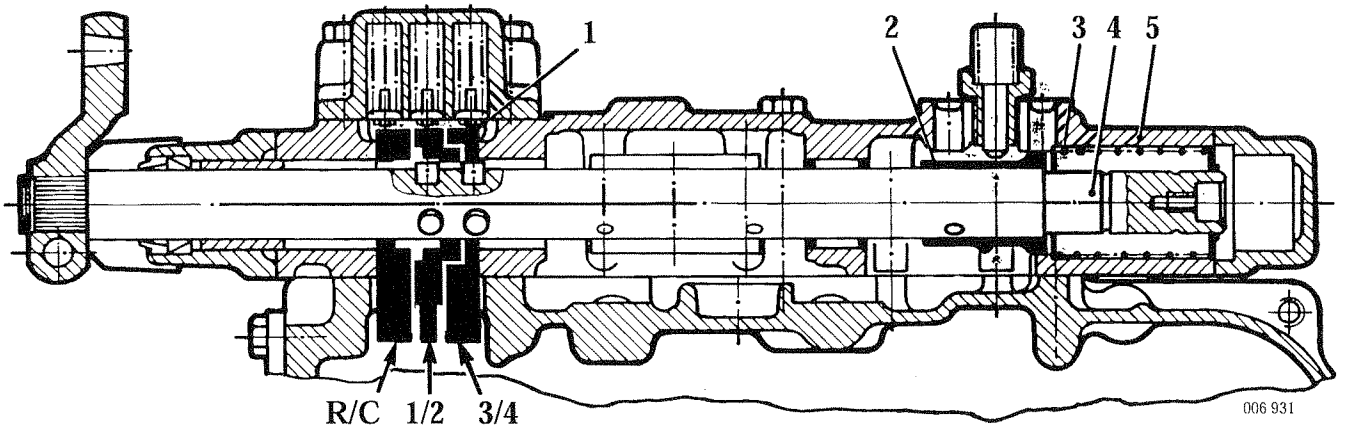
6.4.1 Driver arrangement

Transmission installation position: horizontal left
Shift mechanism type: horizontal
Shift output: left

Selector pattern: I Detent bush on side (2)



Selector pattern: II Detent bush on side (2)



1 = Drivers

2 = Detent bush

*3 = Compression spring(s)**

4 = Selector shaft

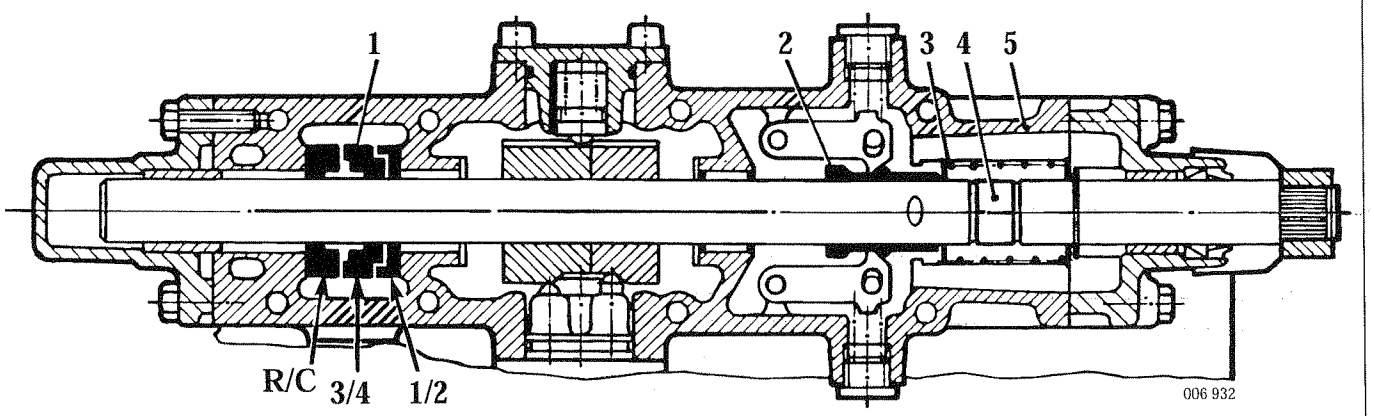
5 = Shift housing

* **NOTE**
The spring arrangement shown is an example only. Spring arrangements as indicated in Section 4.2.

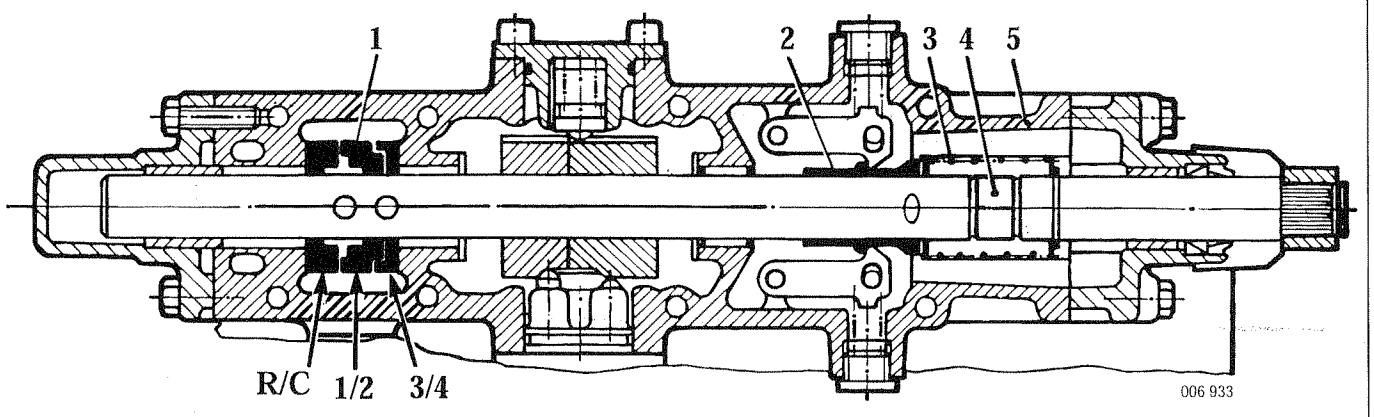
Driver arrangement

Transmission installation postion: horizontal left
Shift mechanism type: horizontal
Shift output: right

Selector pattern: I Detent bush on side (2)



Selector pattern: II Detent bush on side (2)



1 = Drivers

2 = Detent bush

*3 = Compression spring(s)**

4 = Selector shaft

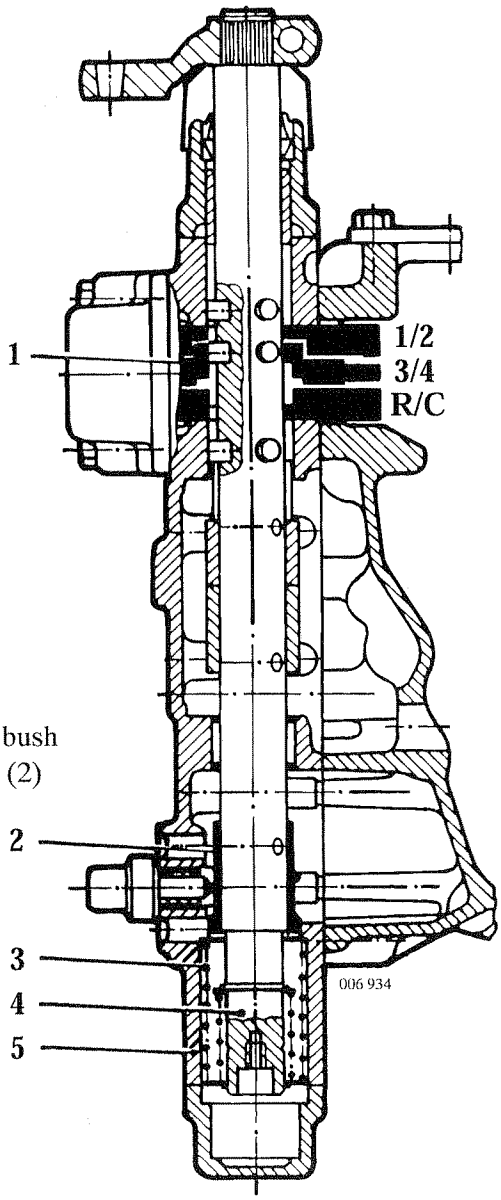
5 = Shift housing

* **NOTE**
The spring arrangement shown is an example only. Spring arrangements as indicated in Section 4.2.

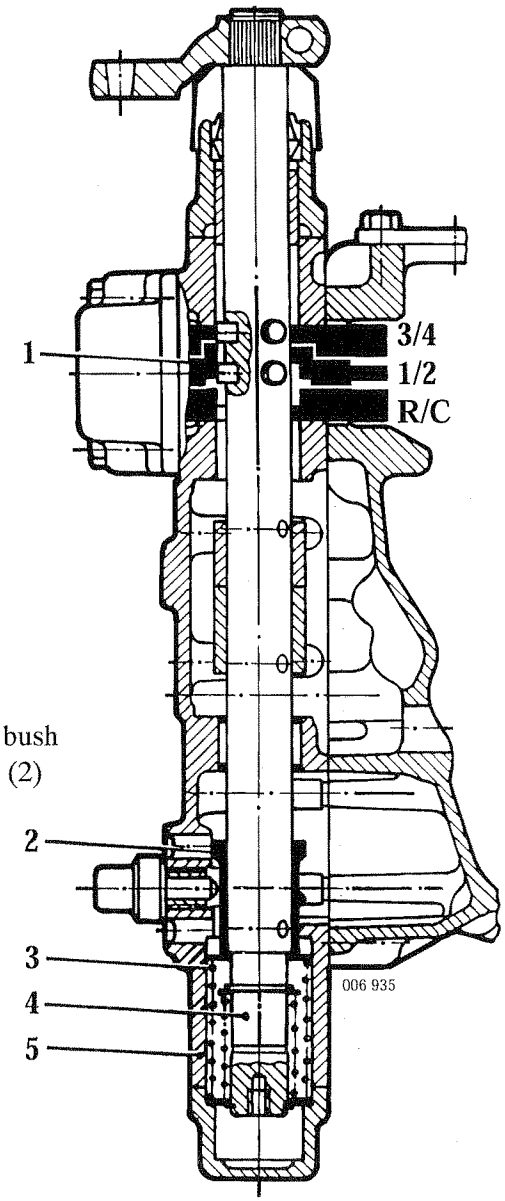
Driver arrangement

Transmission installation position: horizontal left
Shift mechanism type: vertical
Shift output: top

Selector pattern: I



Selector pattern: II



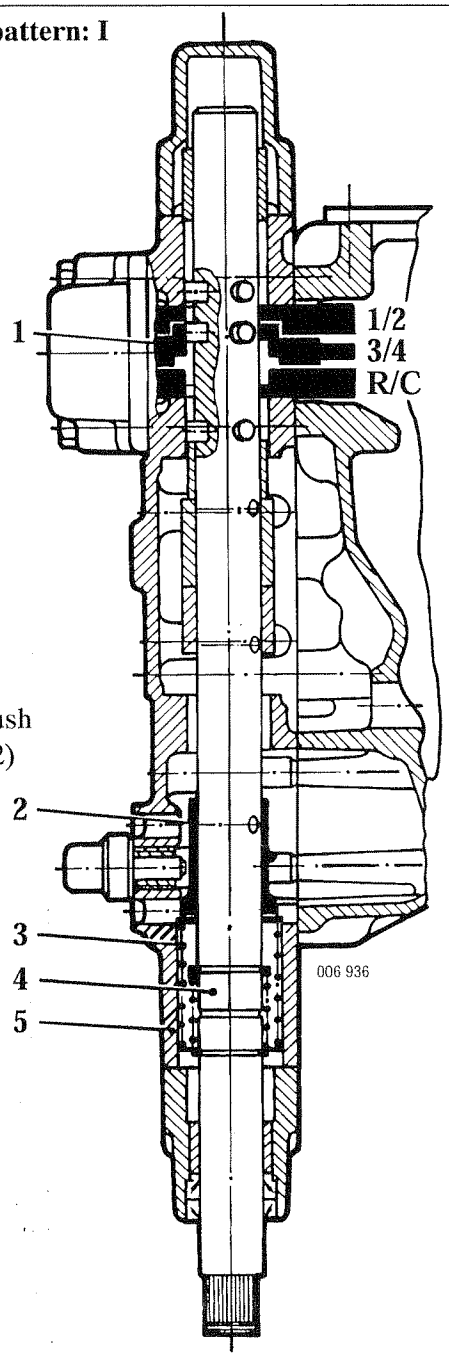
1 = Drivers
2 = Detent bush
*3 = Compression spring(s)**
4 = Selector shaft
5 = Shift housing

* **NOTE**
The spring arrangement shown is an example only. Spring arrangements as indicated in Section 4.2.

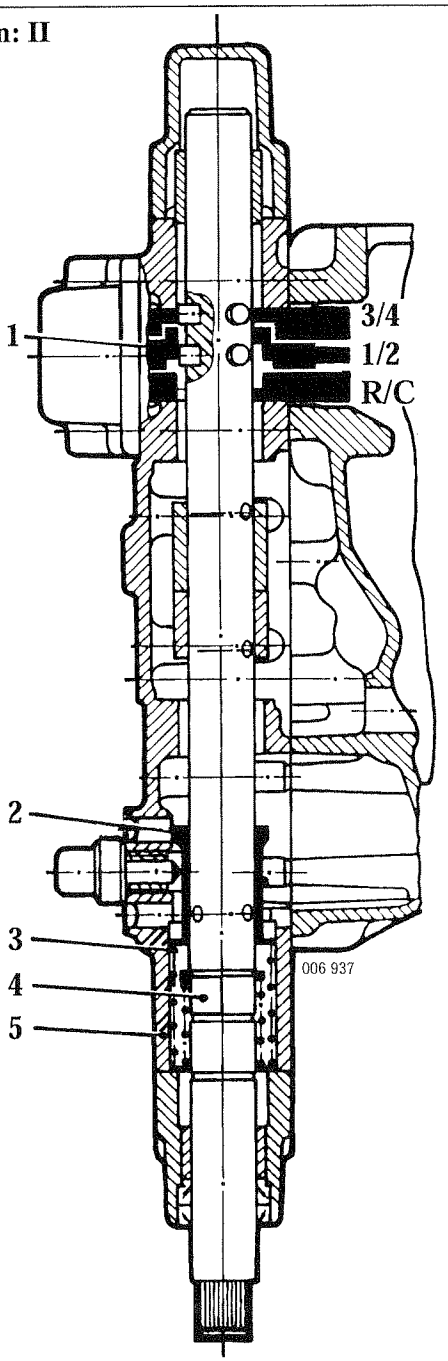
Driver arrangment

Transmission installation position: horizontal left
Shift mechanism type: vertical
Shift output: bottom

Selector pattern: I



Selector pattern: II



1 = Drivers

2 = Detent bush

*3 = Compression spring(s)**

4 = Selector shaft

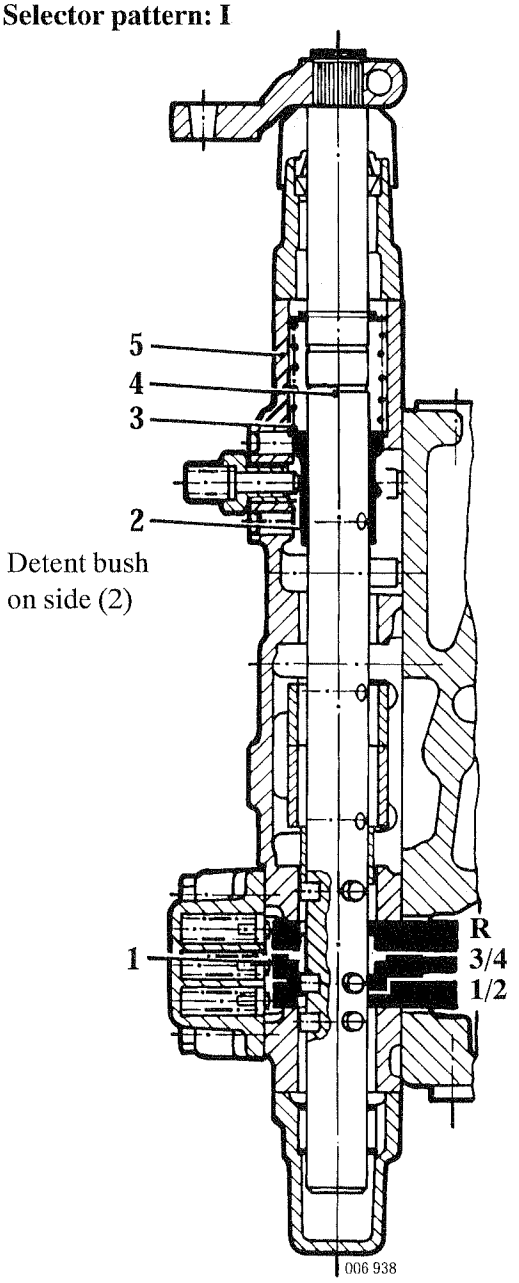
5 = Shift housing

* **NOTE**
The spring arrangement shown is an example only.
Spring arrangements as indicated in Section 4.2.

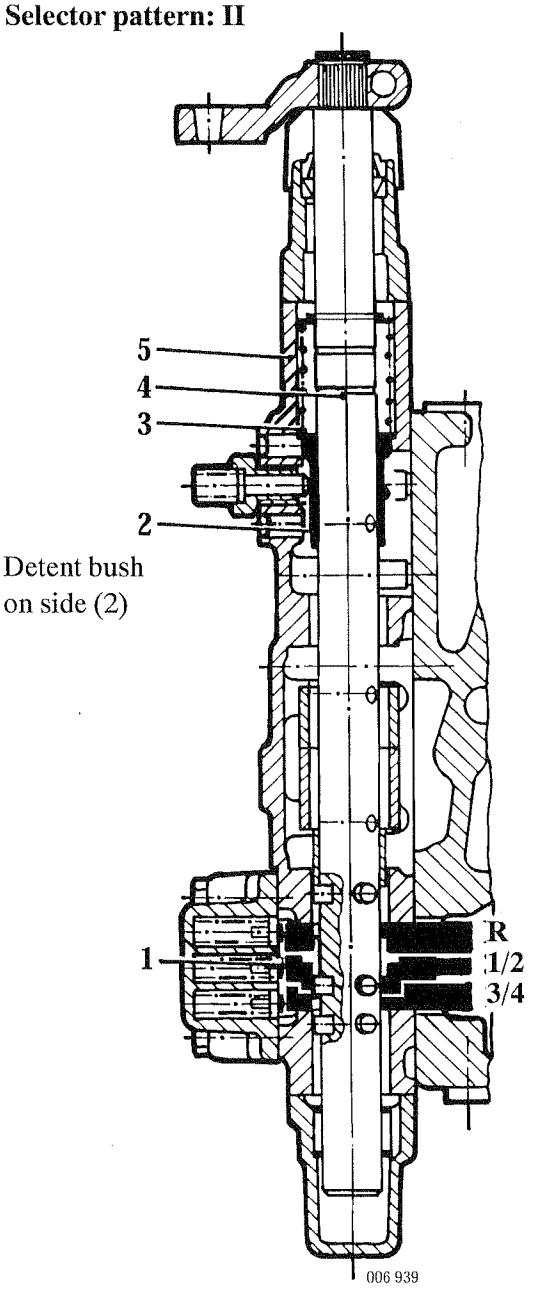
Driver arrangement

Transmission installation position: horizontal right
Shift mechanism type: vertical
Shift output: top

Selector pattern: I



Selector pattern: II

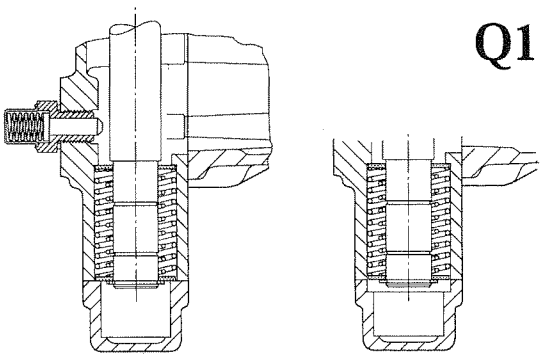


1 = Drivers
2 = Detent bush
*3 = Compression spring(s)**
4 = Selector shaft
5 = Shift housing

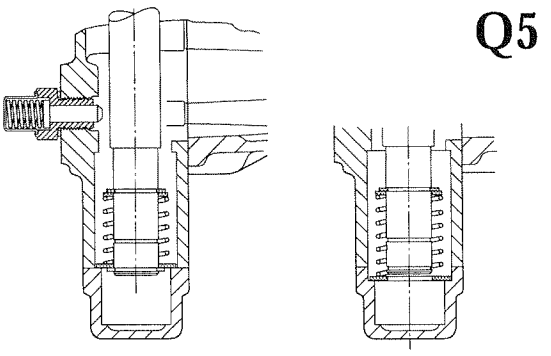
* **NOTE**
The spring arrangement shown is an example only. Spring arrangements as indicated in Section 4.2.

6.4.2 Compression spring arrangement (spring pack) according to parts list (spare parts catalogue)

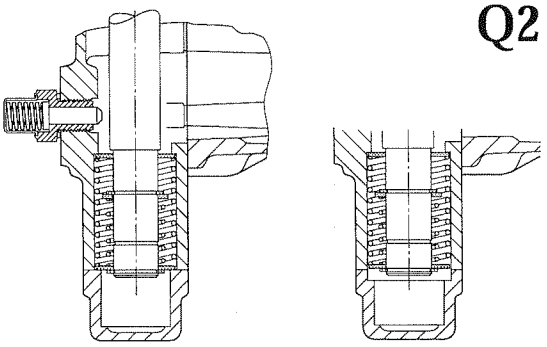
6.4.2.1 Transmission installation position: horizontal left / Shift output: vertical top



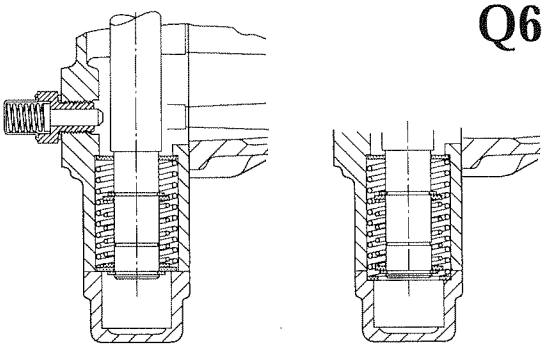
009746



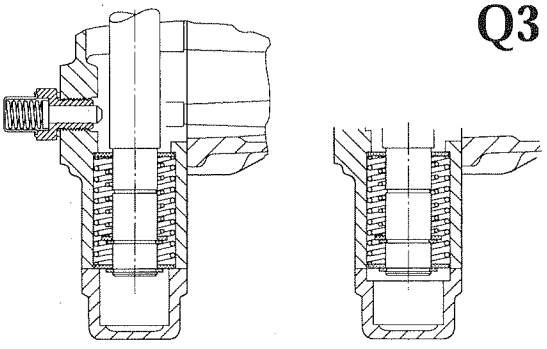
009750



009747



009751



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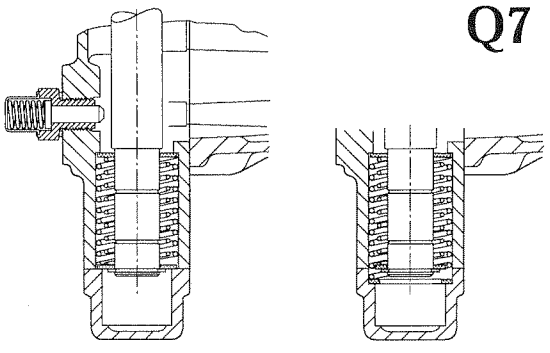

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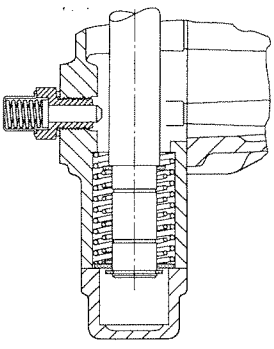
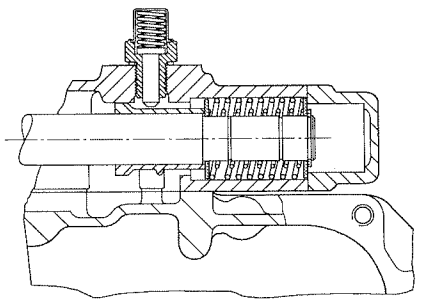


009749

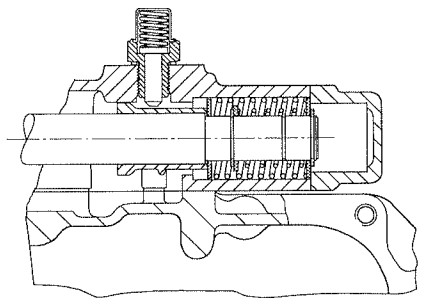
6.4.2.2 Transmission installation position: horizontal left / Shift output: horizontal left

Q1



009753

Q2



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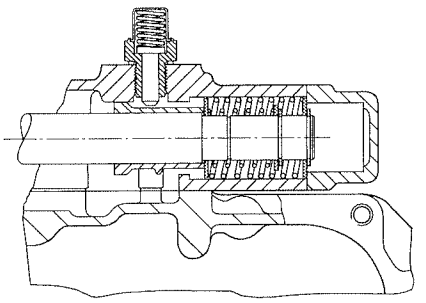
Q3



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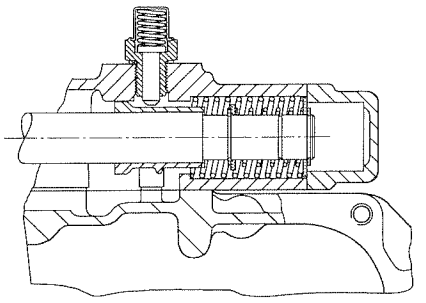
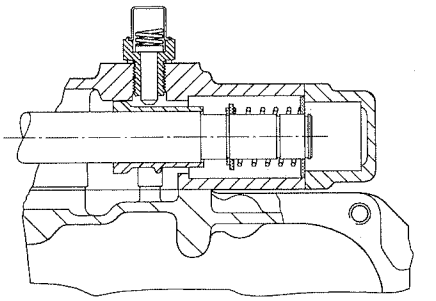
Q4



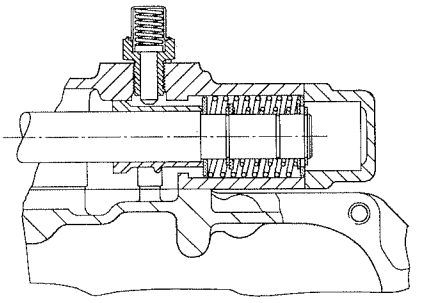
009756

Q5



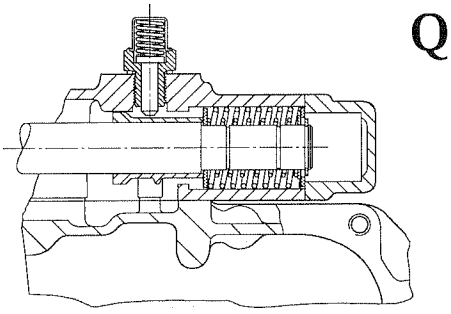
009757

Q6



009758

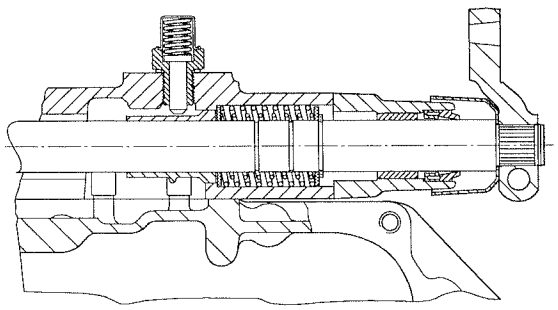
Q7



009759

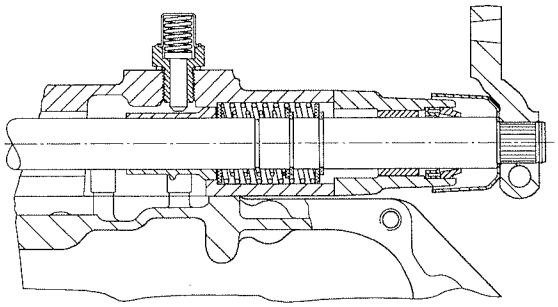
6.4.2.3 Transmission installation position: : horizontal left / Shift output: horizontal right

