

·ZEXEL·

Bosch Group

Pub. No. EE14E-11161

SERVICE MANUAL

REPAIR SERVICE
& MAINTENANCE

VRZ



WARNINGS

The following definitions and warning signs are used in this service manual. These are extremely important to safe operation. Important points are described to prevent bodily injury and property damage. They must be fully understood before beginning VRZ maintenance.



Improper maintenance can result in injury and property damage.

MEANINGS OF MARKS

The following marks are used in this service manual to facilitate correct VRZ maintenance.

Advice Procedures that must be performed to enable the best possible VRZ maintenance.

Note Information assisting in the best possible VRZ maintenance.

FOREWORD

This service manual describes the disassembly, inspection, reassembly and adjustment of the VRZ (radial plunger system position-control distributor type fuel injection pump).

Refer to the separate service manuals listed below to facilitate VRZ type injection pump maintenance.

This manual is intended for use by vehicle maintenance technicians or persons with an adequate knowledge of injection pumps.

The contents of the manual, including illustrations, drawings and specifications were the latest available at the time of printing.

The right is reserved to make changes in specifications and procedures at any time without notice.

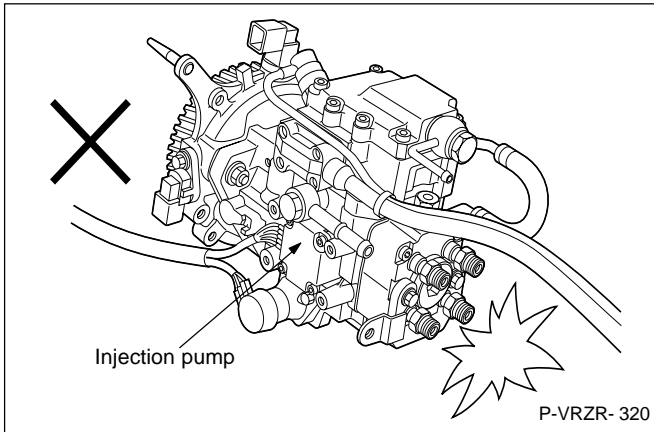
BOSCH K.K.

Sales Automotive Aftermarket Division

Service manual	Publication number
VRZ Construction and Operation	EE14E-11150
INJECTION PUMP TEST BENCH 10NP & 20 NP, Operation	EC18E-11081
CONTINUOUS MEASURING DEVICE ZCM & ZCD, Operation	EC18E-11091
CONTROLLER ASSEMBLY MC-02 FOR VRZ & COVEC-F, Operation	EC14E-11021
MC-02 TESTER SOFTWARE, ADJUSTMENT AND INSPECTION DATA, Installation	ED14E-11010
ECU ASSEMBLY, ADJUSTMENT AND INSPECTION DATA, Installation	ED14E-11020

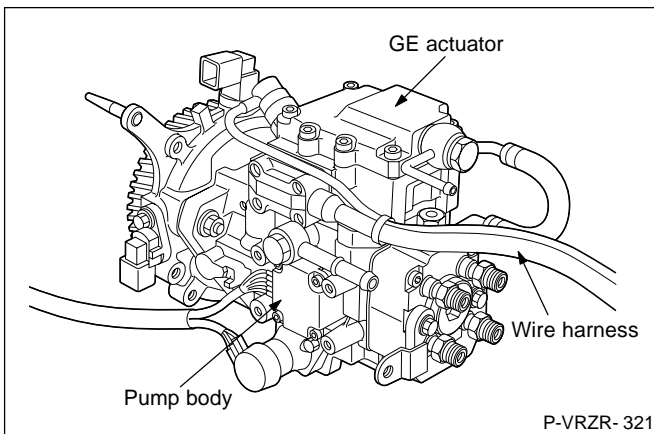
CONTENTS

	Page		Page
[1] SERVICE PRECAUTIONS	1	[8] INSPECTION	102
[2] SPECIAL TOOLS	2	[9] TIGHTENING TORQUES	111
1. DISASSEMBLY, INSPECTION AND REASSEMBLY TOOLS	2	[10] PART NUMBER EXPLANATION	112
2. ADJUSTMENT TOOLS	9	1. INJECTION PUMP ASSEMBLY NUMBER	112
[3] DISASSEMBLY	15	2. BOSCH TYPE NUMBER	112
1. PREPARATION	15		
2. EXPLODED VIEW	15		
3. ENGINE DRIVE GEAR REMOVAL	16		
4. DISASSEMBLY	19		
[4] COMPONENT INSPECTION	29		
1. PREPARATION	29		
2