Q1



009760

Q2



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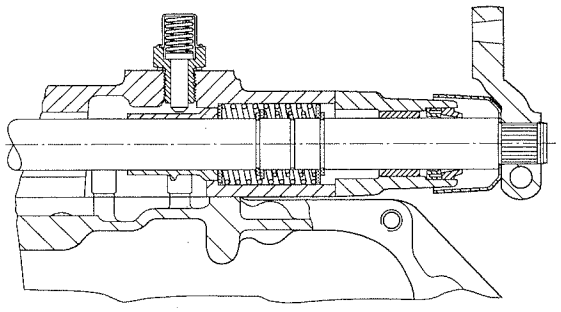
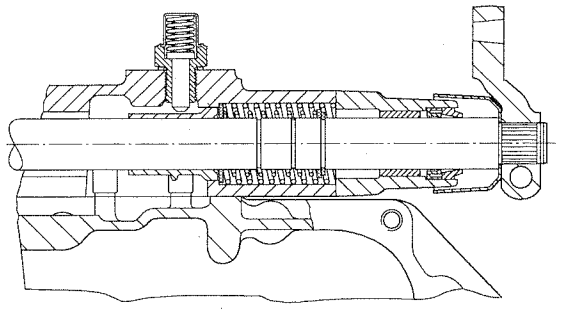
Q3



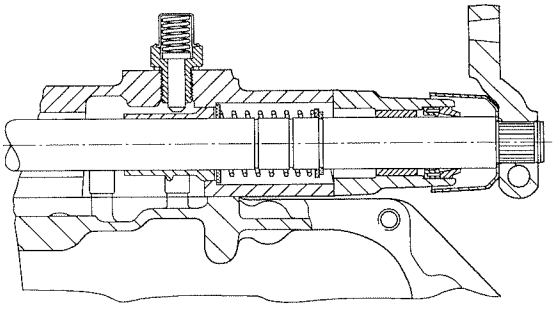
009762

Q4



009763

Q5



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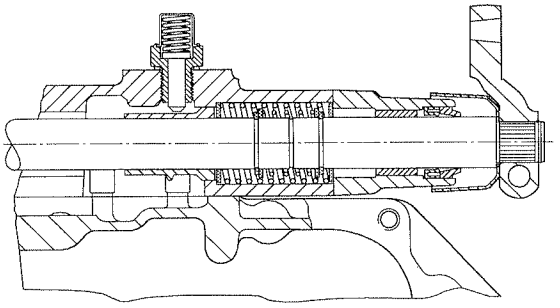
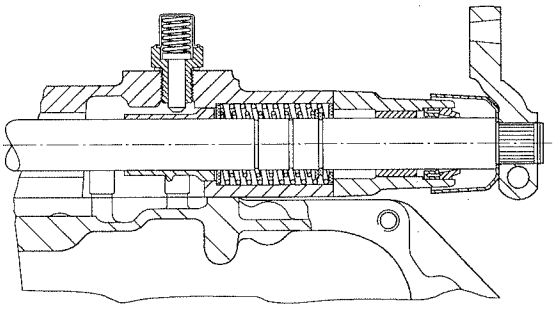
Q6



009765

Q7



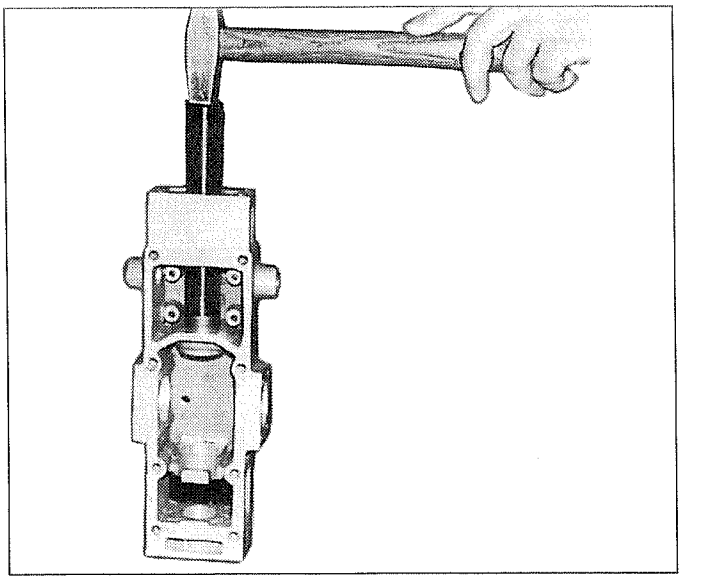
009766

6.5 Assembling shift mechanism

NOTE
The following illustrations depict the "horizontal left" shift mechanism version. Section **6.4** contains details of shift component and compression spring arrangements for each shift mechanism type.

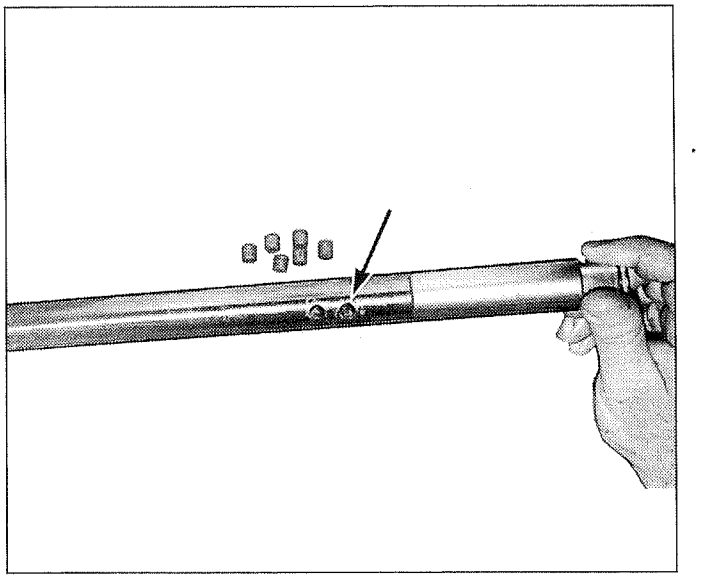
1 Drive needle sleeve into shift housing web using drift **1X56 137 135.**
(Marked side of needle sleeve must face towards drift).

NOTE
The needle sleeve should be recessed approx. 1mm from the web surface facing the detent piece.


006949

2 Insert six rollers into the holes in the selector shaft; to do this, lightly grease the bores (see arrow).

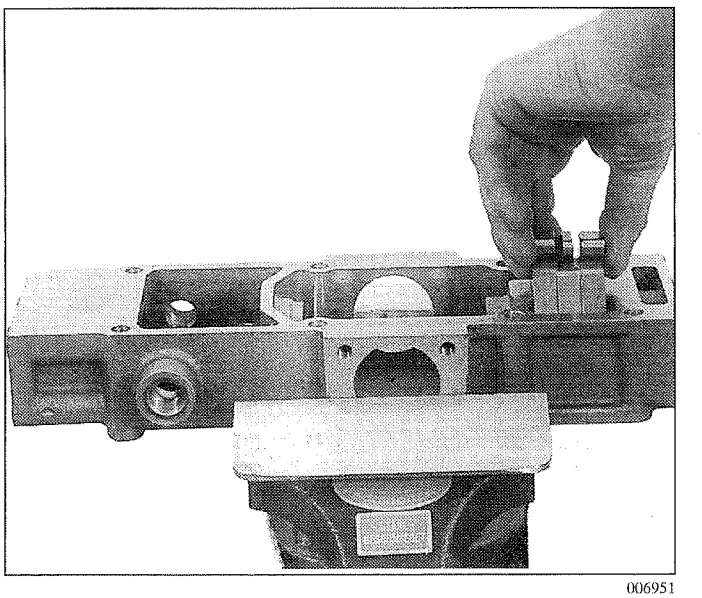
NOTE
Further rollers are installed in the "vertical" shift mechanism version. Each of these three rollers has a flat machined onto it. Position the rollers so that the flat faces towards the bush when the selector shaft is fitted.


006950

3 Assemble drivers depending on shift mechanism type as shown in section **6.4**.

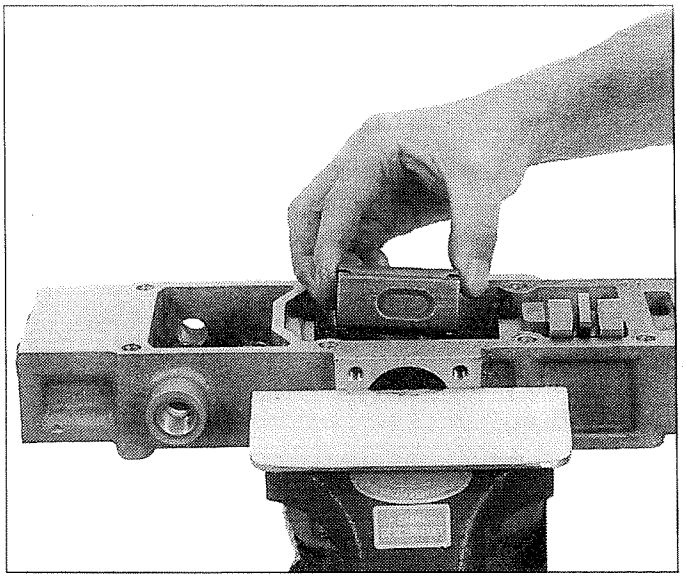
4 Hold drivers in installation position in shift housing.

5 Thread the selector shaft through the drivers.


006951

6 Slip detent piece onto selector shaft and align bores for dowels.

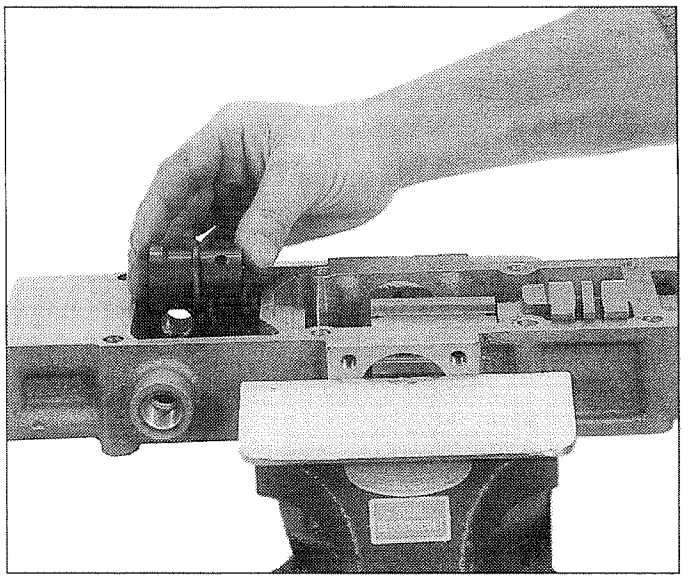
NOTE
Detent face of detent piece must face towards where the cutoff valve is installed.



006952

7 Slip detent bush onto selector shaft, depending on version (as marked during disassembly).

NOTE
Align bores for dowels.



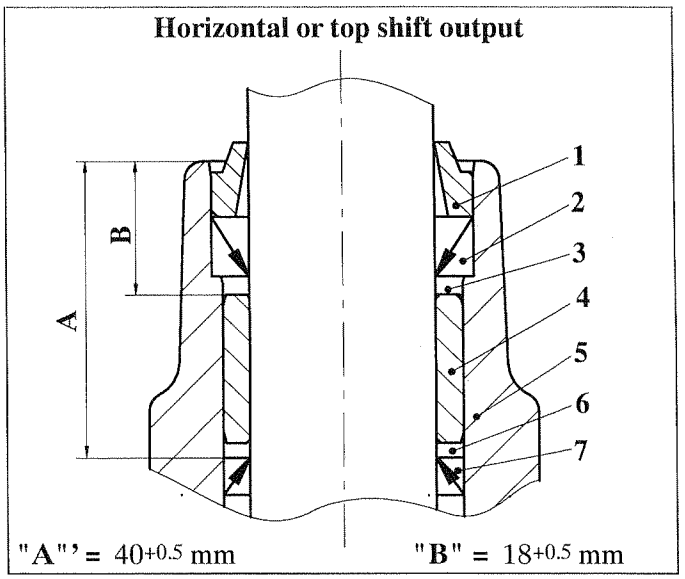
006953

NOTE
Apply light coating of sealing compound to outside of shaft seal with steel surround. Coat outside of shaft seal with rubber surround using lubricant, e.g. concentrated water-soluble washing-up liquid (e.g. Pril).

Version with horizontal or top shift output

1a Drive shaft seal (**7**) into shift cover (**5**) (to **dimension "A"**) using drift **1X56 137 135.**

2a Drive bearing bush (**4**) into shift cover (**5**) (to **dimension "B"**) using drift **1X56 137 135.**



006139

Version with bottom shift output

1b Drive bearing bush (**4**) into shift cover (**5**) (to **dimension "A"**) using drift **1X56 137 135**

2b Drive shaft seal (**7**) into shift cover (**5**) (to **dimension "B"**) using drift **1X56 137 135.**

3 Fully drive in shaft seal (**2**) using drift **1X56 119 916.**

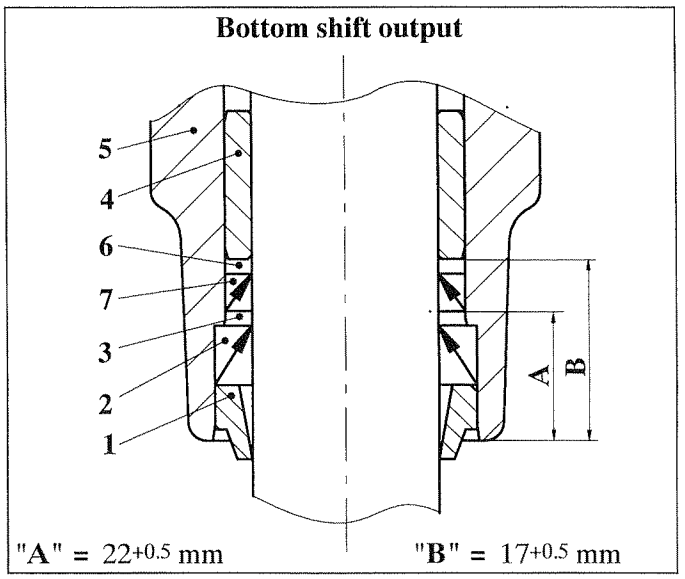
NOTE
The sealing lips on the shaft seals (**7** and **2**) **must** face towards the bearing bush (**4**).

4 Drive wiper (**1**) flush against shift cover using drift **1X56 119 916.**

5 Fill the gaps (**3** and **6**) with grease (ZF order No. 0750 199 001).

6 Depending on version, insert bushing (**4**).

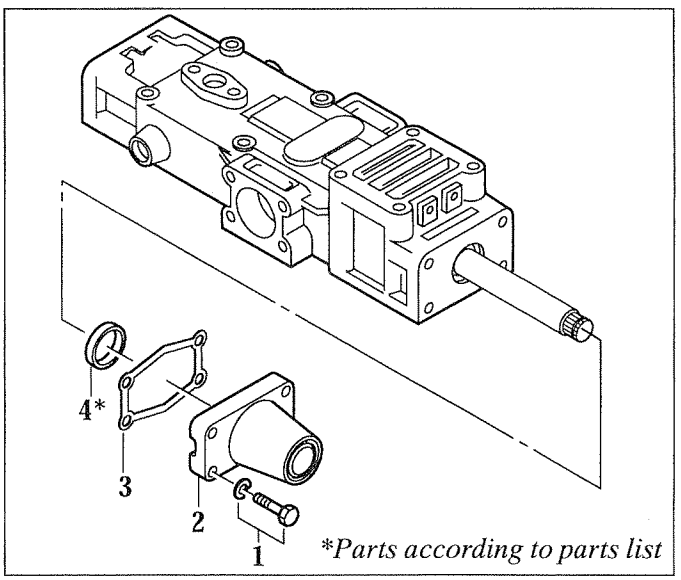
7 Place shift cover (**2**) onto shift housing together with new gasket (**3**).



009496

CAUTION
Take care not to damage shaft seal and wiper when sliding onto selector shaft.
Use protective sleeve 1X56 137 134.

8 Tighten four M8 hex bolts (**1**) to 23 Nm.



007993

9 Drive both dowels into detent piece and detent bush using drift.

CAUTION
Do not mix up dowels!
Dowels for detent piece: = 36 mm
Dowels for detent bush: = 30 or 28 mm

NOTE
Fit circlips and washers as marked.

10 Place washer onto selector shaft.

11 Depending on version, attach circlip into correct annular groove.

12 Depending on version, place small washer onto selector shaft.

13 Depending on version, place compression spring (small) onto selector shaft.

14 Depending in version, place washer (small) onto selector shaft.

15 Depending on version, attach circlip (small) into annular groove using circlip pliers, while pushing back compression spring at the same time.

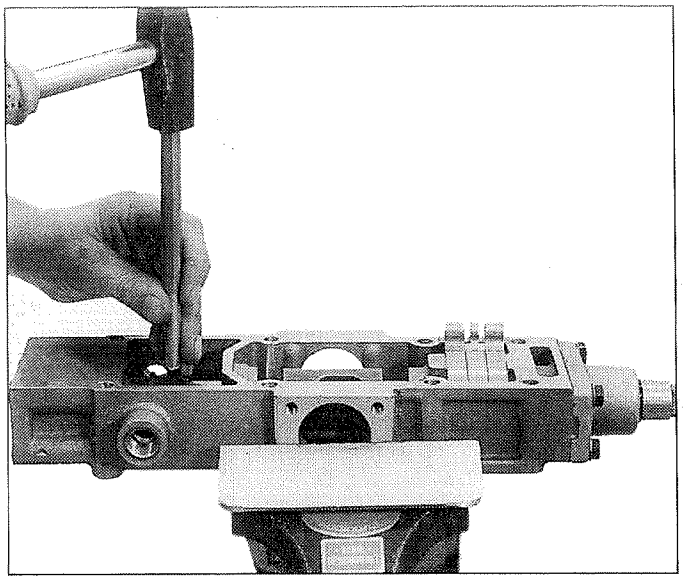
16 Place compression spring (large) onto selector shaft.

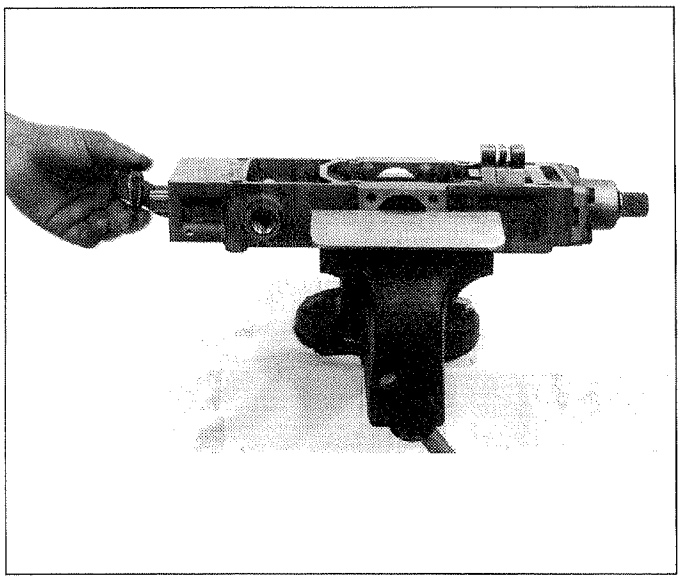
17 Fit washer (large), while pushing back compression spring.

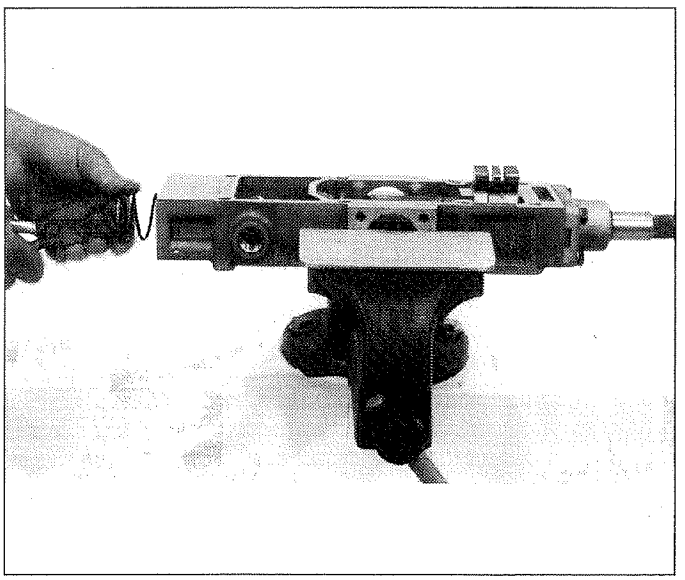
18 Insert circlip (large) into outer annular groove using circlip pliers.

NOTE
Move selector shaft as far as it will go in the direction of the compression springs.

CAUTION
Washer is under spring pressure.


006958

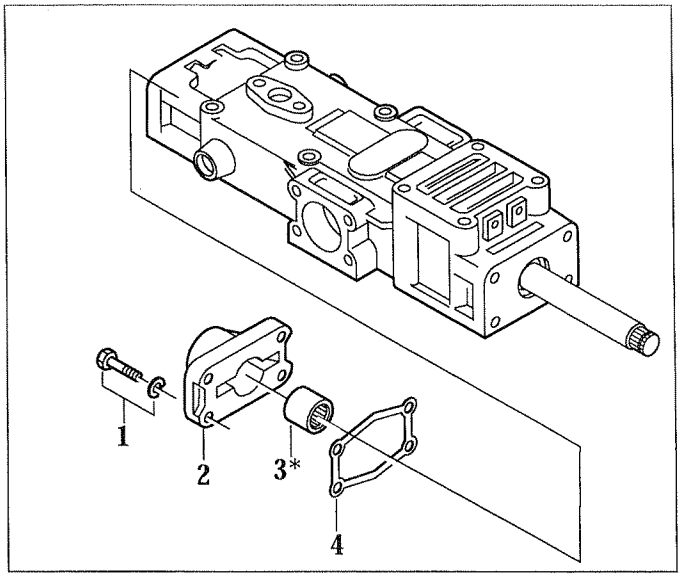

009328


009329

19 Ensure shift mechanism is in neutral position.

20 Depending on version, drive needle bearing (**3**) into cover (**2**) using drift **1X56 137 135,** ensuring marked side of needle bearing faces towards drift.

21 Fit cover (**2**) together with new gasket (**3**). Insert 4 hex bolts (**1**) together with spring washers and tighten to 23 Nm.

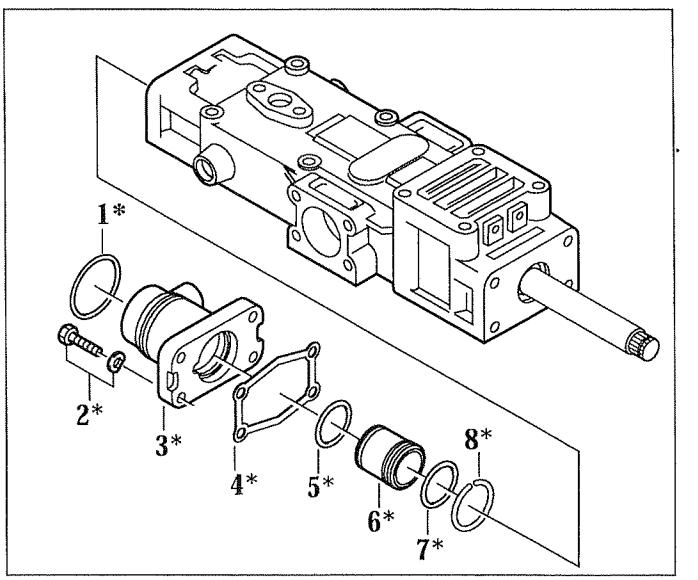


007994

Version **with** gate interlock.

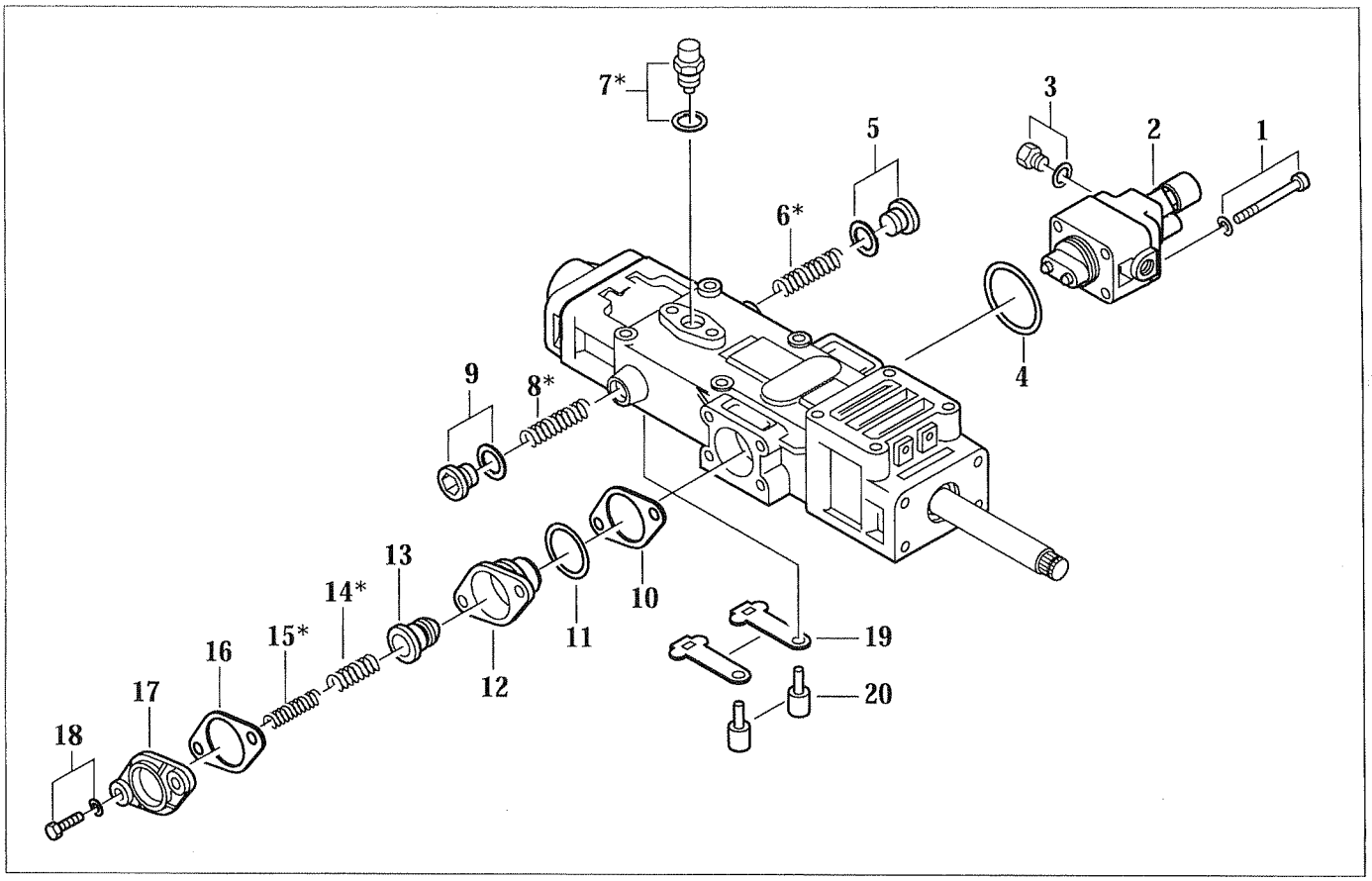
- Lightly grease O-rings (**5 and 7**) and place onto piston (**6**). Apply approx. 2g of grease (ZF# 0750 199001) on piston.
- Insert piston (**6**) into cover (**3**) and attach snapring (**8**).
- Secure cover (**3**) and new gasket (**4**) using four hex bolts. Tightening torque = 23 Nm.
- Place O-ring (**1**) onto cover (**3**).

NOTE
Parts marked with * according to parts list.



007995

CAUTION
It must be easy to move the selector shaft in both directions.



007996

22 Insert both detent levers (**19**) into shift housing.

23 Insert pins (**20**) through detent lever bore and into shift housing.

24 Insert compression springs (**6/8**) and tighten screw plugs (**5/9**) to 35 Nm.

25 Place O-ring (**11**) into insert (**12**).

26 Grease ball rollers (**13**).

27 Fit items **10** to **18**.

28 Tighten bolt (**18**) to 23 Nm.

29 Fit O-ring (**4**) on cutoff valve (**2**).

30 Fit cutoff valve (**2**), ensuring that the pneumatic-connections are in correct position.

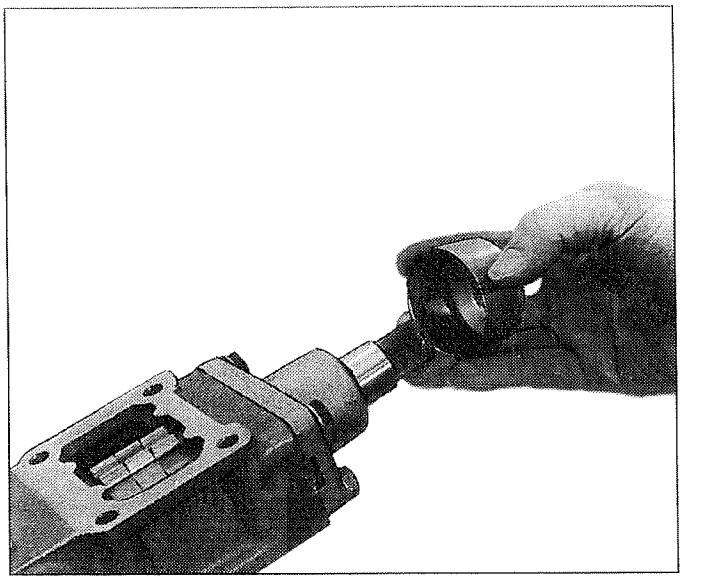
31 Tighten bolts (**1**) to 23 Nm.

32 Insert restrictor (**3**) together with new seal ring
- tightening torque = 20 Nm.

33 Insert detent plunger (**7**) together with new seal ring.
- tightening torque = 50 Nm

NOTE
Parts marked * according to parts list.

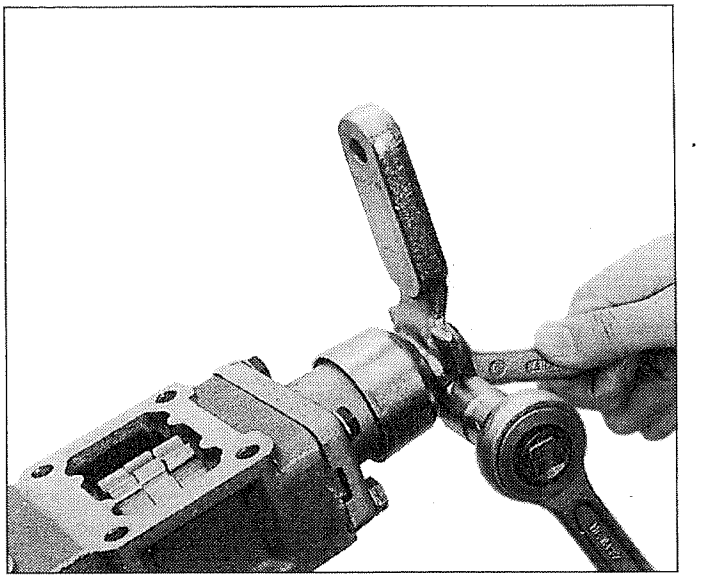
34 Fit protective cap onto selector shaft.



006900

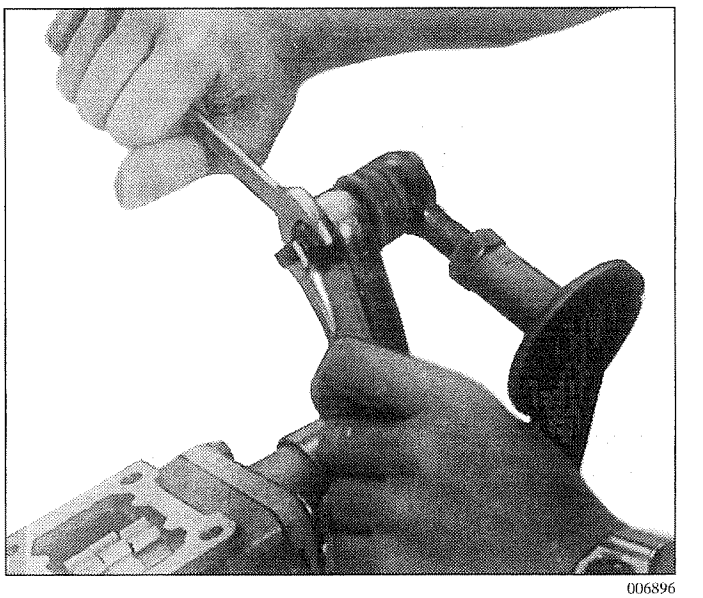
35 Slide shift lever onto selector shaft as marked and tighten protective cap.

36 Insert hex bolt with hex nut and tighten
- M10 tightening torque = 46 Nm



006898

37 Place ball joint into shift lever and tighten hex nut.
- M10x1 tightening torque = 46 Nm



006896

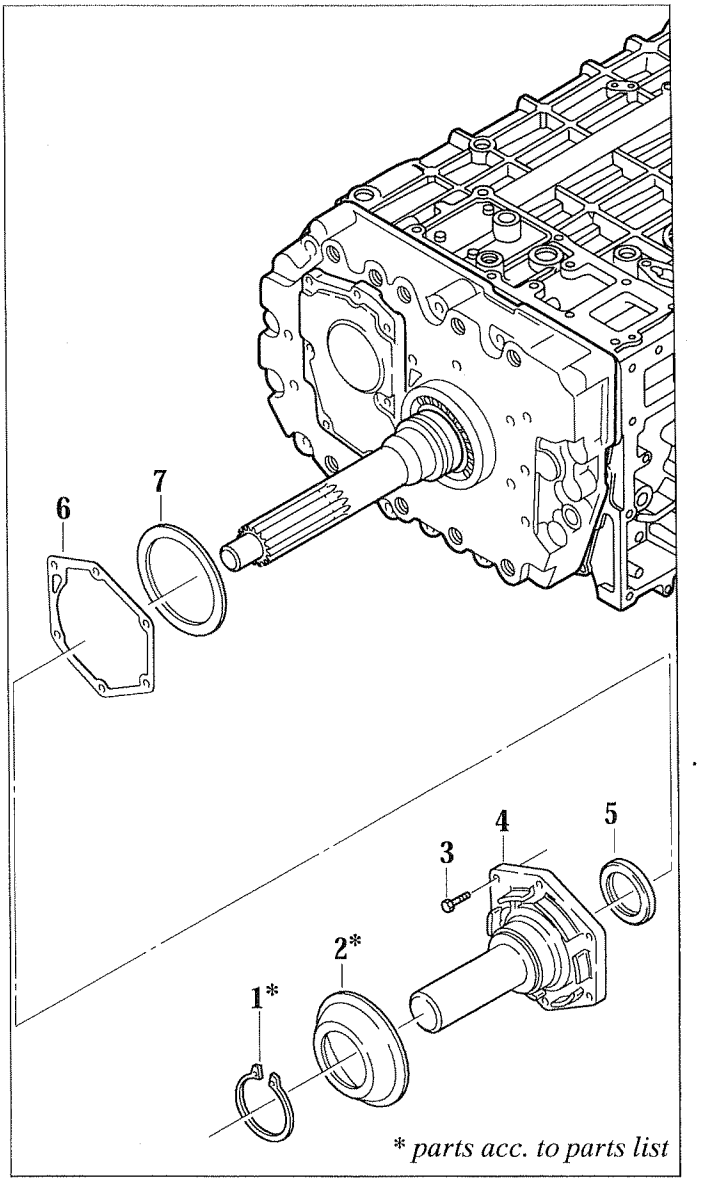
7 Connection plate / lube oil pump

7.1 Removing connection plate

1 Depending on version, detach circlip (**1**) and remove sealing cap (**2**).

2 Remove hex bolts (**3**). Take off connection plate (**4**) together with shim (**7**) and gasket (**6**).

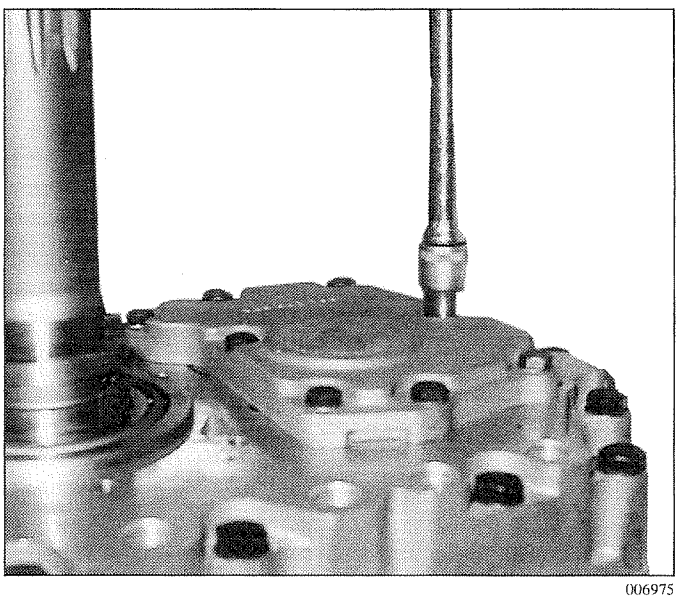
3 Remove shaft seal (**5**) from connection plate (**4**), ensuring that the connection plate sealing faces are not damaged in the process.



007972

7.2 Removing and dismantling lube oil pump

1 Remove hex bolts and spring washers.

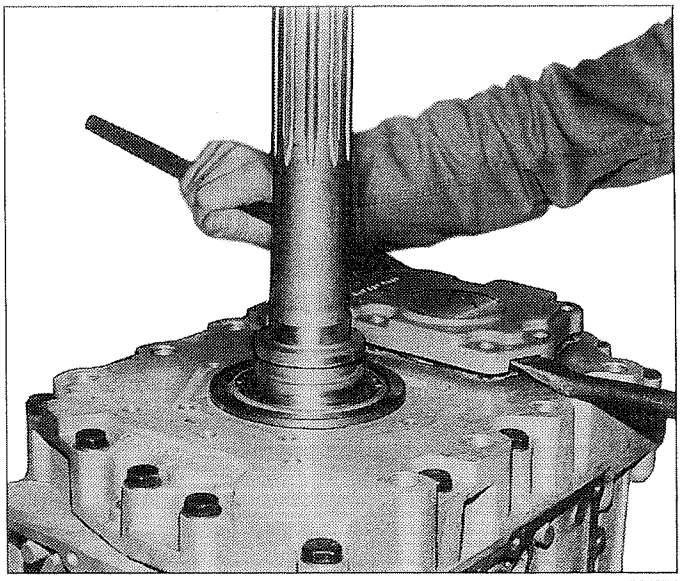


006975

2 Lever out oil pump from housing using prybars. Remove gasket.

NOTE
Place prybars in housing recesses.

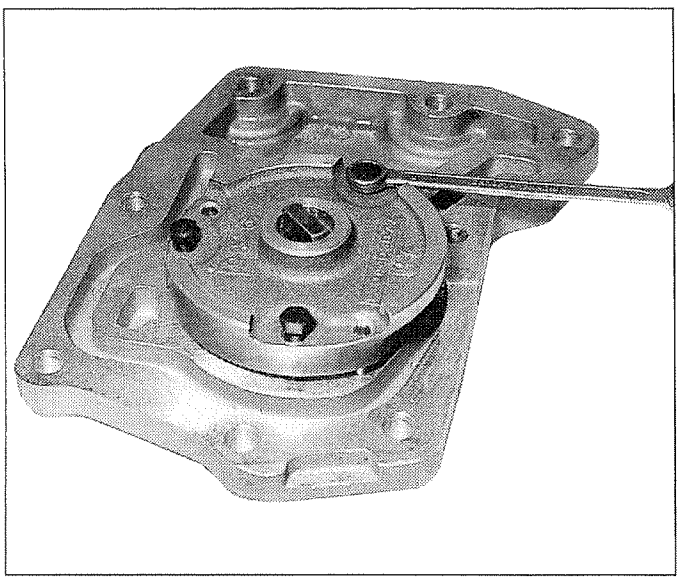
CAUTION
Do not damage pump and housing.


006976

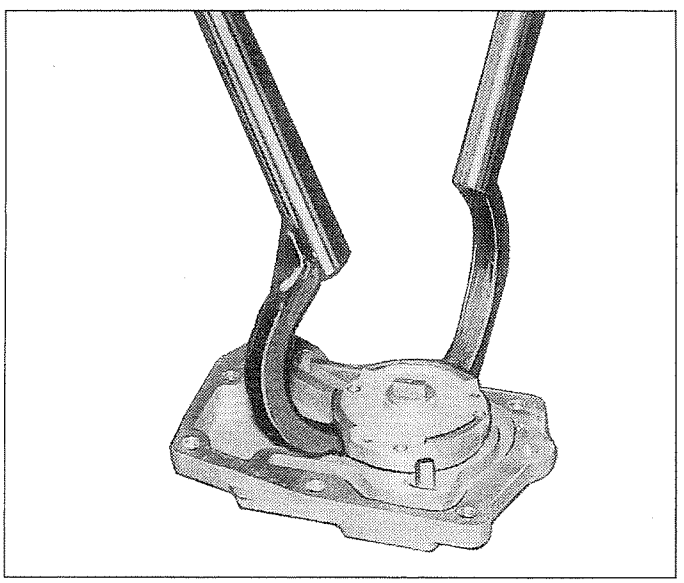
3 Remove shim from bearing outer race on layshaft.

NOTE
Lube oil pump is a complete part and should only be dismantled either for visual inspection or for cleaning purposes.

4 Unscrew bolts from lube oil pump.


006977

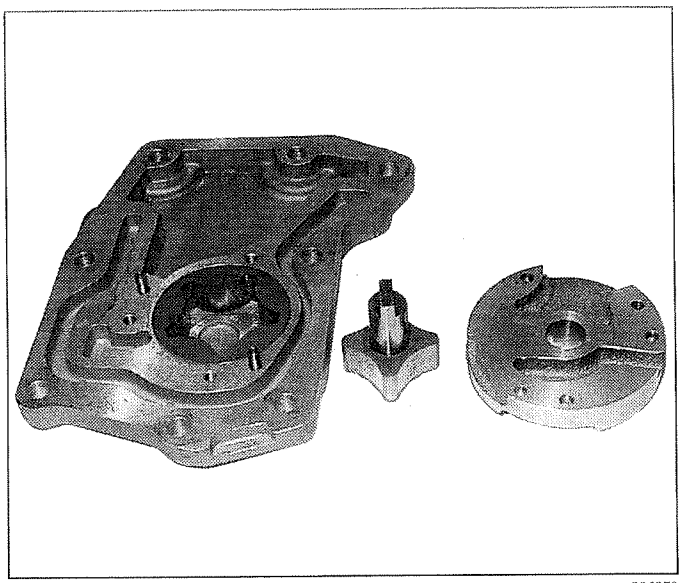
5 Press off pump housing from pump cover, taking care not to damage the sealing face in the process.


006978

6 Remove outer rotor and inner rotor from pump cover.

NOTE
Mark installation position of outer rotor before removing.

7 Remove roll pins if necessary.

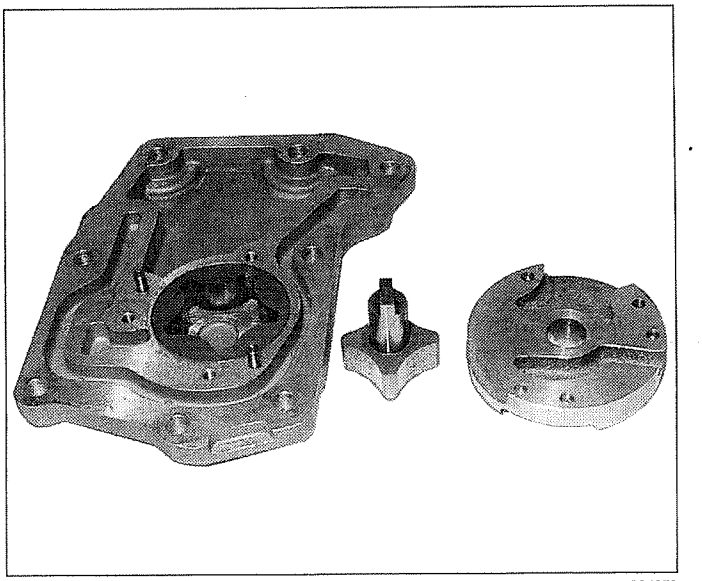

006979

7.3 Assembling and fitting lube oil pump

1 Clean and visually inspect pump parts.

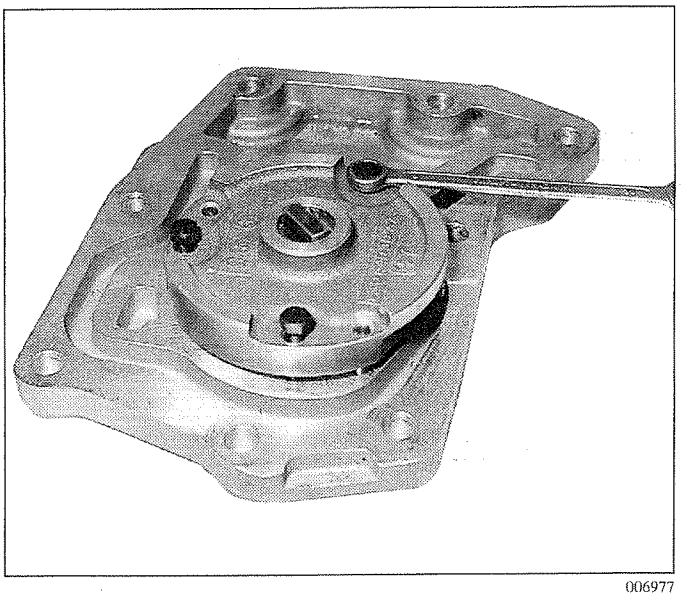
2 If necessary, insert roll pins into pump cover bores.

3 Insert outer rotor (in marked installation position) and inner rotor into pump cover. Pour in a little oil.


006979

4 Fit pump housing and press into firm contact.

5 Insert bolts into lube oil pump and tighten
- M5 tightening torque = 6 Nm

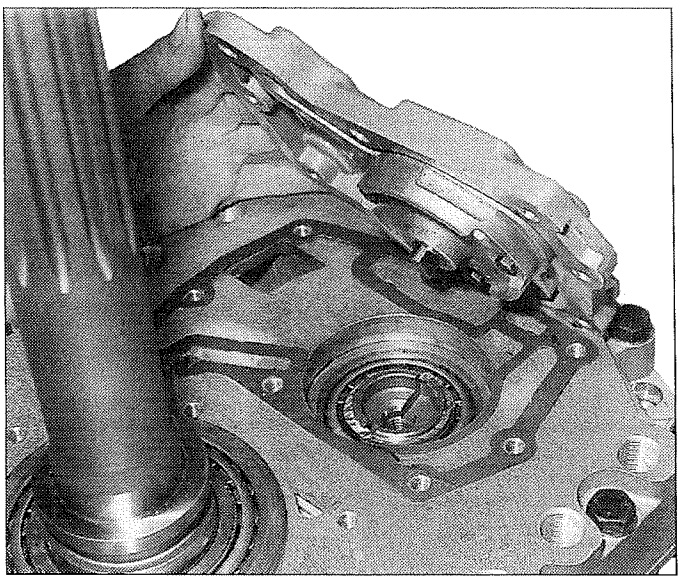

006977

6 Check that lube oil pump turns freely; if necessary, loosen bolts and retighten.

7 Place new gasket onto sealing face for lube oil pump.

NOTE
The shim selected when adjusting the layshaft must be placed onto the outer race of the roller bearing.

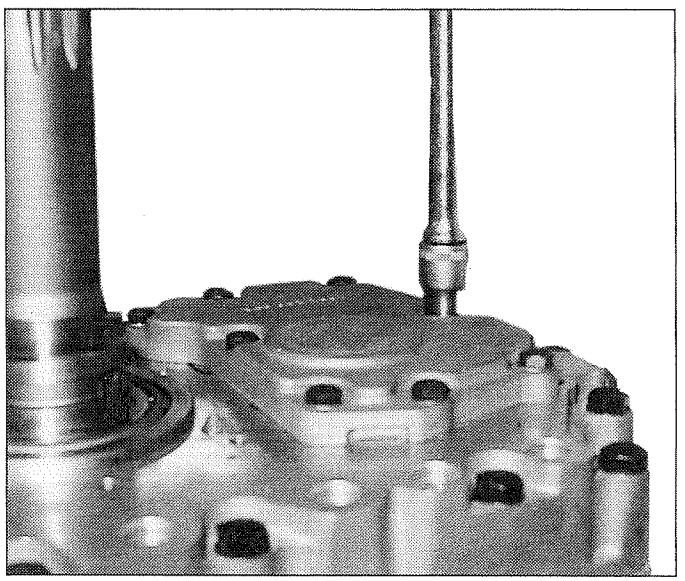
CAUTION
The layshaft, mainshaft and input shaft must be adjusted before the lube oil pump and connection plate are fitted (see Section 8).


006980

8 Slightly heat housing in the area of the bearing bore using hot air blower, fit lube oil pump and press into firm contact.

NOTE
Engage pump driver with recess in layshaft.

9 Insert hex bolts together with spring washers.
- M8 tightening torque = 23 Nm


006975

7.4 Assembing and fitting connection plate

1 Coat outside of shaft seal (**5**) with lubricant, e.g. soap.

2 Drive shaft seal (**5**) flush into connection plate (**4**) using drift **1X56 103 768.**

NOTE
Sealing lip of shaft seal must face towards drift.

3 Lightly grease sealing lip.

NOTE
The shim (**7**) selected when adjusting the main-shaft and output shaft must be placed into the connection plate.

4 Place connection plate (**4**) onto transmission together with new gasket (**6**).

5 Use protective sleeve **1X56 138 064** to make assembly easier.

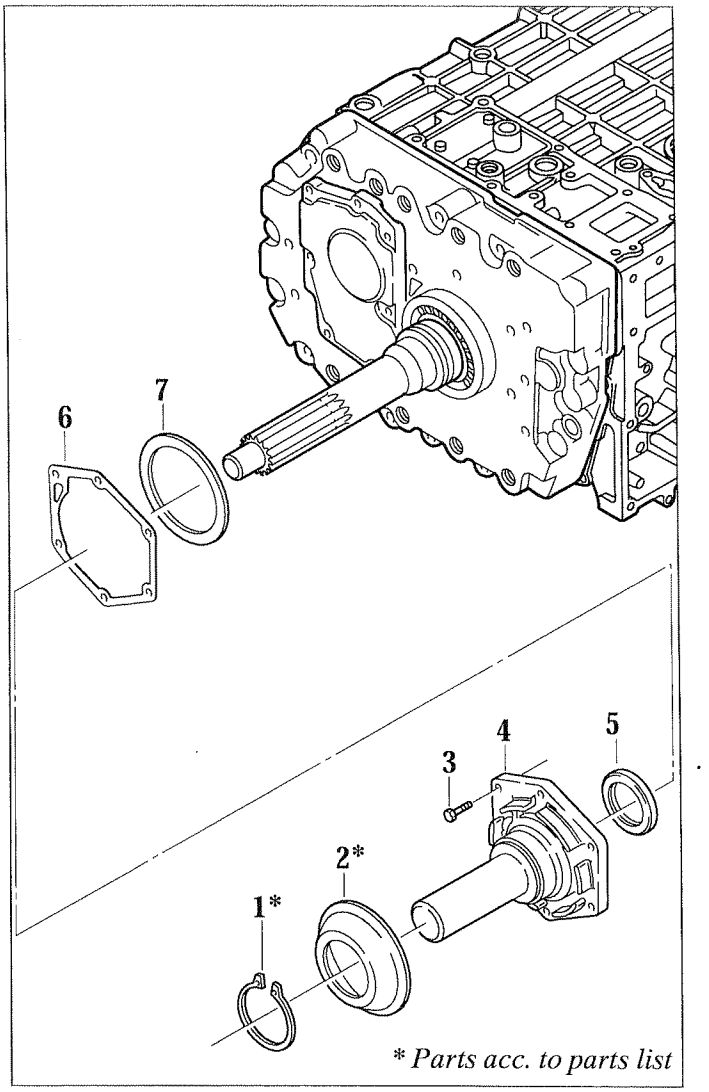
NOTE
Fit connection plate so that oil ducts are aligned.

CAUTION
Take care not to damage shaft seal when fitting the connection plate.

6 Tighten hex bolts (**3**) to 23 Nm.

7 In order to check bearing setting, engage first gear and turn transmission input shaft. A resistance must be clearly felt while doing this.

8 Depending on version, place sealing cap (**2**) onto connection plate and attach circlip (**1**) into annular groove.



007992

8 Adjusting bearings on mainshaft, input shaft and layshaft

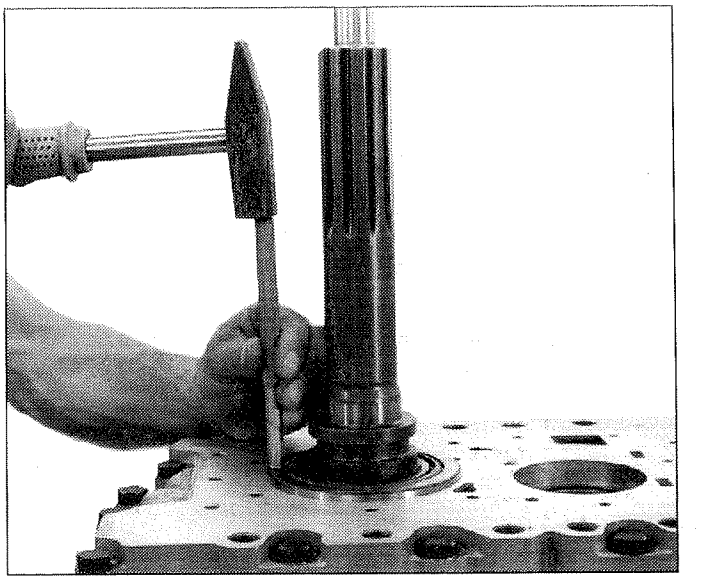
8.1 Adjusting mainshaft and input shaft

CAUTION
Prestress mainshaft and input shaft. Prestress is 0.18 to 0.30 mm.

1 Bring transmission into vertical position.

NOTE
Allow housing to cool down before adjusting bearings.

2 Set input bearing play to zero. To do this, drive bearing outer race towards mainshaft using drift.

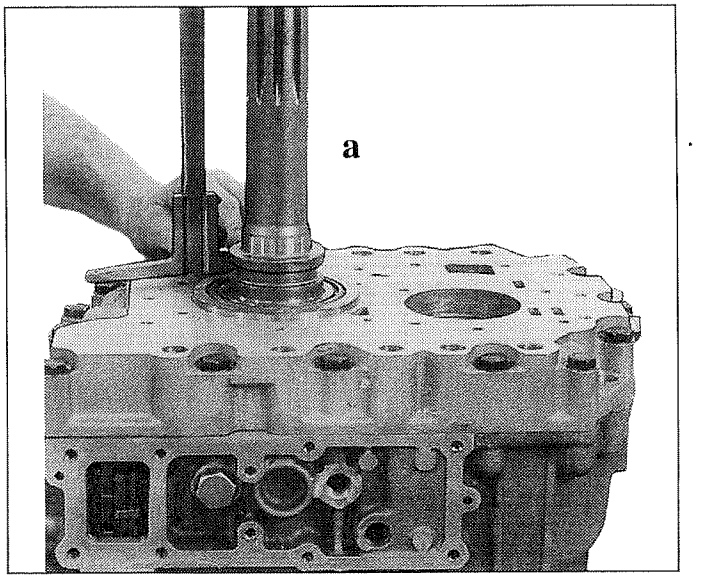

009330

CAUTION
Do not press or hit in the area of the oil ducts; otherwise, the housing will be damaged.

3 Fully turn input shaft and mainshaft a few times in order to centre bearing rollers. Use a sharp instrument to check whether the bearing rollers can be moved.

NOTE
"Zero play" means that the bearing rollers cannot be moved; however, there must be no prestress as yet.

4 Measure distance "a" between upper edge of bearing outer race and housing using depth gauge; note down **distance "a"**.
Example: a = 5.40 mm



006985

NOTE
Measure at two opposite-facing points and calculate the average value.

5 Place new gasket onto connection plate.

6 Measure distance "b" between gasket and shim contact face using depth gauge. Note down distance "b".
Example: b = 7.80 mm

NOTE
Measure on two opposite-facing points and calculate average value.

7 Determine difference "c" and note down.
c = b – a
Example: c = 2.40 mm

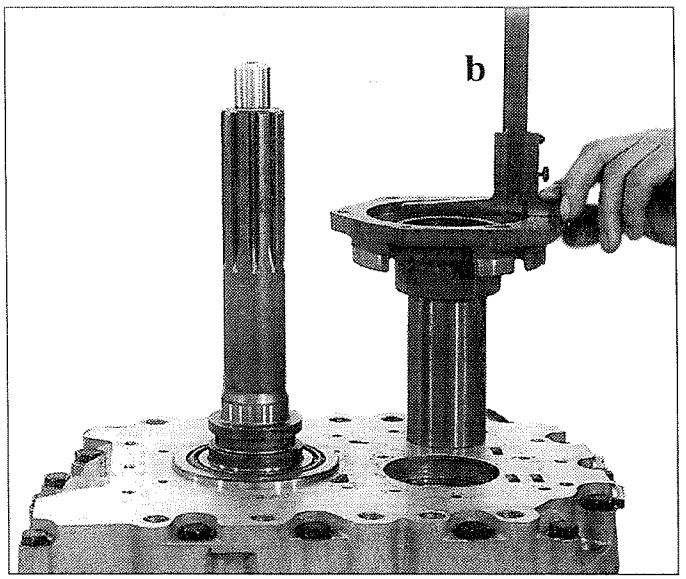
NOTE
Aim for prestress of 0.25mm (distance "e").

8 Calculate thickness "d" of shim;
d = c + e
Example: d = 2.65 mm

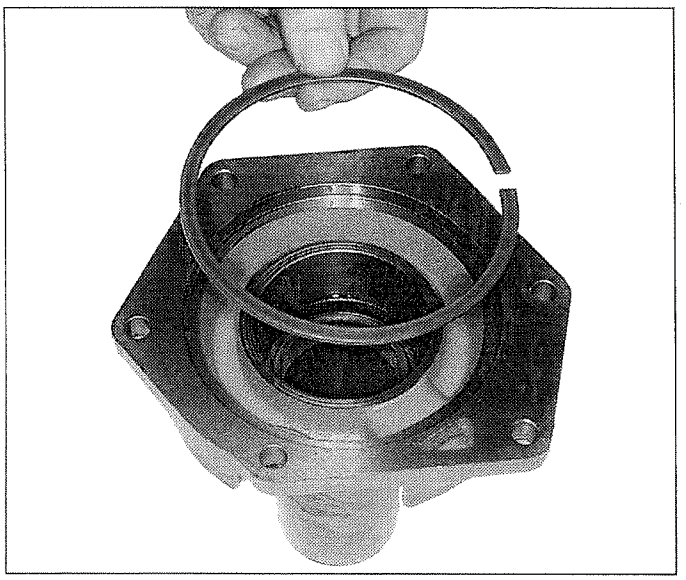
9 Select shim from spare parts catalogue; if necessary, grind down to calculated thickess.

NOTE
Experience has shown that the gasket will settle by 0.03 to 0.05mm when the hex bolts on the connection plate are subsequently tightened. Allow for this when selecting shim.

10 Insert shim into connection plate.



006986


006987

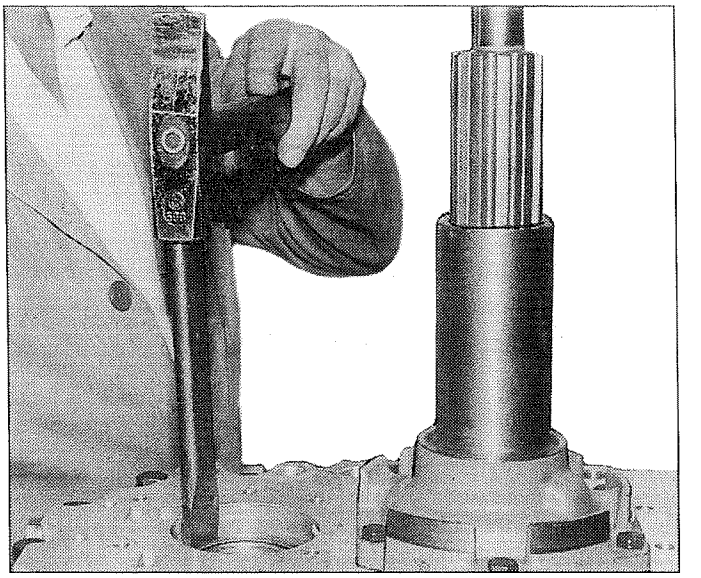
8.2 Adjusting layshaft

NOTE
Prestress layshaft.
Prestress is 0.18 to 0.30 mm.

1 Ensure transmission is in vertical position.

2 Set layshaft roller bearing to zero play. To do this, drive bearing outer race towards layshaft using drift.

CAUTION
Do not press or hit in area of oil ducts; otherwise, housing will be damaged.

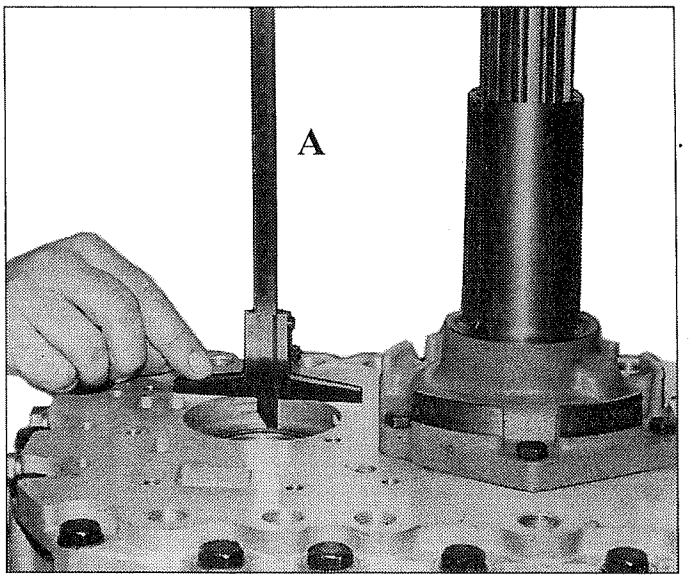

006988

3 Turn layshaft several times in order to centre bearing rollers. Use a sharp instrument to check whether the bearing rollers can be moved.

NOTE
"Zero play" means that the bearing rollers cannot be moved; however, there must be no prestress as yet.

4 Measure **distance "A"** between upper edge of bearing outer race and housing using depth gauge. Note down **distance "A".**
Example: A = 17.80 mm

NOTE
Measure on two opposite-facing points and calculate average value.



006989

5 Place new gasket onto pump.

6 Measure **distance "B"** between gasket and shim contact face using depth gauge. Note down **distance "B"**.
Example: B = 15.50 mm

7 Determine difference "C" and note down.
C = A – B
Example: C = 2.30 mm

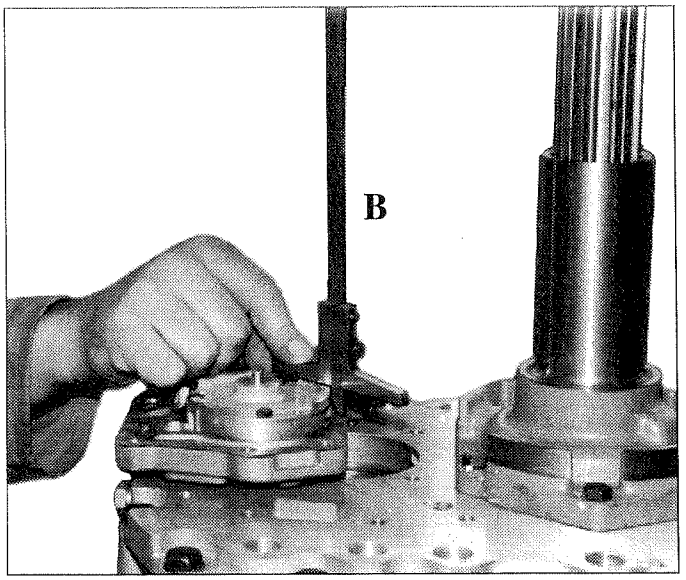
NOTE
Aim for **prestress of 0.25mm** (distance "E"').

8 Calculate thickness "D" of shim:
D = C + E
Example: D = 2.55 mm

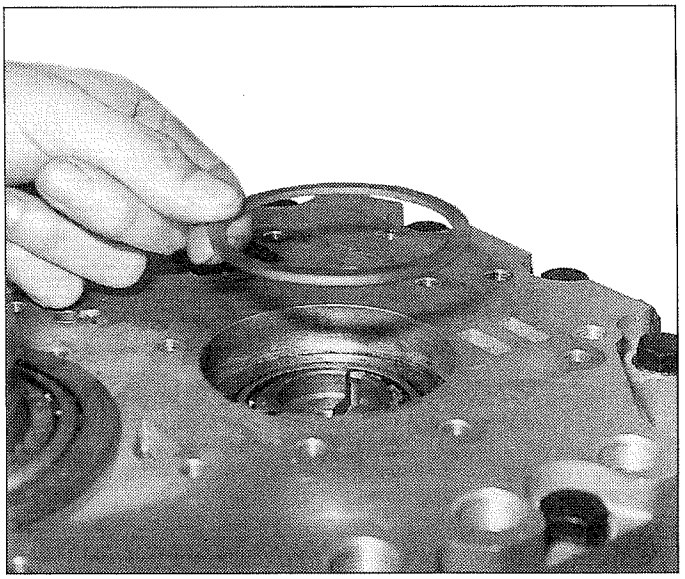
9 Select shim from spare parts catalogue. If necessary, grind down to correct thickness.

NOTE
Experience has shown that the gasket will settle by 0.03 to 0.05 mm when the hex bolts on the pump are subsequently tightened. Allow for this when selecting shim.

10 Place shim onto bearing outer race on layshaft.



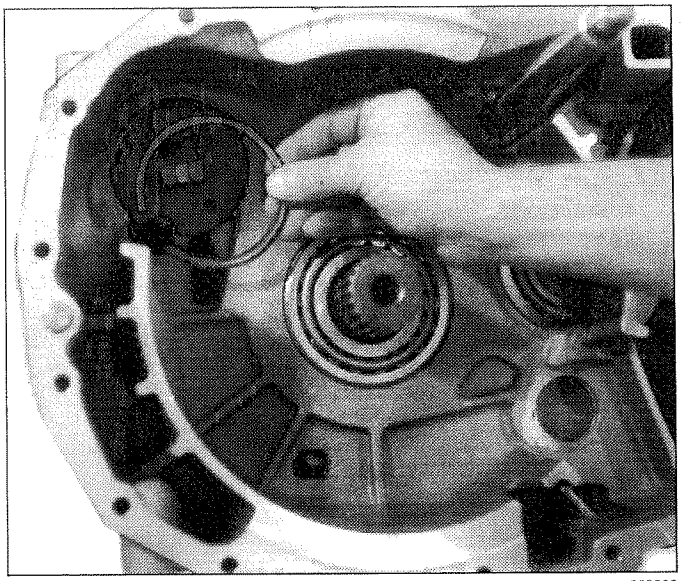
009331


006990

9 Shift rails and reverse idler gear

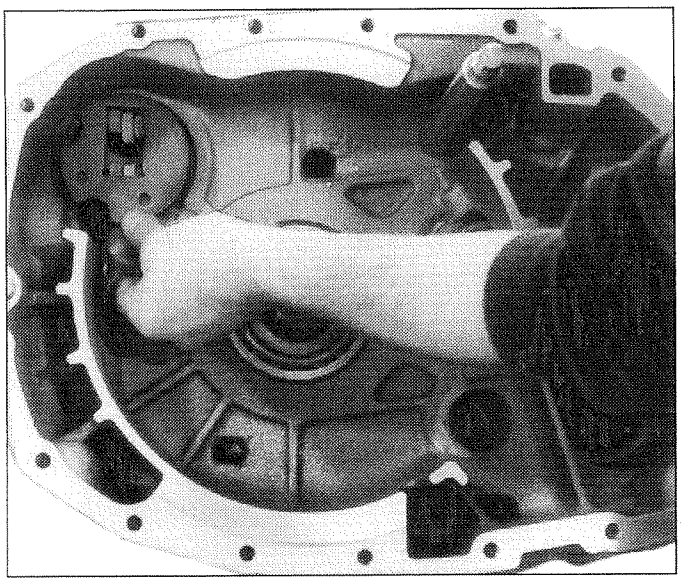
9.1 Removing shift rails

1 Remove circlip from annular groove in shift interlock.



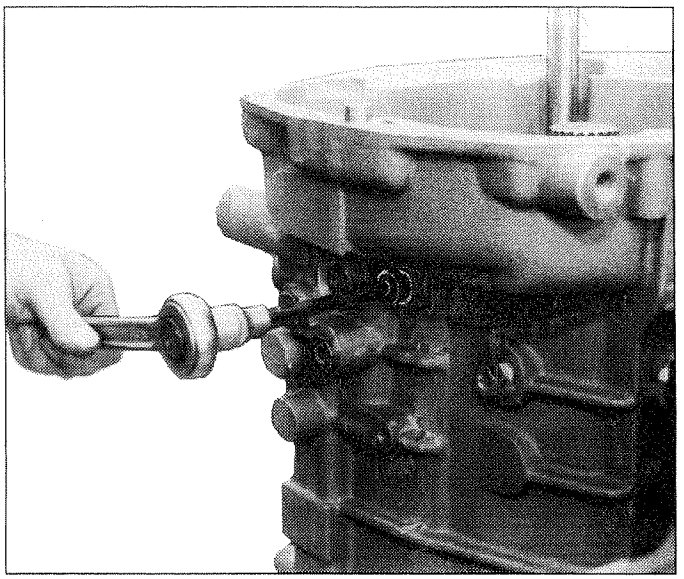
009332

2 Remove bearing plate.



009333

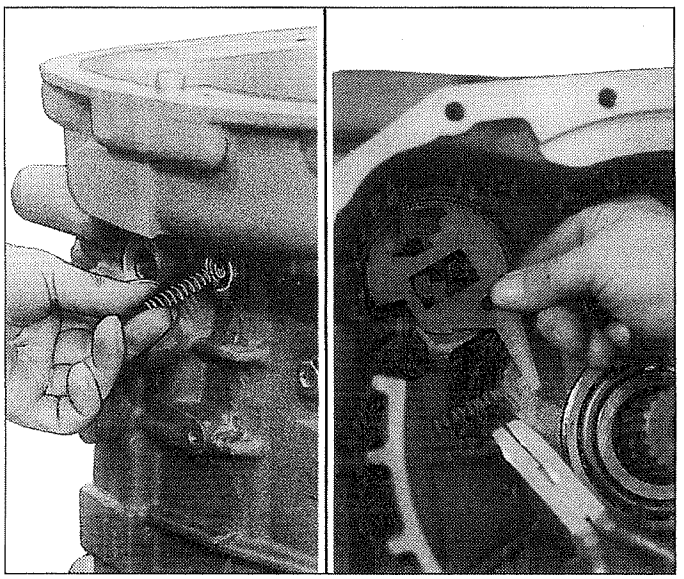
3 Unscrew screw plug from interlock compression spring.



009334

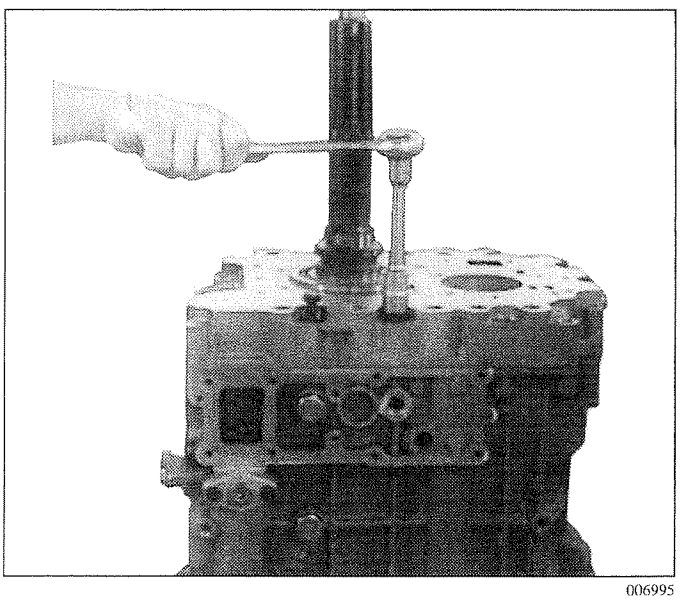
4 Remove compression spring and locking lever.

5 Bring transmission into vertical position with input end facing upwards.



006994

6 Unscrew hex bolts from housing.

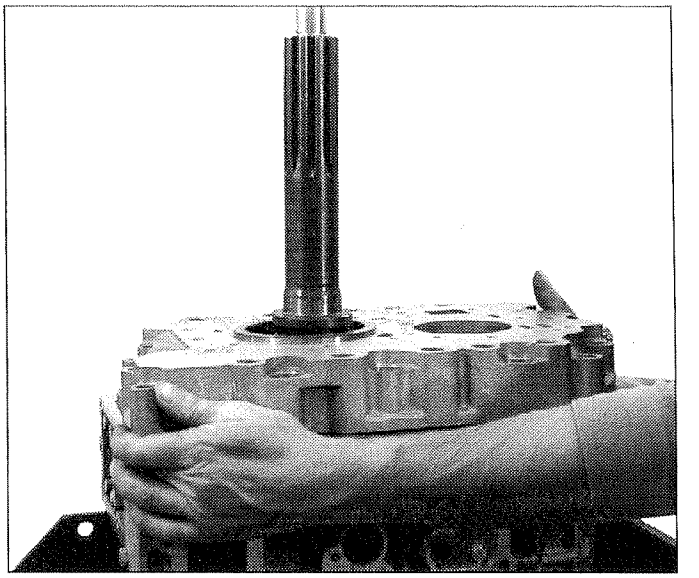


006995

7 Separate housing by lightly tapping housing recesses and lift off.

NOTE
Use plastic drift

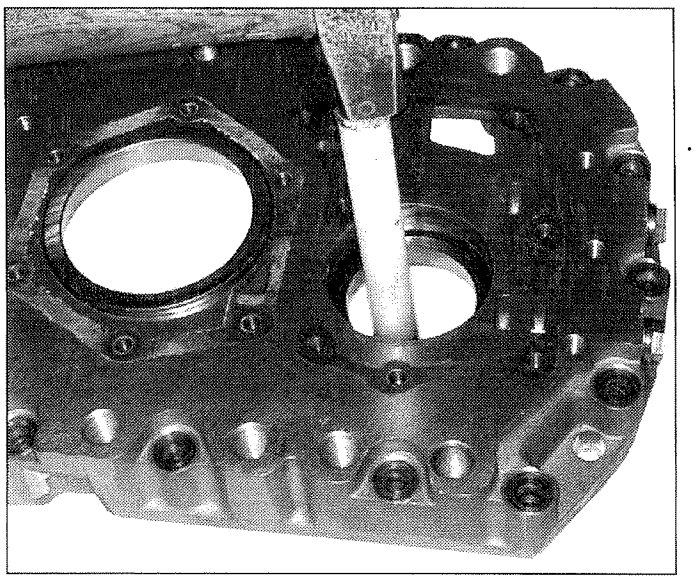
8 Remove screw plugs, oil pipe and roll pins (if necessary) from housing.



009335

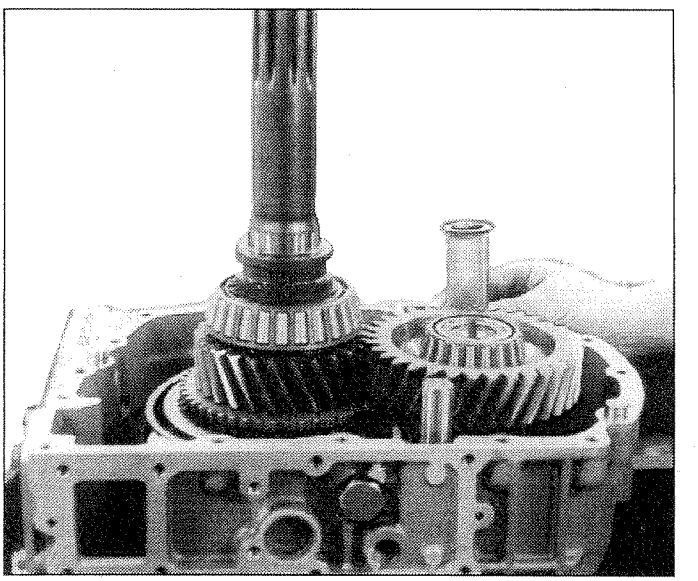
9 Drive out bearing outer races from housing using plastic drift.

10 Remove gasket and clean sealing faces.



009336

11 Remove filter from housing.

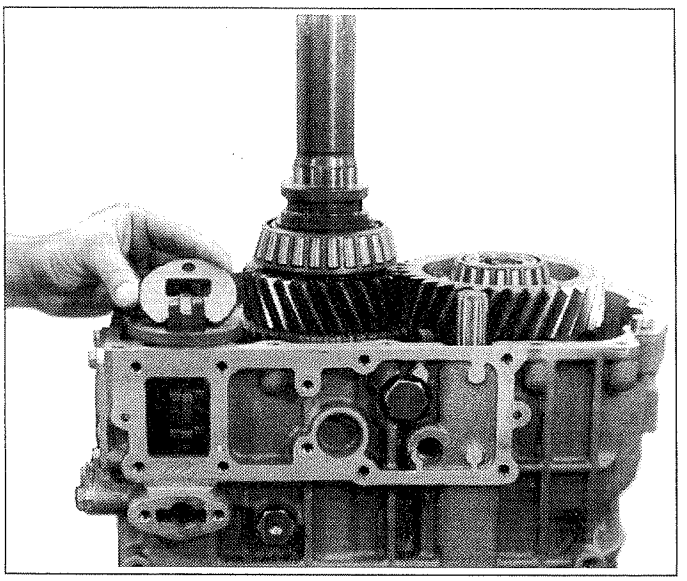


009337

12 Remove locking piece; to do this, push down middle shift rail slightly.
Press indented side of locking piece downwards and pull opposite side up over edges of shift rails.

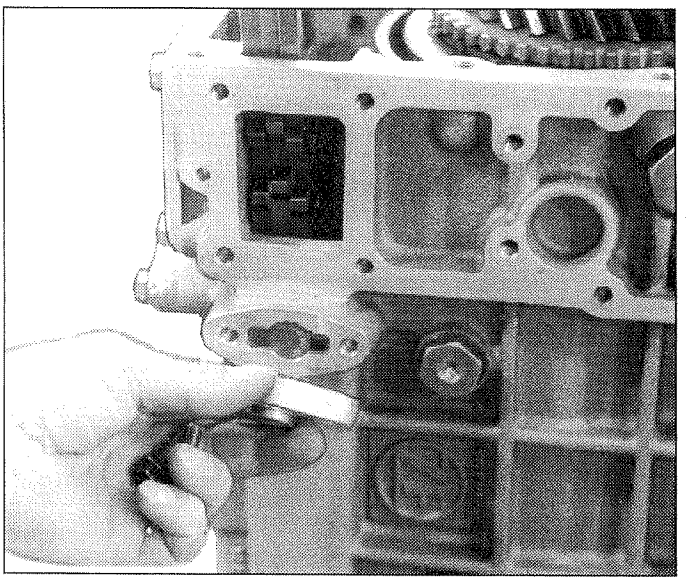
13 Remove bearing plate.

14 Unscrew hex bolts from plate for neutral position switch.


009338

15 Remove plate together with gasket and neutral position switch.

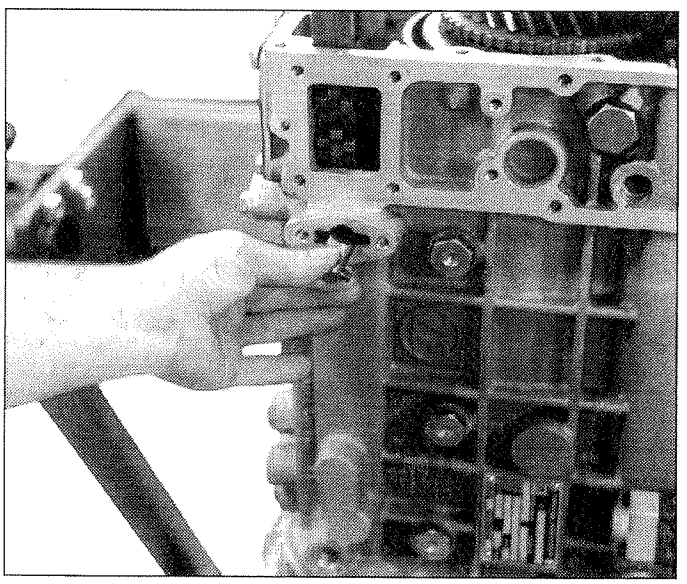
16 Depending on version, unscrew neutral position switch from plate.


009339

17 Remove pin from housing.

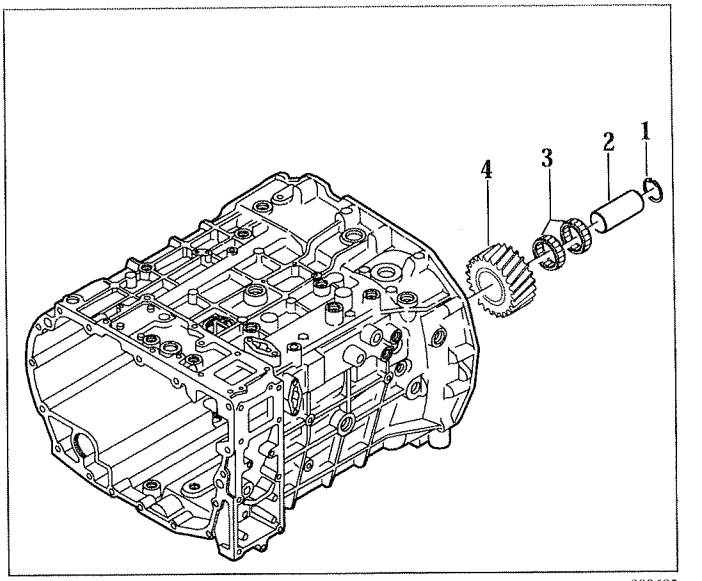
18 Unscrew pivot bolts for splitter shift fork.
Caution: hold splitter shift rail to prevent it falling through.

19 Remove remaining pivot bolts and separate shift rails from shift forks; remove shift rails from housing one by one.


009340

9.2 Removing reverse idler gear

1 Remove circlip (**1**).



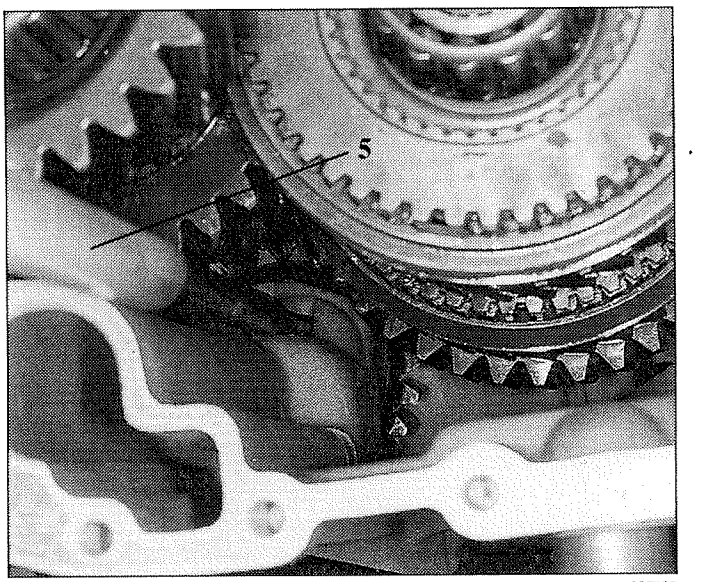
009682

2 Using rod (5), drive out reverse idler gear pin (**2**) towards output end.
Use tool(s) 50 00 26 2380.

3 Push reverse idler gear (**4**) towards housing wall.

4 Lift out mainshaft and layshaft from housing as described in Section 10.

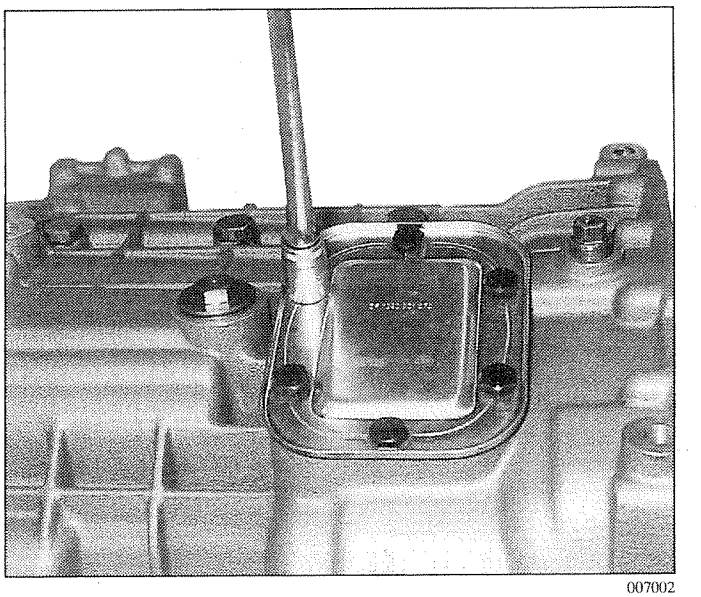
5 Remove reverse idler gear (**4**) from housing together with two roller cages (**3**).



007003

6 Remove hex bolts.

7 Lift off cover, remove gasket and clean sealing face.


007002

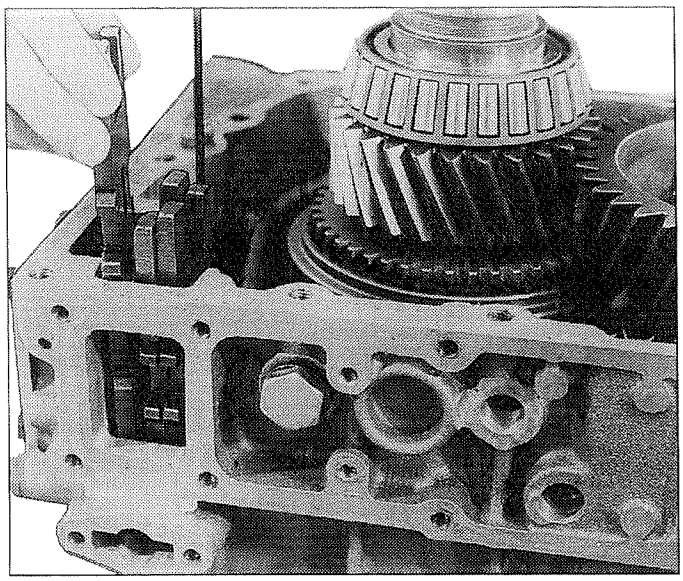
9.3 Installing shift rails

1 Bring transmission into vertical position with input end facing upwards.

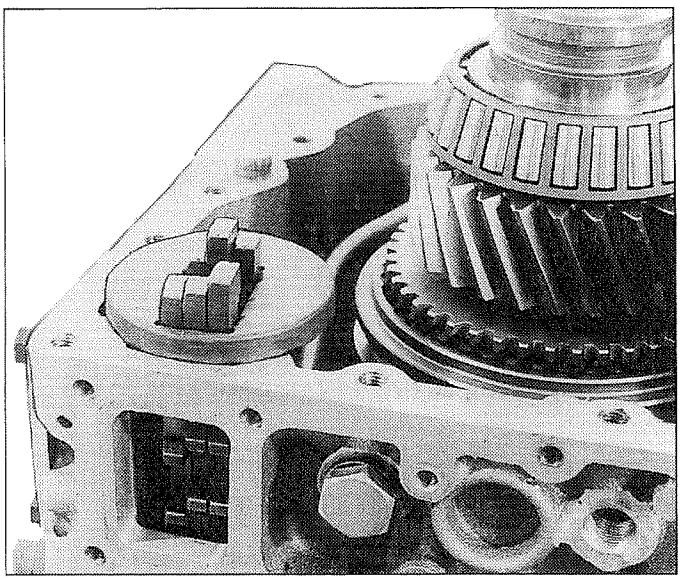
2 Insert shift rails into housing one by one. Insert lugs on shift forks into recesses on shift rails; to do this, use hook **1X56 137 451** to guide the shift forks.

Installation sequence:
1. = 1st / 2nd and 5th / 6th gear
2. = 3rd / 4th and 7th /8th gear
3. = Reverse gear

NOTE
Compare part numbers of shift rails; shift rail with different number must in the middle.

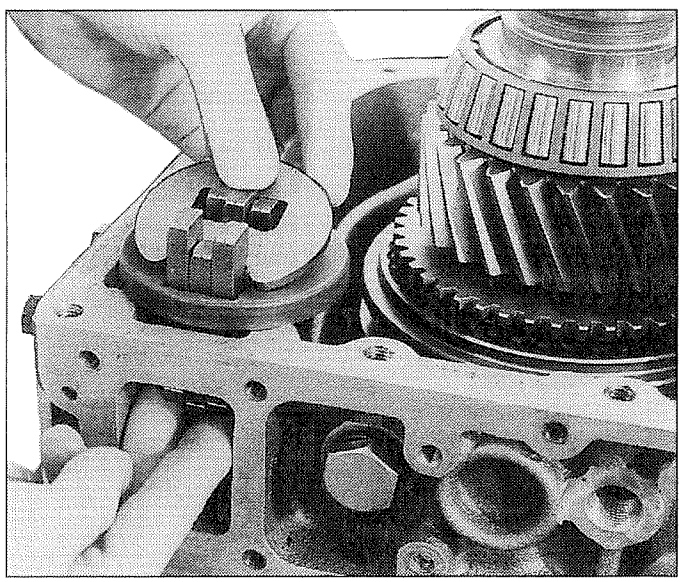

007005

3 Slide bearing plate (see parts list) over shift rails; recessed side must come into contact with the housing sealing face.

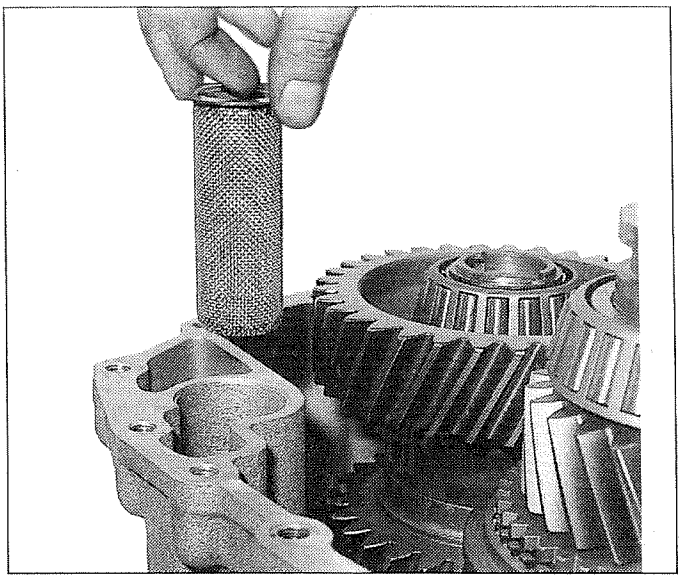

007006

4 Fit locking piece; to do this, push down middle shift rail slightly and lower locking piece over edges of shift rails.

NOTE
Tab on locking piece must engage into bore in bearing plate.


007007

5 Fit cleaned filter or new filter into housing.


006998

6 Depending on parts list version

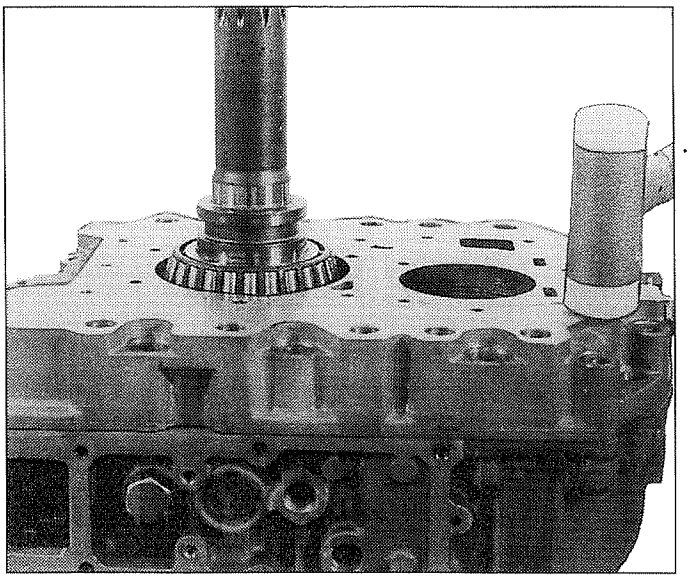
- **Version A**
  Place new gasket onto housing.
- **Version B**
  Coat sealing faces with sealing compound, ZF No. **0666 790 054**.

CAUTION
Do not use any other type of sealing compound.

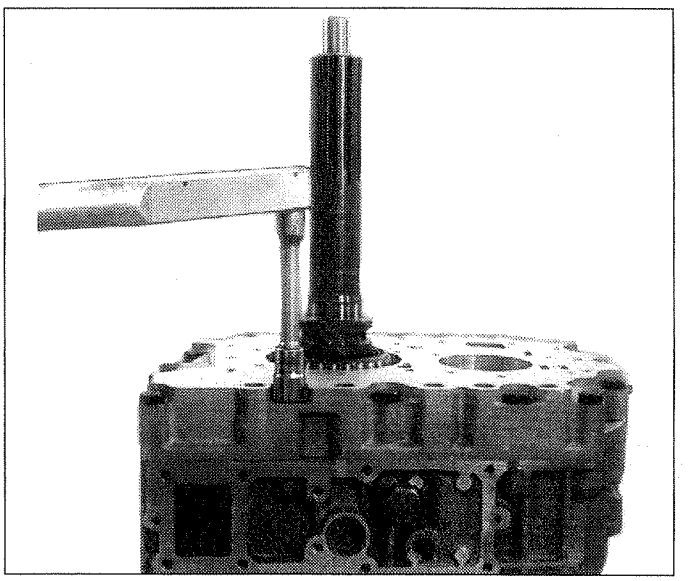
7 If necessary, insert roll pins into housing bores.

8 Fit housing and bring into firm contact by tapping lightly with plastic hammer.

CAUTION
Do not tap in the area of the oil ducts; otherwise, the housing will be damaged.

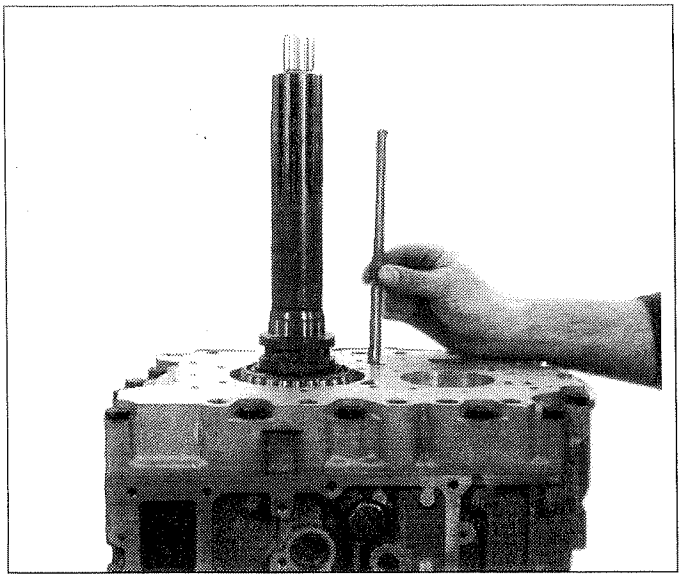

007008

9 Insert hex bolts together with spring washers.
- M10 tightening torque = 50 Nm


009342

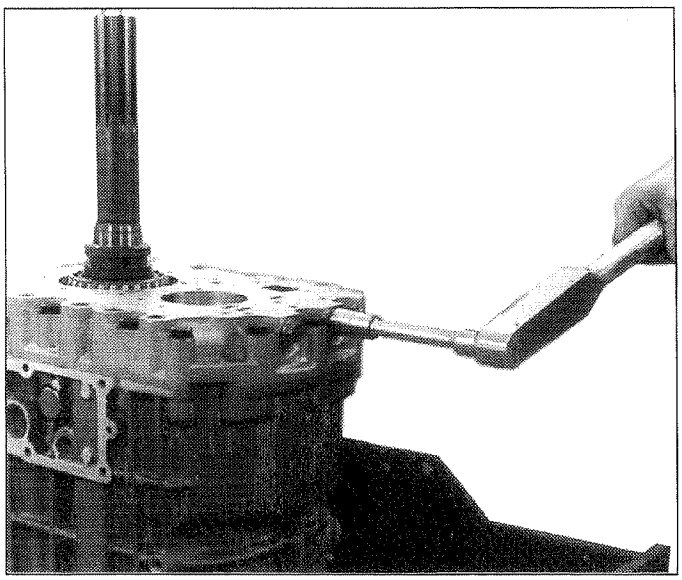
10 Fully insert spray tube (form depending on version) into housing. The tab on the tube must engage into the slot in the housing.

NOTE
Check that the spray bores are clear; if necessary, open spray bores.

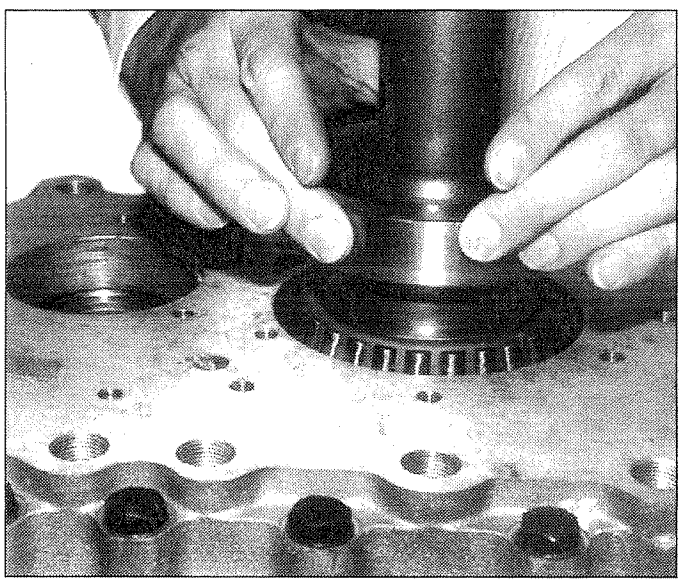

009343

11 Insert screw plug into housing together with new seal ring
- M16x1.5 tightening torque = 45 Nm

12 Slightly heat bearing seats for taper roller bearings (input shaft and layshaft) in housing using hot air blower.

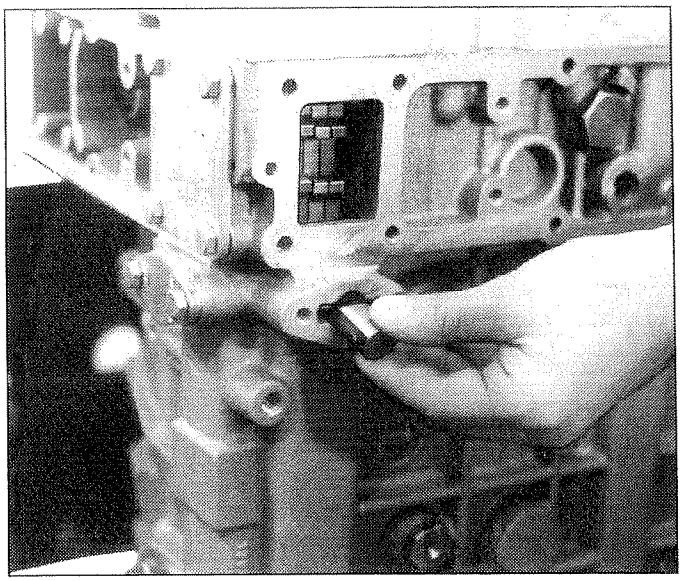

009344

13 Insert bearing outer races (input shaft and layshaft) into housing and press into firm contact.

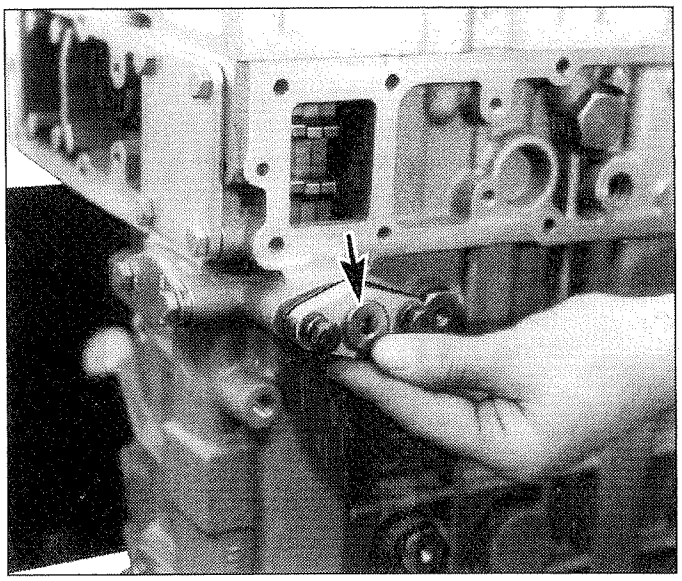

009345

14 Insert pin into housing.

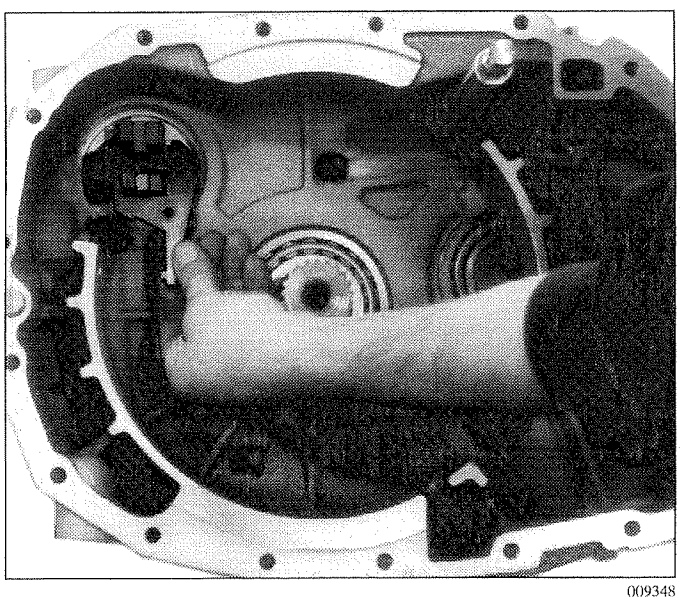
15 Depending on version
Fit plate together with new gasket and screw plug or switch (for neutral indicator).
M8 bolt tightening torque = 23 Nm
M18 x1.5 screw plug tightening torque = 35 Nm
M18 x1.5 switch tightening torque = 50 Nm


009346

16 Bring transmission into vertical position with output end facing upwards.


009347

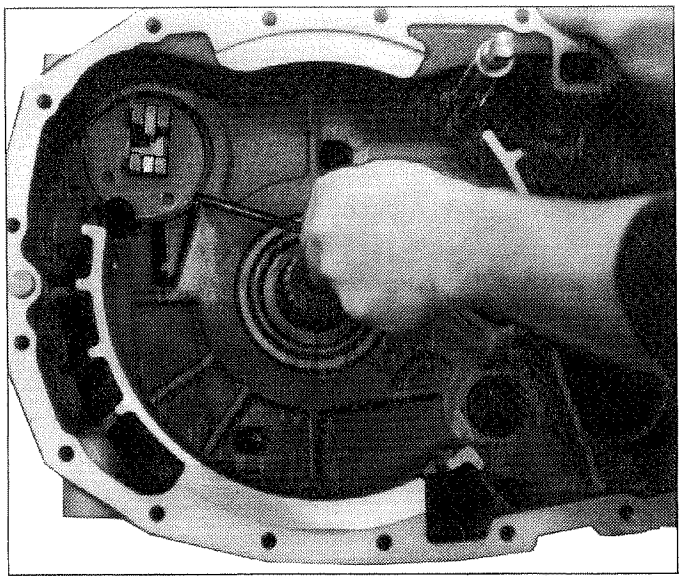
17 Slide locking lever over shift rails.


009348

18 Slide bearing plate over shift rails and push down into firm contact.

19 Fit ring into annular groove to secure bearing plate.

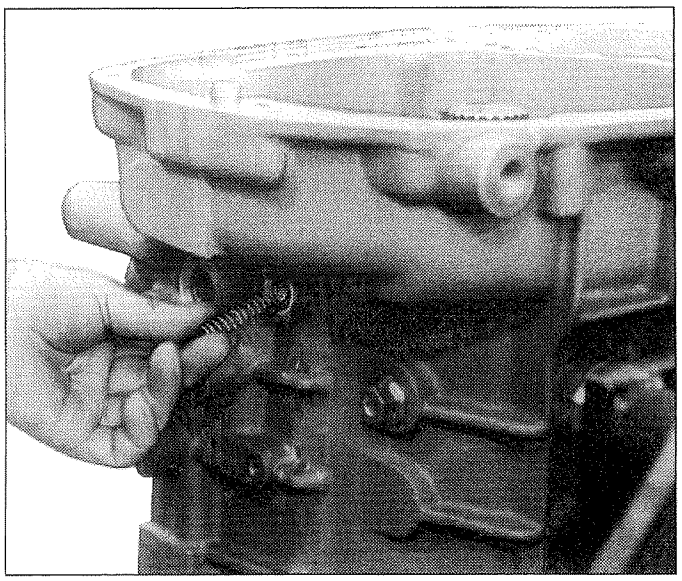
NOTE
Ring must not obstruct entry hole for range-change shift rail.



009349

20 Insert compression spring into housing bore and engage with locking lever.

21 Insert screw plugs for interlock compression springs together with new seal ring.
- M14x1.5 tightening torque = 35 Nm



009350

9.4 Installing reverse idler gear

1 Insert roller cages (**3**) into reverse idler gear (**4**).

2 Insert reverse idler gear into housing together with roller cages and push towards housing wall.

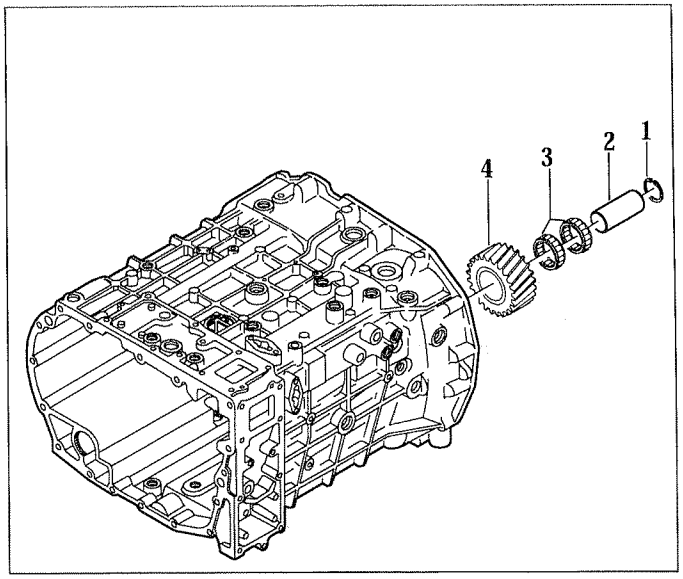
NOTE
The shoulder with wider diameter must face towards the output end.

3 Install mainshaft and layshaft as described in Section **10.2**.

4 Align reverse idler gear with bearing bores.

5 Slightly heat housing bores using hot air blower.

6 Drive in pins from underneath until annular groove for circlip in housing is completely free.

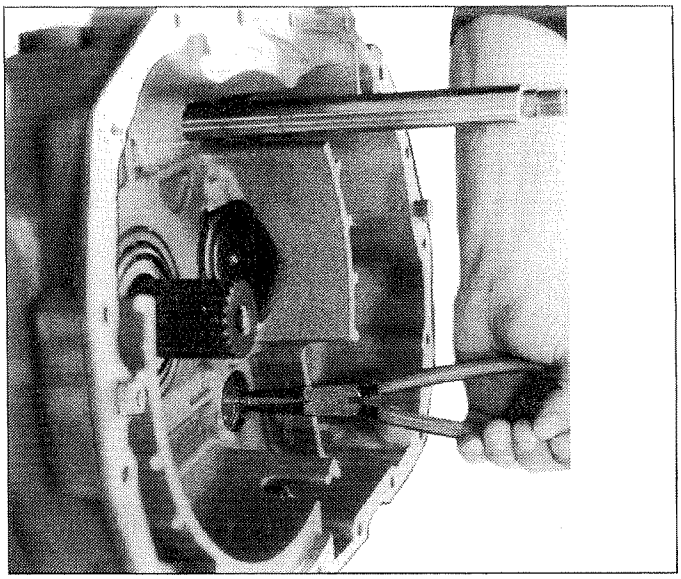


009682

NOTE
Assembly of the transmission input end is now complete.

7 Insert circlip into annular groove using circlip pliers, ensuring that it is seated correctly.

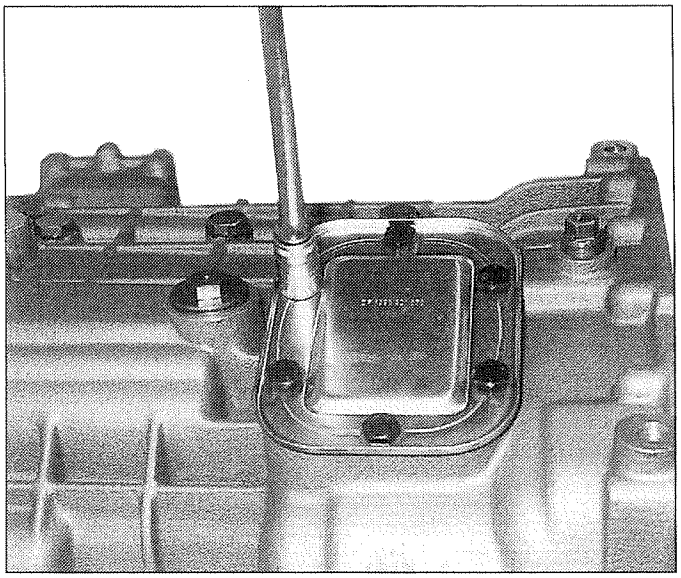
8 Check axial play of reverse idler gear using feeler gauge.
Axial play 0.20 to 0.60 mm


009353

NOTE
Covers with sealing bead must only be used once.

9 Place new cover onto sealing face together with new gasket.

10 Insert hex bolts and tighten
- M10 tightening torque = 49 Nm


007002

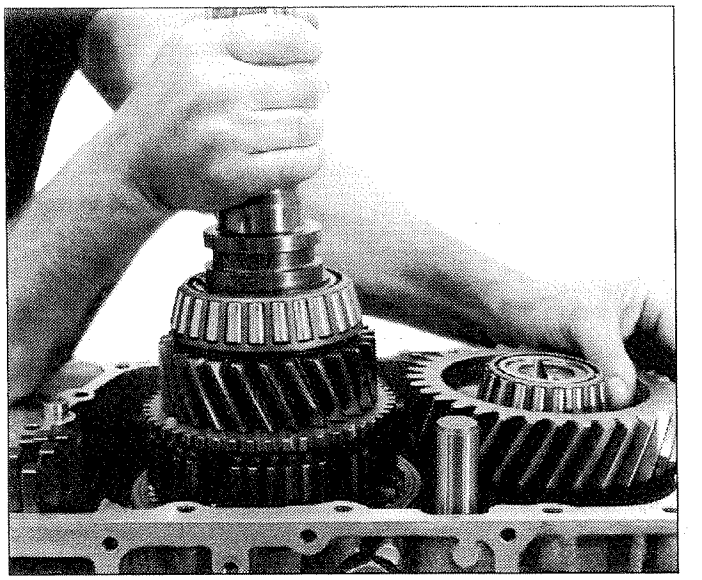
10 Input shaft, mainshaft and layshaft

10.1 Removing shafts

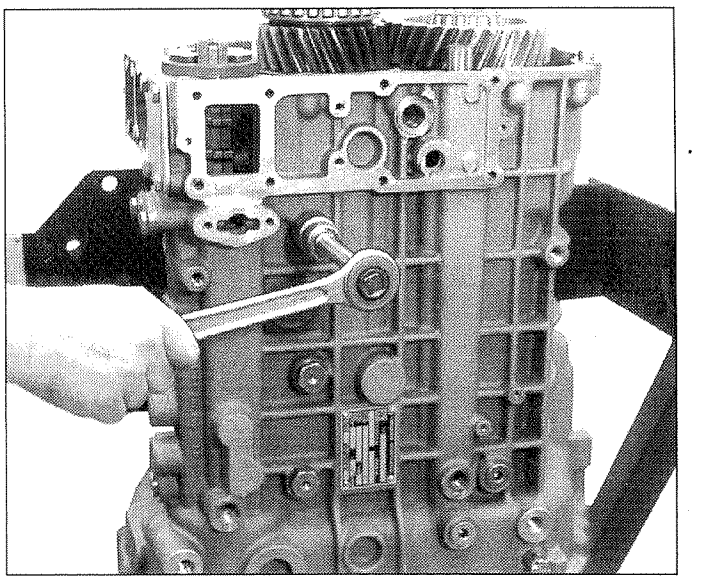
1 Lift off input shaft from mainshaft while pressing down sliding sleeve for low/high group. Sliding sleeve cannot be removed yet.

NOTE
See Section **11.1** for dismantling input shaft.

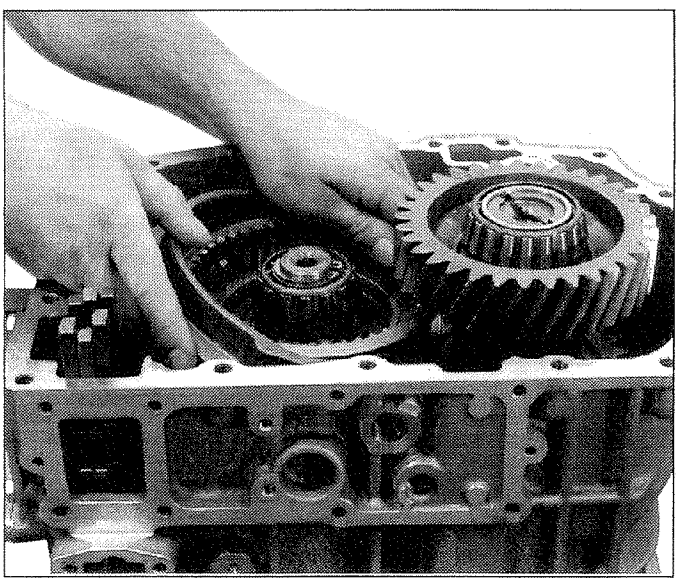
CAUTION
When the input shaft is lifted off, pressure pieces and compression springs are released. These parts are under spring pressure. Secure them to prevent them flying out.


009354

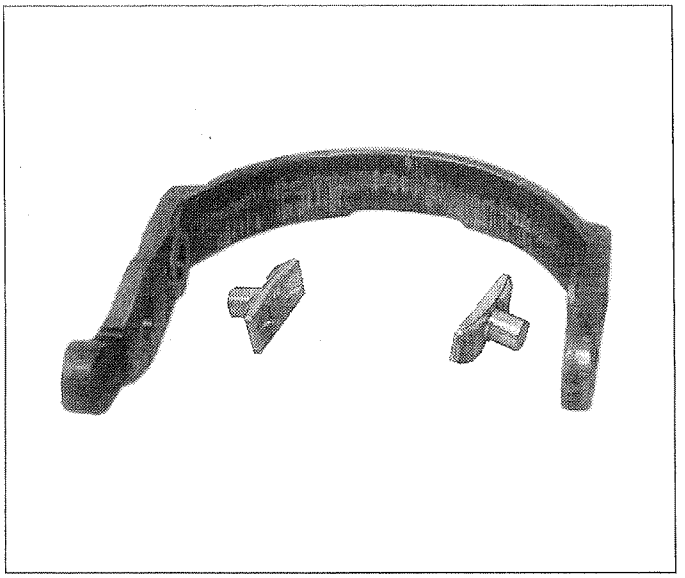
2 Unscrew 8 pivot bolts from housing.


009355

3 Lift up low/high group shift fork together with sliding sleeve and remove from transmission housing.


009356

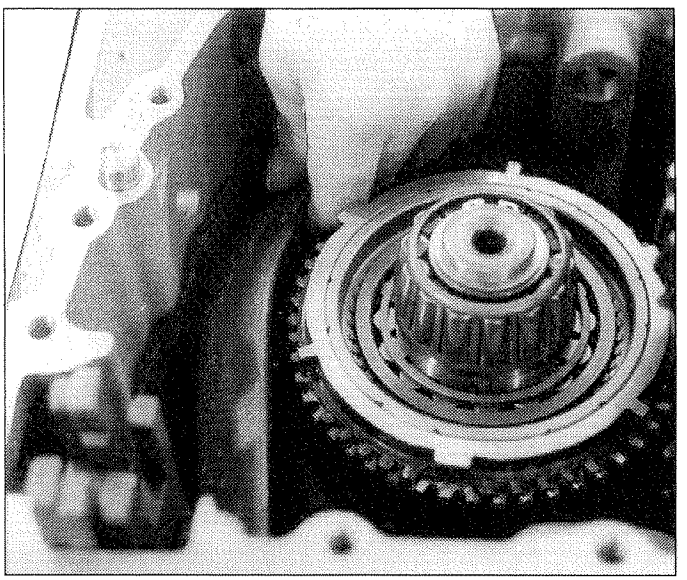
4 Remove fulcrum pads from shift fork.



009357

5 Lift up shift fork for 3rd/4th gear and remove from transmission housing.

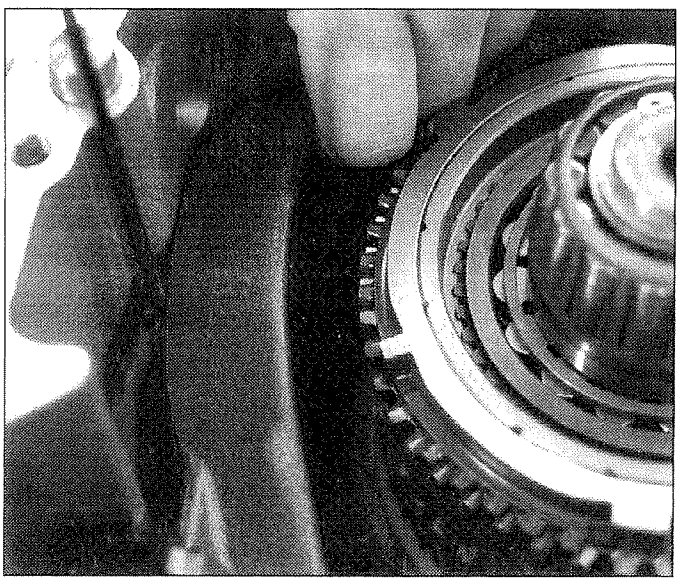
6 Remove fulcrum pads from 3rd/4th gear shift fork.



009358

7 Lift out 1st/2nd gear shift fork from sliding sleeve using hook **1X56 137 451** and remove from transmission housing.

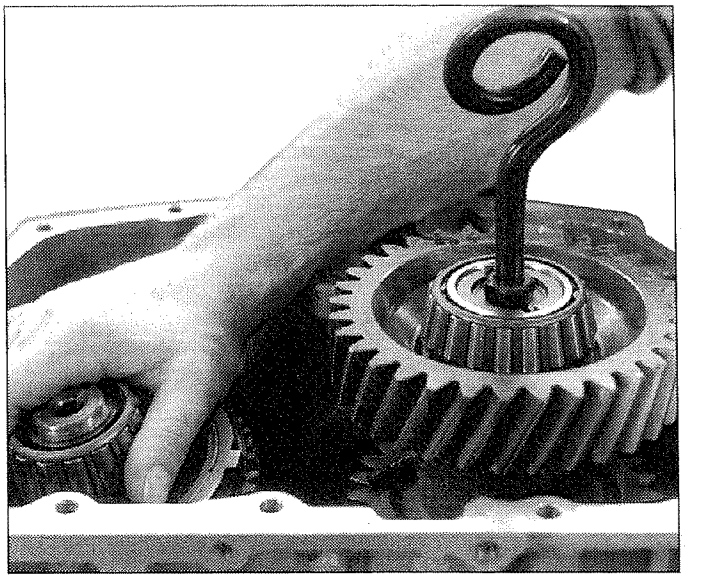
8 Remove fulcrum pads from 1st/2nd gear shift fork.



009359

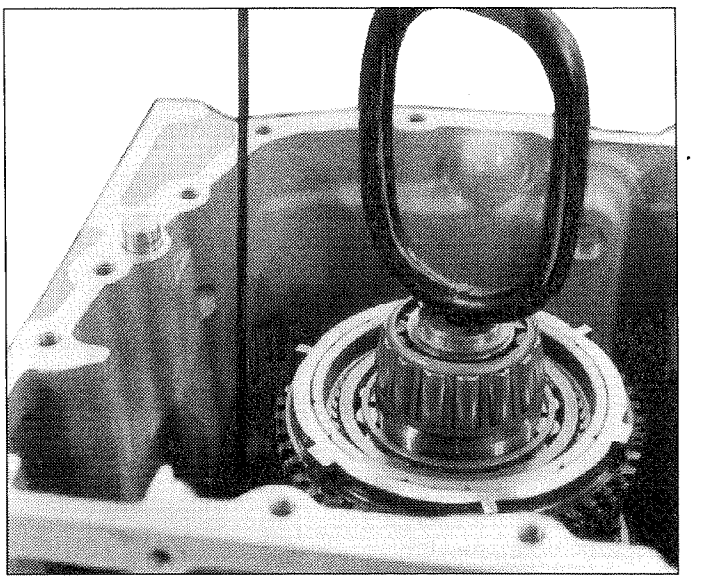
9 Insert M12 hook **1X56 136 599** into layshaft.

10 Lift out layshaft from transmission, pushing the mainshaft to one side while doing this.



009360

11 Insert lifting rod **1X56 137 200** into central bore in mainshaft, pushing oil pipe out of mainshaft in the process. Secure lifting rod at output end by attaching the supplied hex nut.

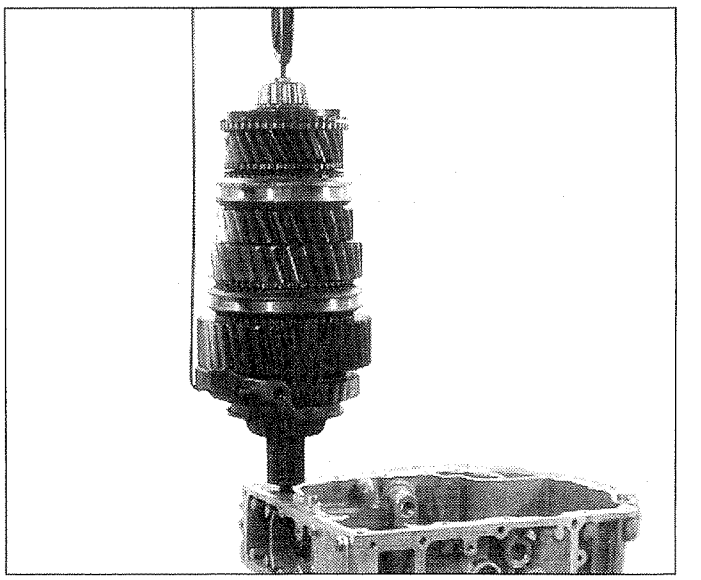


009361

12 Lift out mainshaft from transmission housing using lifting rod. While doing this, secure reverse gear shift fork using hook **1X56 137 451**.

13 Pick up reverse gear shift fork.

14 Remove fulcrum pads from shift fork.



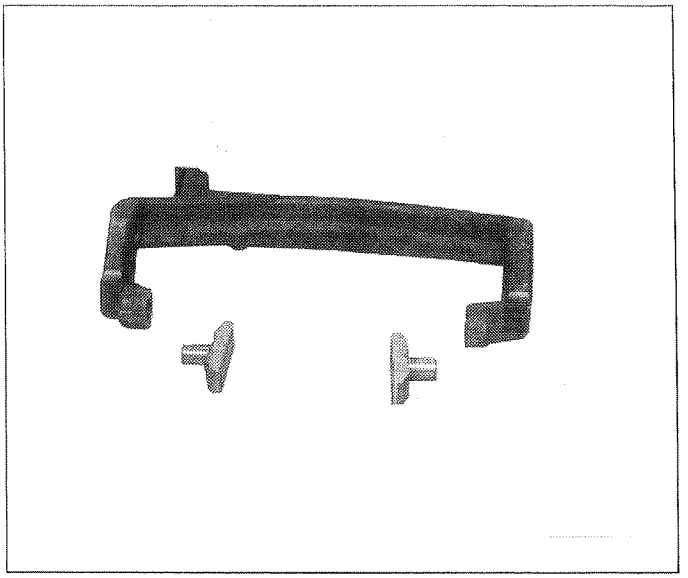
009362

10.2 Installing shafts

1 Insert lifting rod **1X56 137 200** into central bore in mainshaft and secure at output end using supplied hex nut.

2 Position mainshaft above transmission housing using lifting rod.

3 Insert fulcrum pads into reverse gear shift fork.



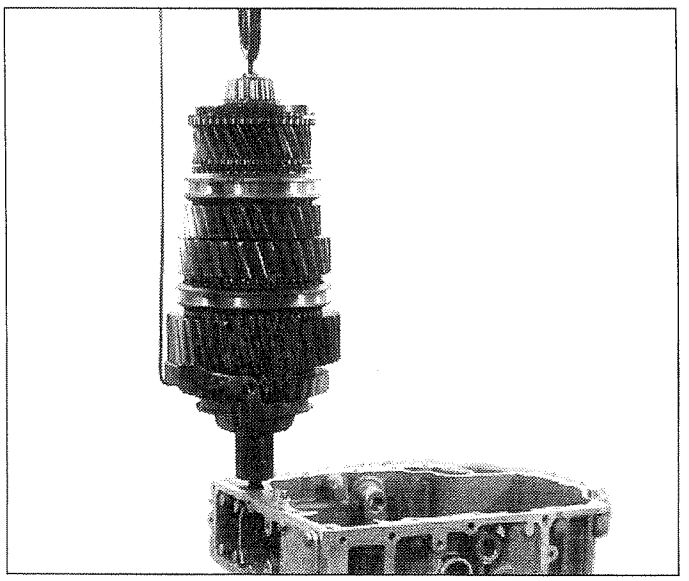
009363

4 Insert shift fork into reverse gear sliding sleeve and secure using hook **1X56 137 451**. When the mainshaft is installed, the tab on the shift fork must face towards the opening in the housing for the shift mechanism.

5 Guide mainshaft into bearing point in transmission housing.

6 Remove lifting rod **1X56 137 200** from mainshaft.

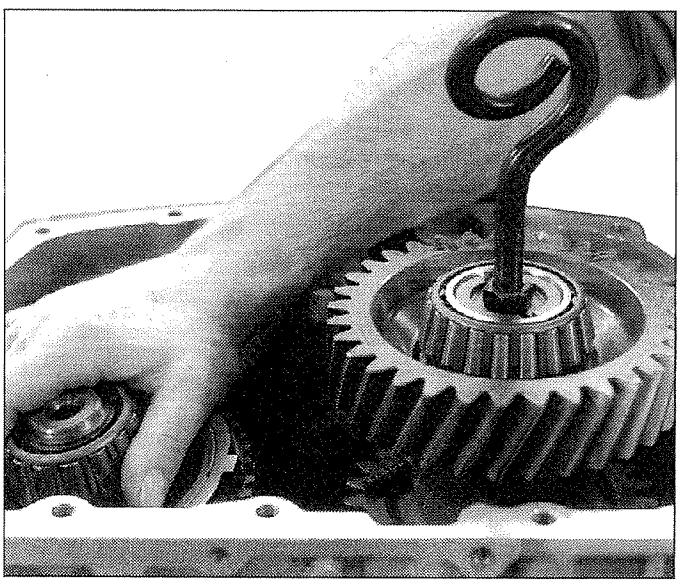
7 Insert hook **X56 136 599** into layshaft.



009362

8 Insert layshaft into bearing point in transmission housing, pushing mainshaft to one side in the process.

NOTE
Reverse idler gear must not be installed yet.

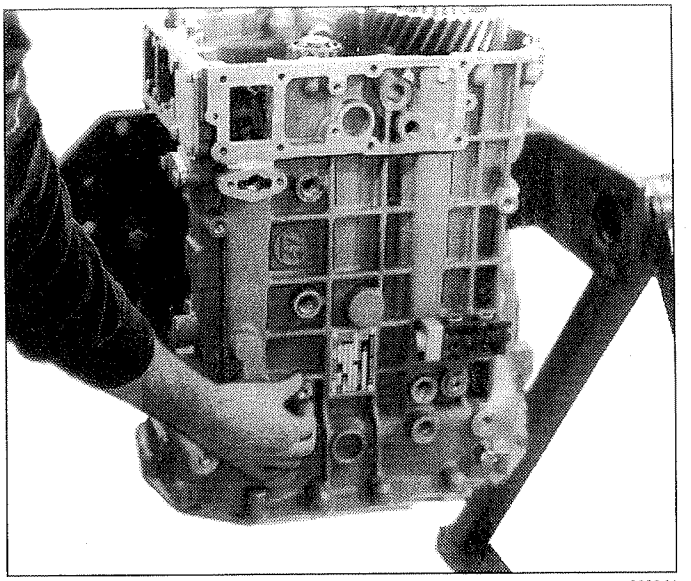


009360

9 Bring teeth of mainshaft and layshaft into mesh and remove hook **1X56 136 599** from layshaft.

10 Align reverse gear shift fork using hook **1X56 137 451** so that the guide bores in the shift fork are visible through the threaded bores in the transmission housing.

11 Coat the threads of the pivot bolts with Loctite No. 241. Insert pivot bolts into threaded bores on both sides of housing together with spring washers.
- M18x1.5 tightening torque = 160 Nm

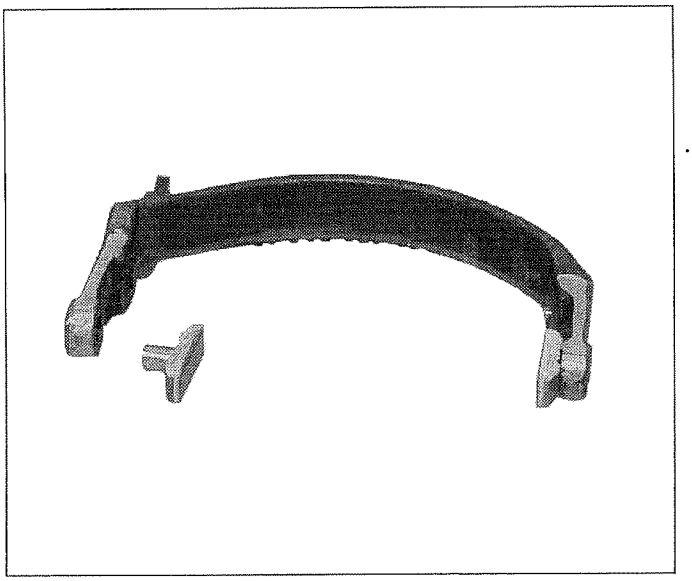


009364

12 Insert fulcrum pads in 1st/2nd gear shift fork.

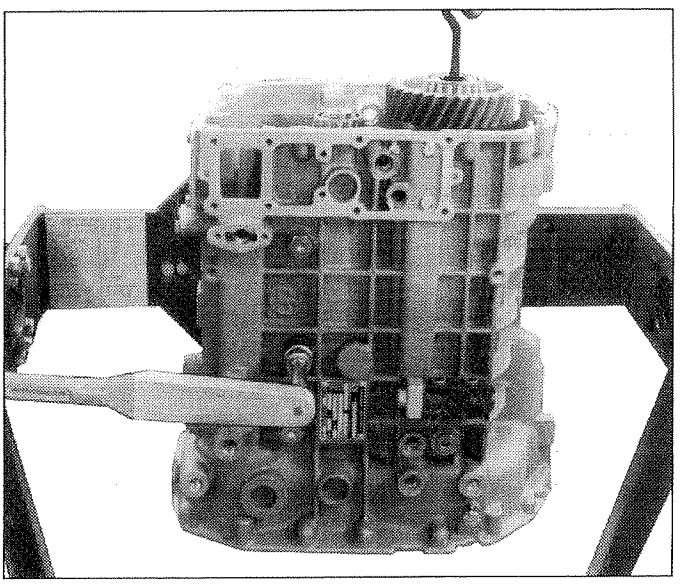
13 Insert shift fork in 1st/2nd gear sliding sleeve so that the tab on the shift fork is facing towards the opening in the housing for the shift mechanism.

14 Align 1st/2nd gear shift fork using hook **1X56 137 451** so that the guide bores in the shift fork are visible through the threaded bores in the transmission housing.



009365

15 Coat threads of pivots bolts with Loctite No. 241. Insert pivot bolts into threaded bores on both sides of transmission housing together with spring washers.
- M18x1.5 tightening torque = 160 Nm

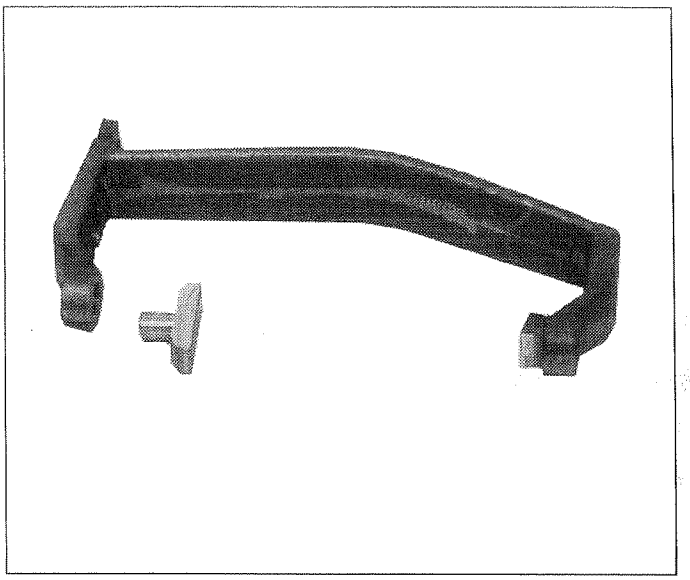


009366

16 Insert fulcrum pads into 3rd/4th gear shift fork.

17 Insert 3rd/4th gear shift fork into sliding sleeve. The tab on the shift fork must face towards the opening in the housing for the shift mechanism.

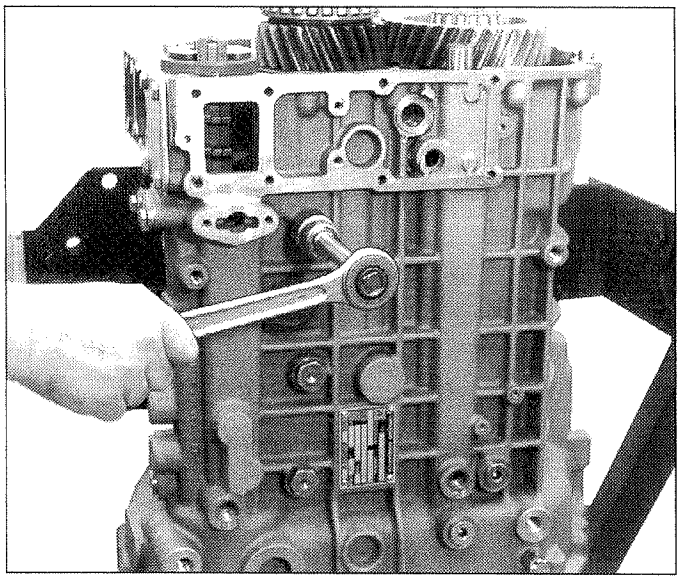
18 Align shift fork using hook **1X56 137 451** so that the guide bores in the shift fork are visible through the threaded bores in the transmission housing.



009367

19 Coat threads of pivot bolts with Loctite No. 241. Insert pivot bolts into threaded bores on both sides of transmission housing together with spring washers.
- M18x1.5 tightening torque = 160 Nm

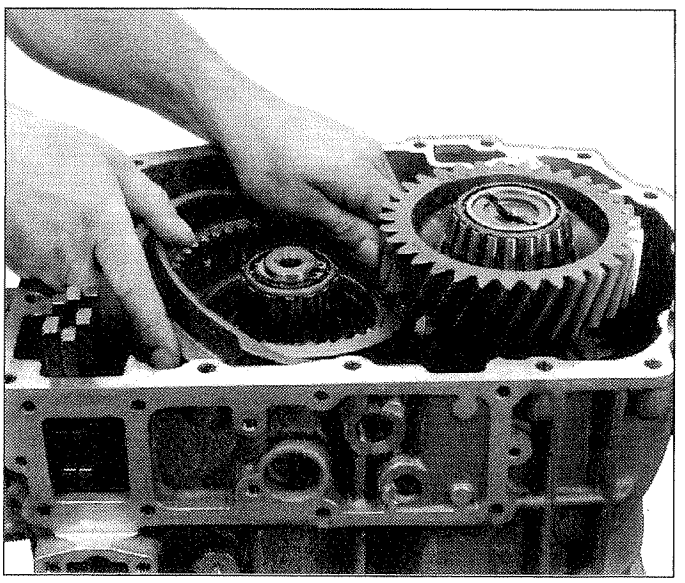
20 Insert fulcrum pads into low/high group shift fork.



009355

21 Place low/high group shift fork onto mainshaft together with sliding sleeve. The tab on the shift fork must face towards the opening in the housing for the shift mechanism.

NOTE
The stop tabs on the synchronizer ring must slide into the slots machined in the sliding ring. The sliding sleeve is symmetrical and can therefore be fitted either way up.



009356

22 Align shift fork so that the guide bores in the shift fork are visible through the threaded bores in the transmission housing.

23 Coat threads of pivot bolts with Loctite No. 241. Insert pivot bolts into threaded bores on both sides of transmission housing together with spring washers.
- tightening torque = 180 Nm

24 Push sliding sleeve fully down into firm contact.

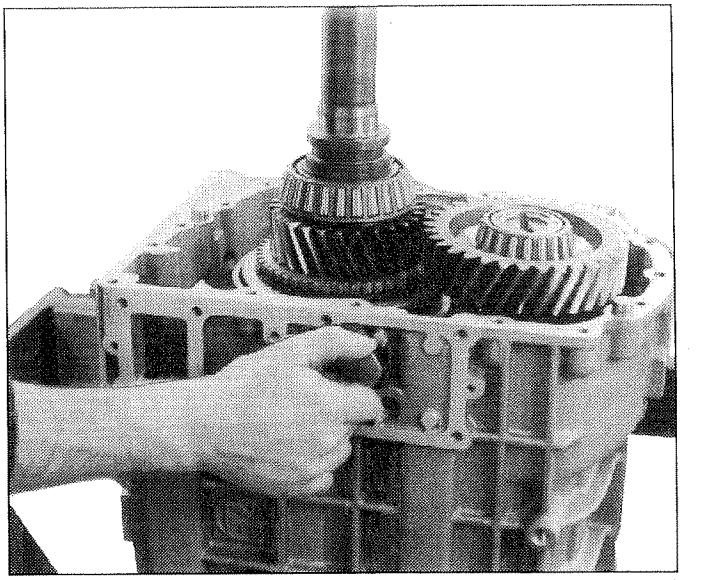
25 Insert shift rail into housing from underneath. Insert tab on low/high group shift fork into slot in shift rail.

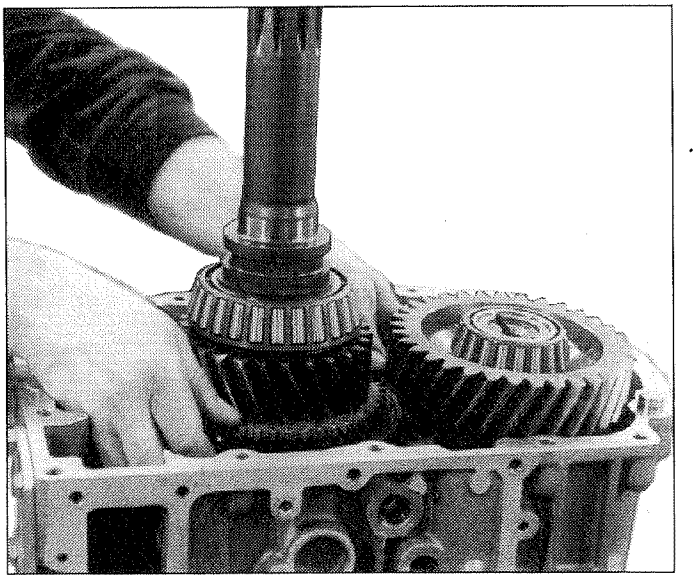
NOTE
See Section **11.2** for assembling input shaft.

26 Place complete input shaft onto mainshaft. Ensure that the points for the compression springs and pressure pieces in the synchronizer body on the input shaft are aligned correctly with the slots in the sliding sleeve.

27 Insert two **new** compression springs and pressure pieces into each of the three points in the synchronizer hub.

28 Insert each pressure piece and guide into sliding sleeve. Pull sliding sleeve into central (neutral) position. Press down on clutch body while doing this.


009368


009369

11 Input shaft

11.1 Dismantling input shaft

1 Remove circlip (**1**).

2 Place gripper **1X56 136 719** onto inner race of taper roller bearing on input shaft. Rotate knurled ring of gripper until gripper is firmly secure.

3 Attach extension **1X56 122 310** and adapter **1X56 122 317** to basic puller **1X56 122 304**.

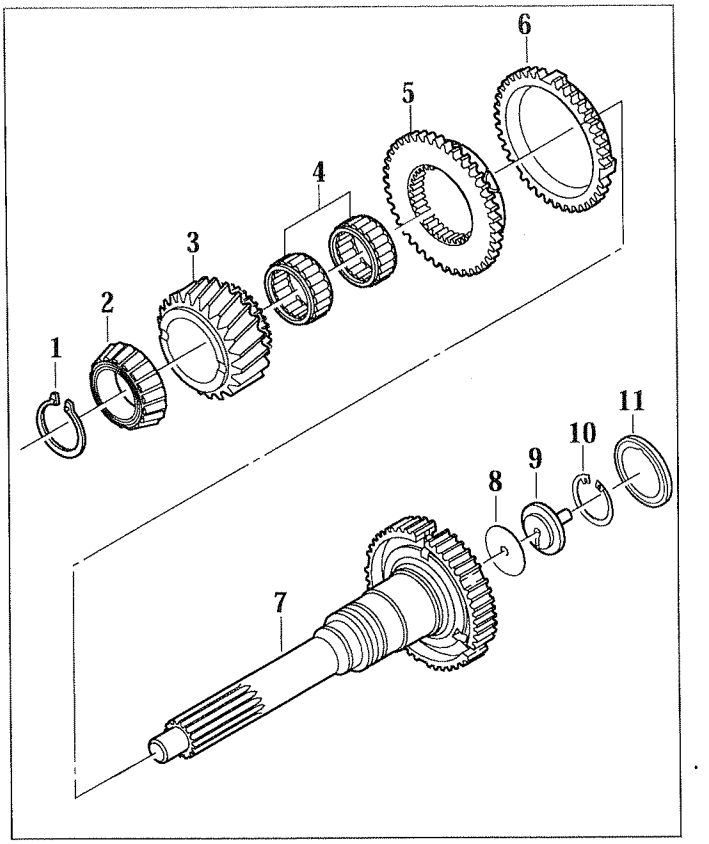
4 Attach extension **1X56 122 310** to gripper **1X56 136 719**.

5 Pull off inner race (**2**) of taper roller bearing from input shaft (**7**).

6 Remove helical gear (**3**) together with 2 needle cages (**4**).

7 Remove clutch body (**5**) and synchronizer ring (**6**).

8 Remove baffle plate (**11**) using suitable tool. Remove circlip (**10**), cover (**9**) and disc (**8**) from input shaft (**7**).



007990

11.2 Assembling input shaft

1 Place disc (**8**) and cover (**9**) into input shaft (**7**) and attach circlip (**10**) .

2 Press baffle plate (**11**) flush onto input shaft using tool **1X56 138 026**.

3 Place synchronizer ring (**6**) and clutch body (**5**) onto input shaft. Tabs on synchronizer ring must face downwards and engage into the slots in the synchronizer body section.

4 Lightly oil running areas for needle cages and helical gear.

5 Place needle cages (**4**) onto input shaft.

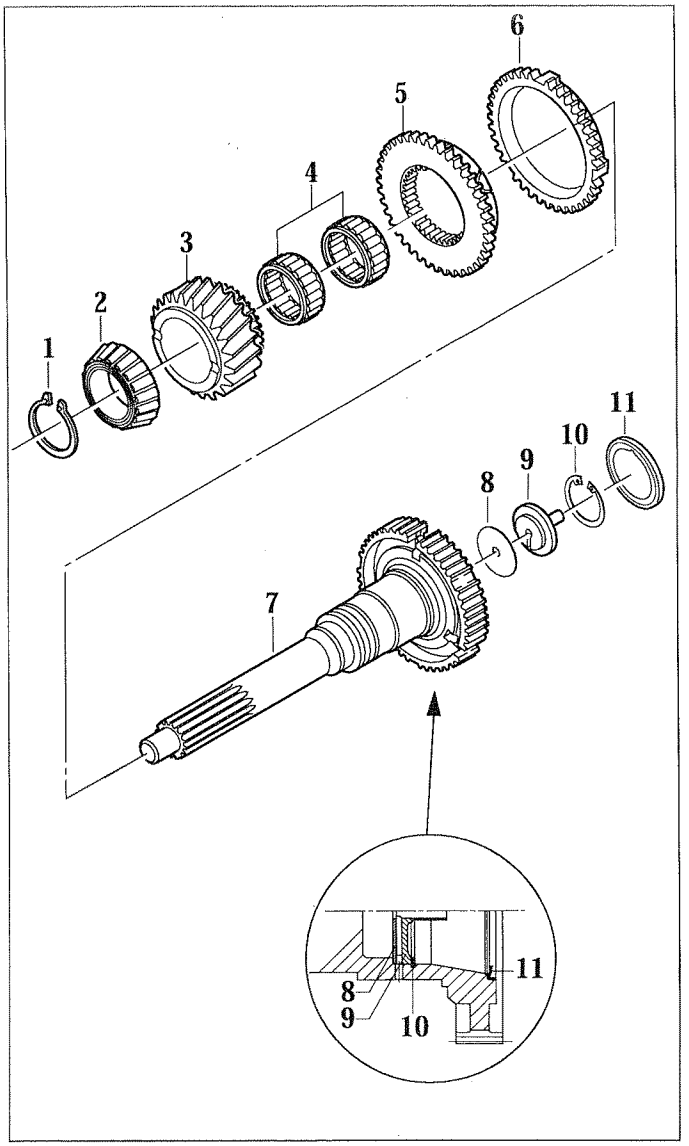
6 Slide helical gear (**3**) over needle cages. The dog teeth must face downwards and engage with the internal spline in the clutch body.

7 Heat inner race (**2**) of taper roller bearing to approx. 85°C and place flush onto input shaft.

⚠DANGER
Always wear protective gloves when handling heated parts.

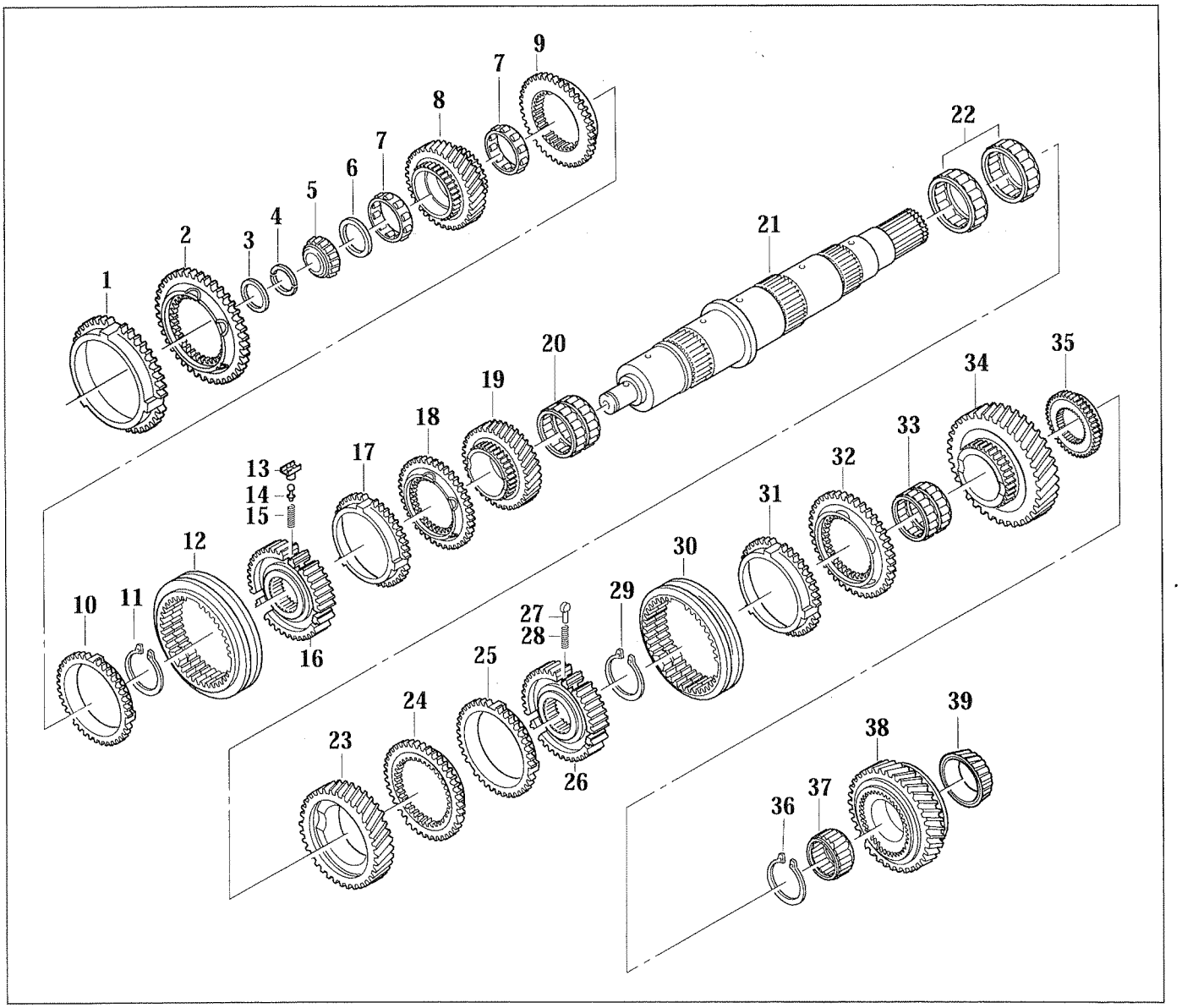
8 The circlip (**1**) must have axial play of between 0 and 0.5 mm. Select suitable circlip from spare parts catalogue and attach onto input shaft.

NOTE
Do not fit splitter synchronizer yet.



007991

12 Mainshaft



007989

12.1 Dismantling mainshaft

NOTE
Mainshaft removal is described in Section **10.1**.

1 Use chisel to break and remove circlip (**3**) on split ring.

⚠ DANGER
Always wear protective goggles when using chisel.

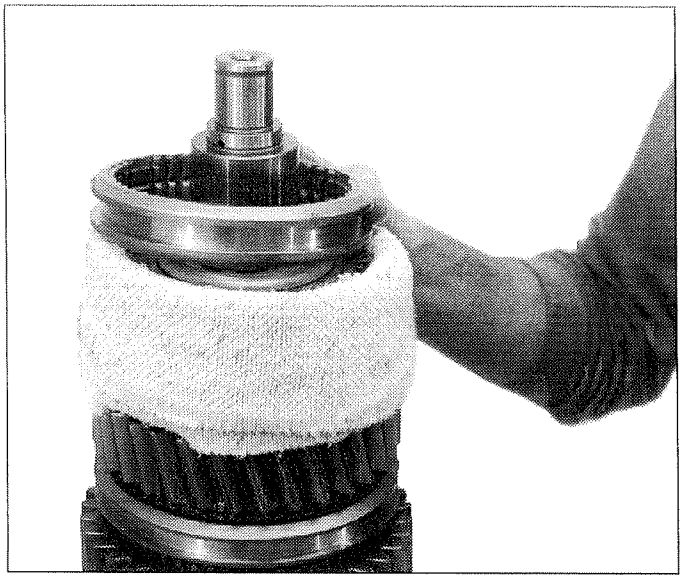
4 Remove split ring (**4**).

5 Place gripper **1X56 136 737** onto inner race of taper roller bearing. Rotate knurled ring on gripper until gripper is securely fixed. Attach basic puller **1X56 122 304** to gripper and pull off bearing inner race (**5**).

6 Remove thrust washer (**6**). If necessary, place puller **1X56 137 457** against clutch body (**9**) and pull off together with helical gear (**8**).

7 Remove helical gear (**8**) together with roller cages (**7**) and clutch body (**9**) together with synchronizer ring (**10**).

8 Pull off 3rd/4th gear sliding sleeve (**12**) .



009370

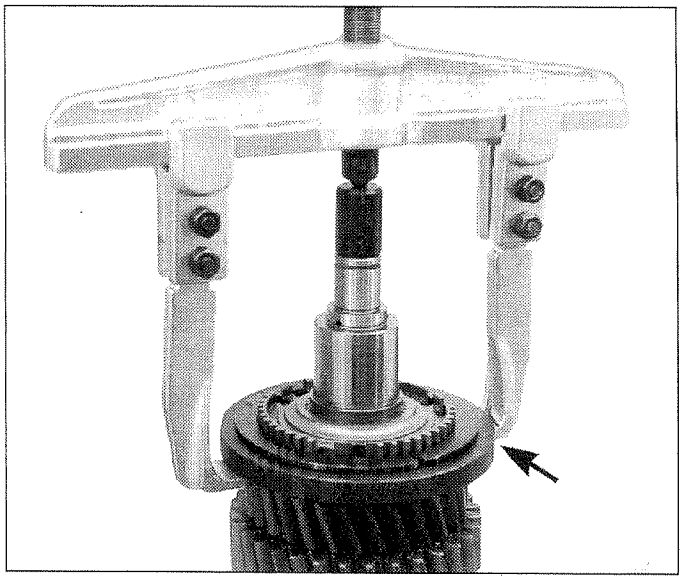
⚠ DANGER

When the sliding sleeve is pulled off, pressure pieces (13), ball pins (14) and compression springs (15) are released. These parts are under spring pressure. Secure them to prevent them flying out (e.g. using a cloth).

9 Remove circlip (**11**).

10 Attach puller **1X56 137 457** between synchronizer ring and 3rd gear clutch body (see arrow). Place adapter onto mainshaft. Attach standard two- or three-leg puller to puller ring and pull off synchronizer hub (**16**) together with synchronizer ring (**17**).

11 Remove 3rd-speed helical gear (**19**) from mainshaft (**21**) together with clutch body (**18**) and needle cage (**20**).



009371

12 Turn mainshaft over and clamp input end in vice.

CAUTION
Use aluminium jaws in vice to prevent mainshaft damage.

13 Place adapter onto mainshaft. Attach standard two-leg puller underneath reverse spur gear **(38)** and pull off together with inner race **(39)** of taper roller bearing.

14 Remove needle cage **(37)** and detach circlip **(36)**.

15 Pull off clutch body **(35)** together with 1st-speed helical gear **(34)**.

NOTE
Place adapter onto mainshaft.
Attach standard two- or three-leg puller underneath 1st-speed helical gear.

16 Remove needle cage **(33)**, clutch body **(32)** and synchronizer ring **(31)** .

17 Pull off 1st/2nd gear sliding sleeve **(30)**.

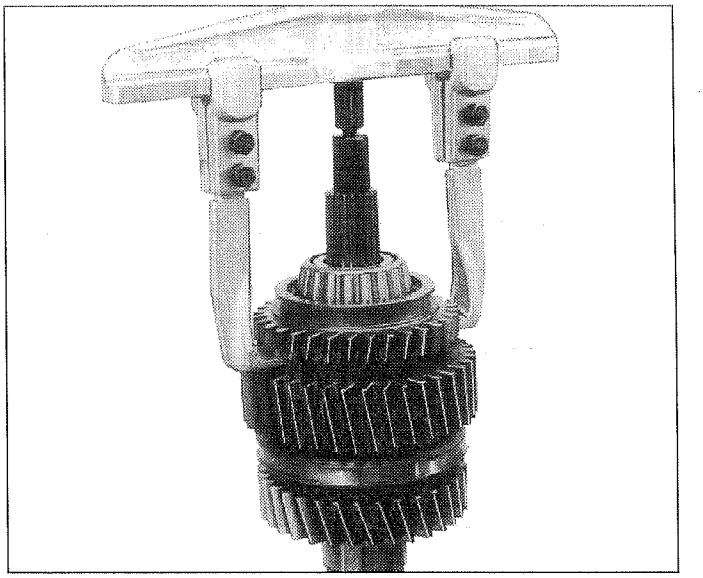
⚠ **DANGER**
When the sliding sleeve is pulled off, pressure pieces (27) and compression springs (28) are released. These parts are under spring pressure. Secure parts to prevent them flying out (e.g. using a cloth).

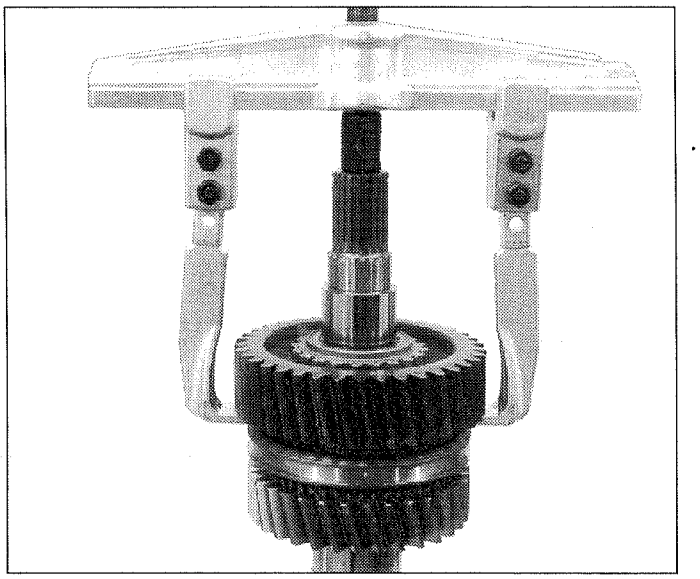
18 Detach circlip **(29)**.

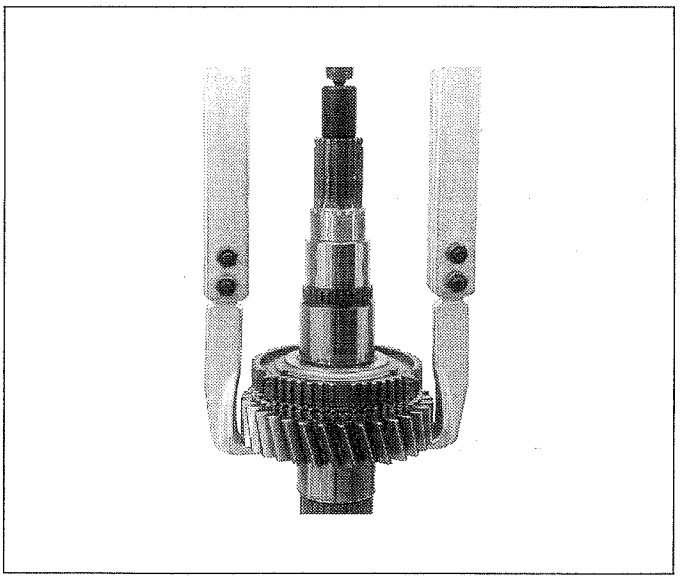
19 Pull off the synchronizer hub **(26)**, synchronizer ring **(25)** and clutch body **(24)** together with 2nd-speed helical gear **(23)**.

NOTE
Place adapter onto mainshaft. Attach standard two- or three-leg puller underneath 2nd-speed helical gear.

20 Remove needle cages **(22)** .


009372


009373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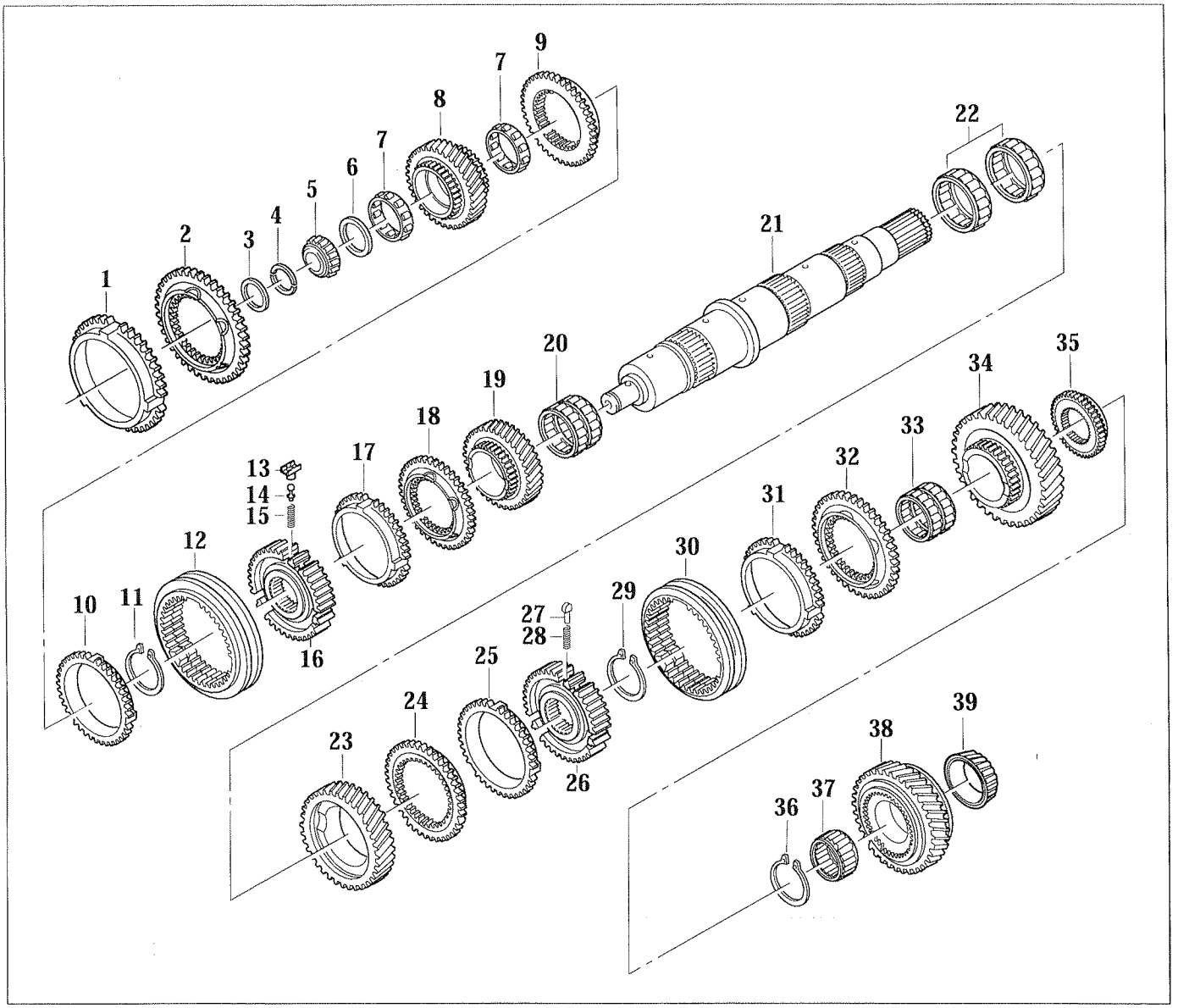


007989

12.2 Assembling mainshaft

1 Check mainshaft to ensure that lube oil bores are clear.

2 Clamp input end of mainshaft in vice.

CAUTION
Use aluminium jaws in vice to prevent mainshaft damage.

NOTE
Lightly oil running surfaces and contact faces for needle cages and helical gears.

3 Slide needle cages (**22**) onto mainshaft.

4 Fit 2nd-speed helical gear (**23**) over needle cage, turning it slightly while doing do. Dog teeth must face towards output end.

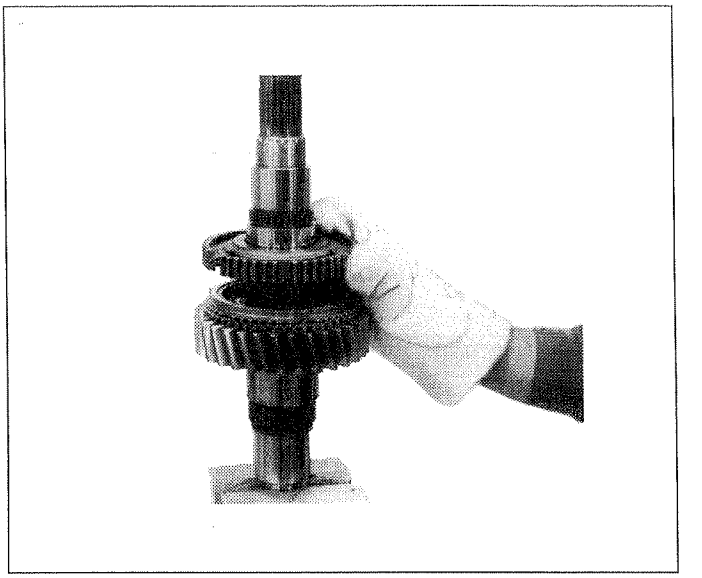
5 Place clutch body (**24**) onto dog teeth together with synchronizer ring (**25**). Light coat inside of synchronizer ring with oil.

CAUTION
Check the wear limit of all synchronizer rings and clutch bodies as described in Section 4.6. In all synchronizers, use parts as specified in 1297 754 001 "Inspecting ZF lock synchronizer components". Lightly coat running areas for all synchronizer rings with oil.

6 Heat synchronizer hub (**26**) to approx. 120°C and slide onto mainshaft spline. The synchronizer hub is symmetrical and can therefore be fitted either way up. Drive synchronizer hub down into firm contact.

NOTE
The lugs on the synchronizer ring must engage into the recesses in the synchronizer hub.

⚠ **DANGER**
Always wear protective gloves when handling heated synchronizer hubs.


009375

7 Check axial play of 2nd-speed helical gear. Axial play must be between 0.20 and 0.45mm

8 Attach circlip (**29**) .

NOTE
The circlip axial play must be between 0 and 0.1 mm. Select circlip from spare parts catalogue.

CAUTION
Ensure circlip is free of burrs since it provides the contact face for the needle cage.

9 Slip 1st/2nd gear sliding sleeve (**30**) over synchronizer hub, synchronizer ring and clutch body so that it abuts against the 2nd-speed helical gear. While doing this, ensure that the recesses inside the sliding sleeve align with the recesses in the synchronizer hub (for inserting compression springs and pressure pieces).

10 Insert 3 compression springs (**28**) and pressure pieces (**27**) into synchronizer hub bores using suitable tool and guide into sliding sleeve.

NOTE
Use **new** compression springs.

11 Fit synchronizer ring (**31**). The lugs on the synchronizer ring must engage into the recesses in the synchronizer hub.

12 Place clutch body (**32**) onto synchronizer ring (**31**) and pull sliding sleeve into middle (neutral) position. While doing this, press down onto synchronizer ring and synchronizer hub.

13 Slide needle cage (**33**) onto mainshaft.

14 Slide 1st-speed helical gear over needle cage and onto mainshaft, rotating it slightly while doing so. Dog teeth must face downwards and engage in clutch body.

15 Heat reverse gear clutch body (**35**) to approx. 120°C and place onto mainshaft. If necessary, drive down into firm contact. The collar must face towards the output end.

⚠ **DANGER**
Always wear protective gloves when handling heated clutch body.

16 Attach circlip (**36**) .

CAUTION
Ensure circlip is free of burrs, since it provides the contact face for the needle cage.

NOTE
The circlip axial play must be between 0 and 0.1mm. Select circlip from spare parts catalogue.

17 Check axial play of 1st-speed helical gear. Axial play must be between 0.20 and 0.45mm

18 Slide needle cage (**37**) onto mainshaft.

19 Slide reverse helical gear (**38**) over needle cage and onto mainshaft, turning it slightly while doing so. Dog teeth must face towards input end.

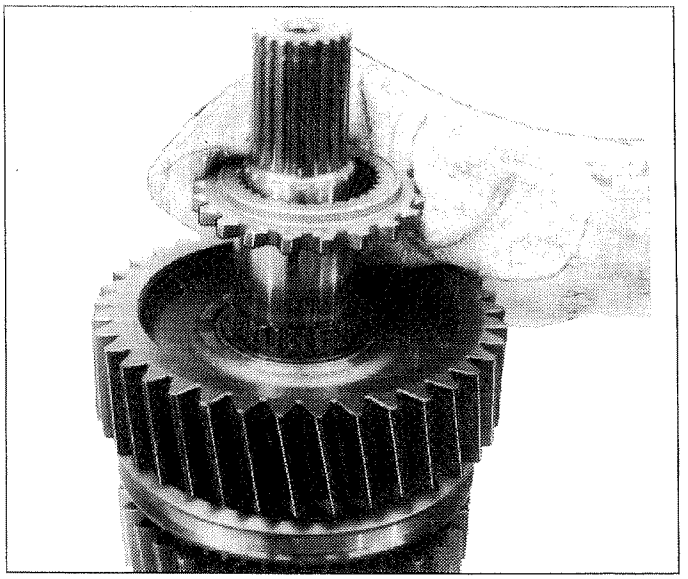
20 Heat inner race (**39**) of taper roller bearing to approx. 120°C and slide onto mainshaft. If necessary, drive down into firm contact.

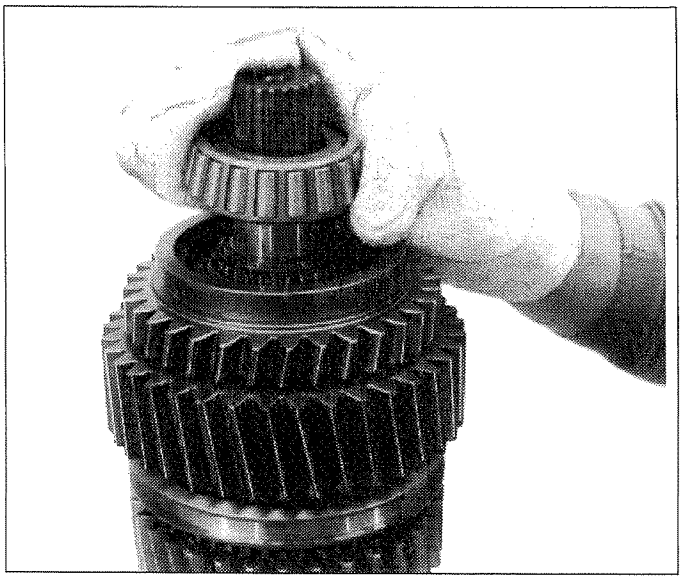
⚠ **DANGER**
Always wear protective gloves when handling heated inner race.

21 Clamp output end of mainshaft in vice and lightly oil running areas for needle cages and helical gears.

CAUTION
Use aluminium jaws in vice to prevent mainshaft damage.

22 Slide needle cage (**20**) onto mainshaft.


009376


009377

23 Slide 3rd-speed helical gear (**19**) over needle cage and onto mainshaft, turning it slightly while doing so. Dog teeth must face towards input end.

24 Place clutch body (**18**) onto dog teeth together with synchronizer ring (**17**) .

25 Heat 3rd/4th gear synchronizer hub (**16**) to approx. 120°C. The smaller hub diameter must face towards the input end.

⚠ **DANGER**
Always wear protective gloves when handling heated synchronizer hub.

26 Attach circlip (**11**) .

CAUTION
Ensure circlip is free of burrs since it provides the contact face for the needle cage.

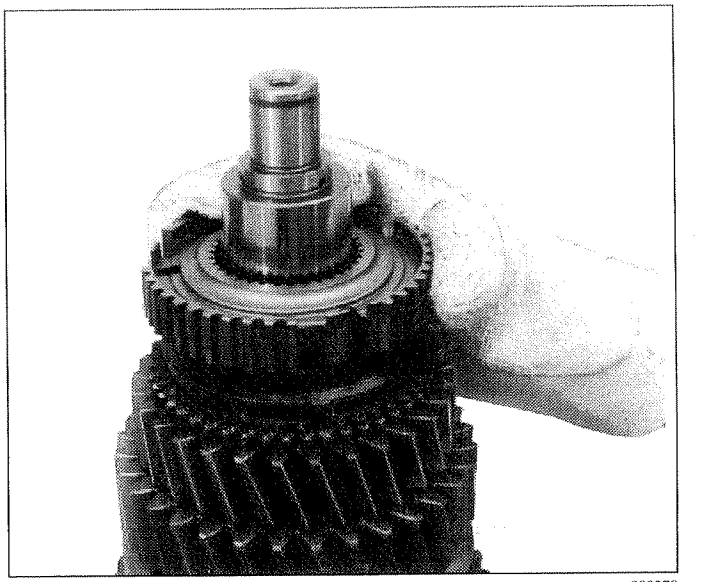
NOTE
The circlip axial play must be between 0 and 0.1mm. Select suitable circlip from spare parts catalogue.

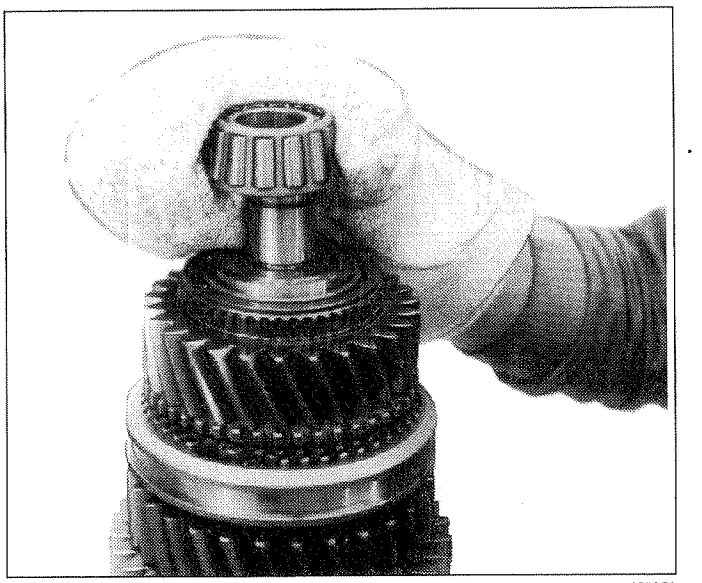
27 Check axial play of 3rd-speed helical gear. Axial play must be between 0.20 and 0.40mm

28 Slide 3rd/4th gear sliding sleeve (**12**) over synchronizer hub, synchronizer ring and clutch body, pushing it down into firm contact with 3rd-speed helical gear. While doing this, ensure that the recesses inside the sliding sleeve align with the recesses in the synchronizer hub (for compression springs, ball pins and pressure pieces).

29 Using suitable tool, insert three compression springs (**15**) into synchronizer hub bores, together with ball pins (**14**) and pressure pieces (**13**), and guide into sliding sleeve.

NOTE
Use **new** compression springs.


009378


009379

30 Place synchronizer ring (**10**) and clutch body (**9**) in position. The lugs on the synchronizer ring must face downwards and engage into the recesses in the synchronizer hub.

31 Pull sliding sleeve into middle (neutral) position, pressing down on the clutch body and synchronizer ring while doing so.

32 Slide first roller cage (**7**) onto mainshaft.

33 Insert second roller cage (**7**) into 4th-speed helical gear (**8**) and slide onto mainshaft together, turning slightly while doing so. The dog teeth must engage in the clutch body.

34 Heat thrust washer (**6**) to approx. 120°C, place onto mainshaft (with grooves facing towards output end) and push into firm contact.

35 Heat taper roller bearing inner race (**5**) to approx. 120°C and slide onto mainshaft. If necessary, drive down into firm contact.

⚠ **DANGER**
Always wear protective gloves when handling heated thrust washer and inner race.

NOTE
Do not reuse the taper roller bearing inner race which was pulled off when dismantling the mainshaft.

36 Apply approx. 2g grease (ZF# 0750 199 001) evenly between bearing inner race and bearing cage. Do not apply grease to the outside of the bearing rollers.

37 Measure the thickness of the split ring (**4**).

NOTE
The split ring must have 0.05 mm prestress or play.

Example:
3.75 mm measured using feeler gauge.
3.75 mm ± 0.05 mm = 3.70 or 3.80 mm.

38 Select split ring (**4**) from spare parts catalogue and install.

39 Place new circlip (**3**) onto split ring and peen over at 3 points (120° apart).

40 Place clutch body (**2**) and synchronizer hub (**1**) onto 4th-speed helical gear.

NOTE
See section **10.2** for installing mainshaft.

13 Layshaft

NOTE
See Section **10.1** for removing layshaft.

13.1 Dismantling layshaft

1 Place gripper **1X56 136 708** onto inner race (**1**) of taper roller bearing. Turn knurled ring of gripper until gripper is firmly secured.

2 Place suitable adapter onto layshaft.

3 Screw basic puller **1X56 122 304** onto gripper.

4 Pull off inner race of taper roller bearing from layshaft (**2**).

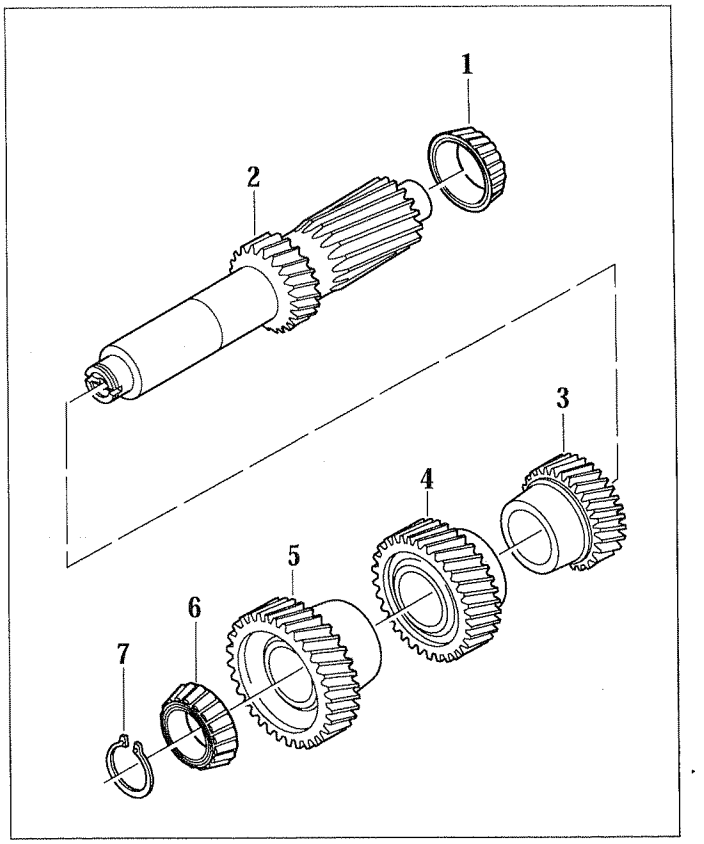
5 Detach circlip (**7**).

6 Place gripper **1X56 136 711** onto inner race (**6**) of taper roller bearing. Turn knurled ring of gripper until gripper is firmly secured.

7 Screw basic puller **1X56 122 304** onto gripper.

8 Pull off inner race (**6**) of taper roller bearing from layshaft.

9 Press off helical gears (**5, 4 and 3**) one by one using a suitable hydraulic press. Do not attempt to press off together since the pressure required would be too great.



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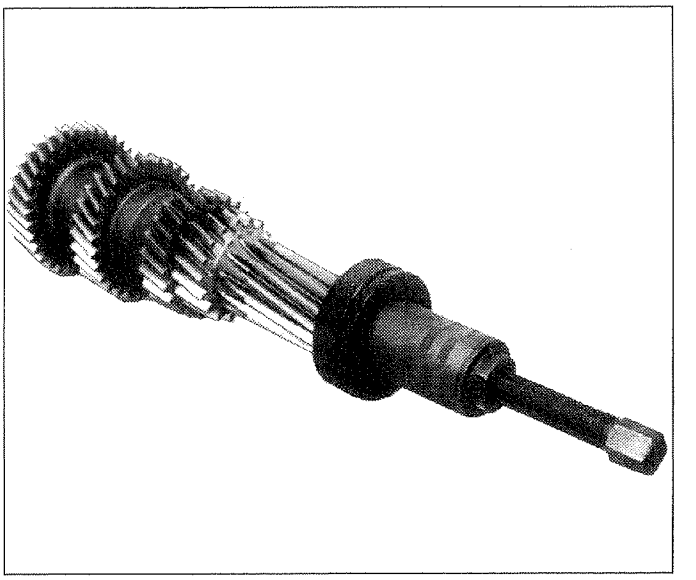
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13.2 Assembling layshaft

⚠ DANGER
Always wear protective gloves when handling heated helical gears and taper roller bearings.

1 Clean bores in helical gears and shrink-fit seats on layshaft.

2 Heat helical gears to between 150 and 170°C for max. 15 minutes.

3 Arrange heated helical gears (**5, 4 and 3**) on a hydraulic press and align precisely.

4 Press layshaft into bores in helical gears.

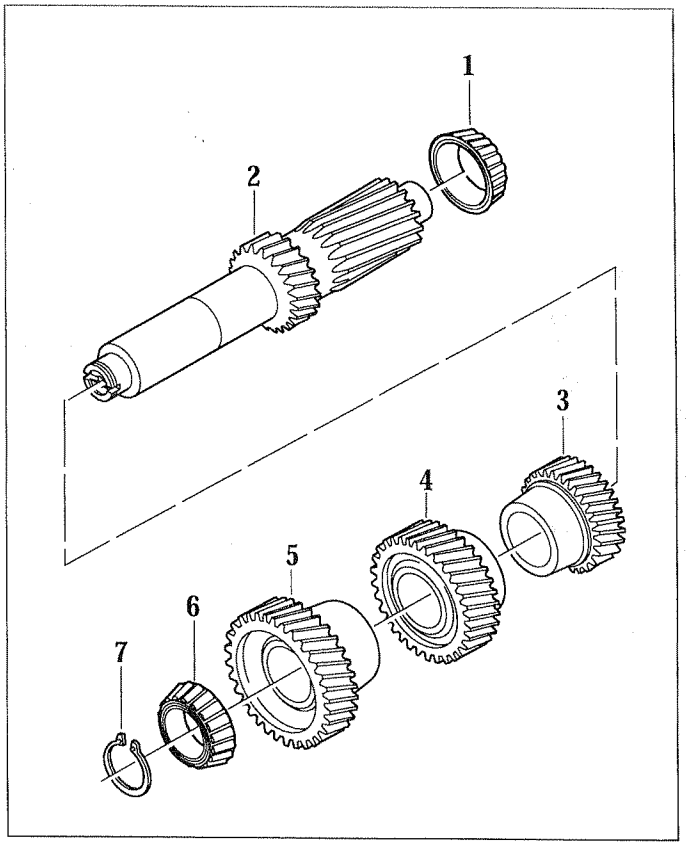
NOTE
Immediately press helical gears down into firm contact. Allow components to cool.

5 Heat inner races (**1 and 6**) of taper roller bearing to approx. 120°C and slide onto layshaft. Drive inner races into firm contact.

NOTE
The taper roller bearing inner races are often damaged when being pulled off. Therefore, check thoroughly and use new taper roller bearing inner race if necessary.

6 Attach circlip (**7**) into groove in layshaft.

NOTE
The circlip axial play must be between 0 and 0.1 mm. Select suitable circlip from spare parts catalogue.



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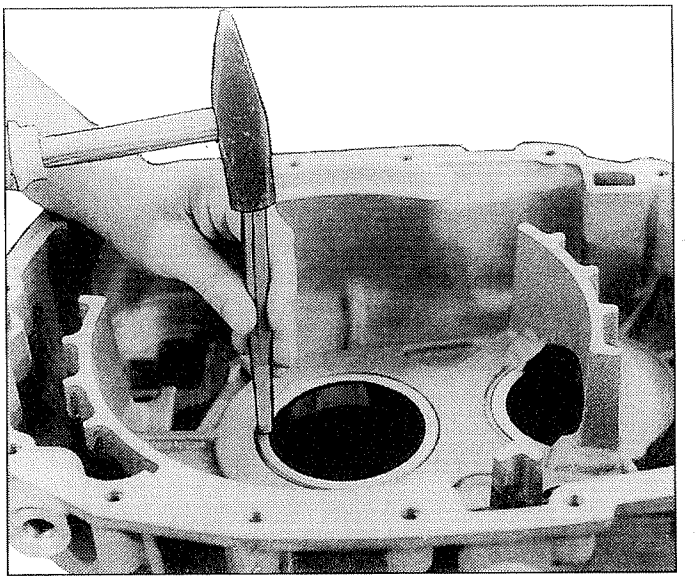
14 Housing

14.1 Dismantling housing

1 Drive out taper roller bearing outer races (mainshaft, input shaft and layshaft) from housing sections using drift.



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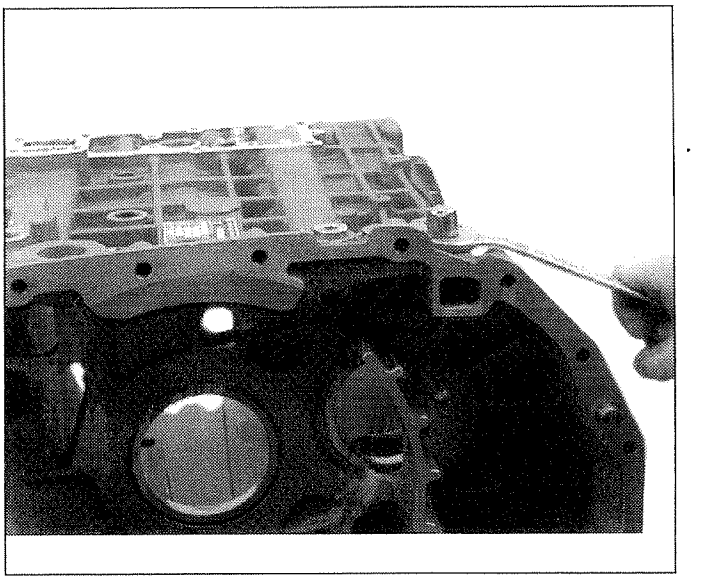
2 If necessary, remove screw plugs.

3 Remove breather.



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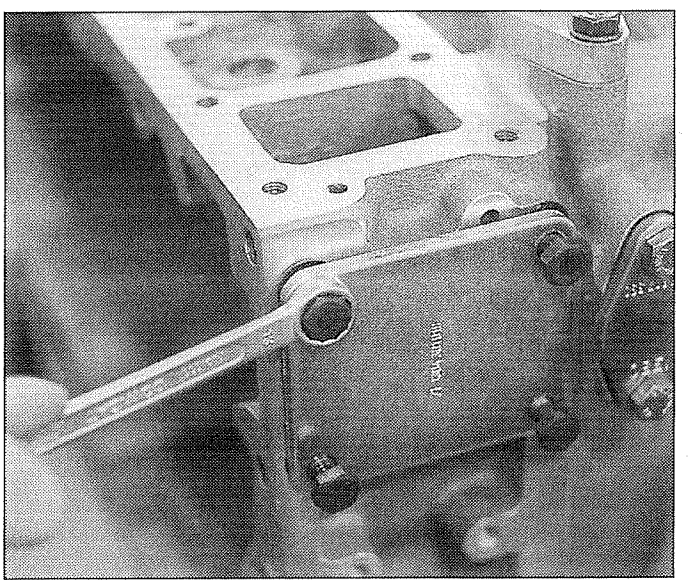
4 Remove hex bolts and take off both covers (1 and 2) together with gasket.



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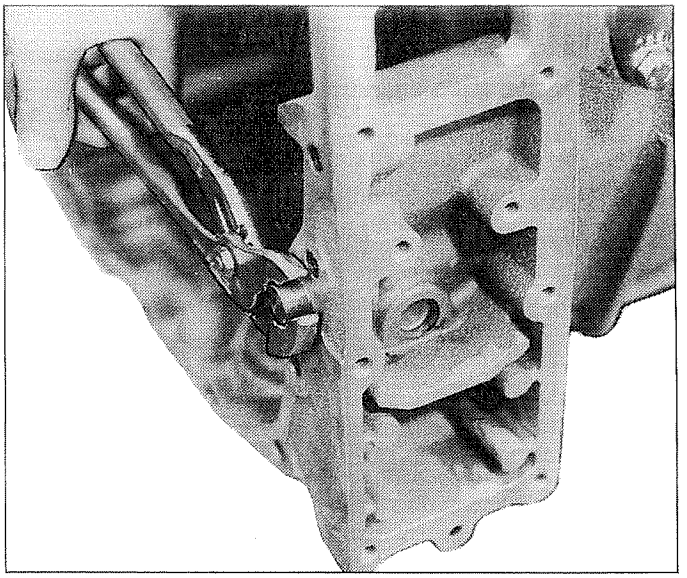
5 Remove roll pins (two) from housing.



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14.2 Assembling housing

1 If necessary, drive in roll pins.

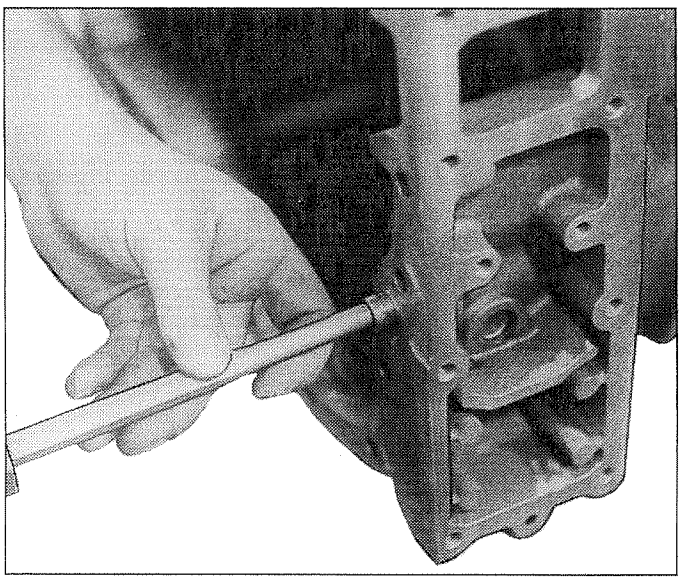
2 Fit both both covers together with **new** gaskets.

3 Insert hex bolts.
- M8 tightening torque = 23 Nm

4 Screw breather into housing.

5 Insert screw plugs together with new seal rings
- M18x1.5 tightening torque = 50 Nm

6 Insert screw plug together with new seal ring
- M38x1.5 tightening torque = 120 Nm



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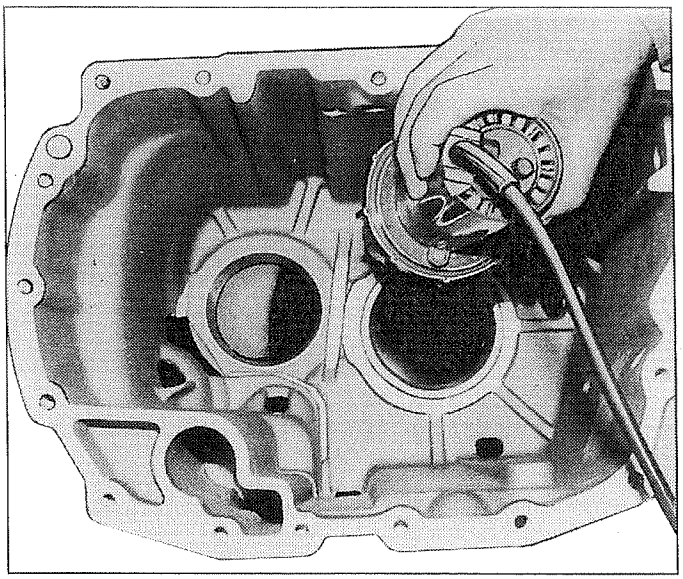
7 Insert screw plugs (conical).
- M24x1.5 tightening torque = 50 Nm

8 Insert outer races of taper roller bearings for mainshaft, input shaft and layshaft into housing sections. Heat housing in area around bearing bores to approx 80°C using hot air blower.

NOTE
Drive in outer races of taper roller bearings using a plastic drift or suitable tool until free of axial play.

NOTE
If a new housing is used, fully drive taper roller bearing outer race for PTO attachment into bearing bore in housing as described above.



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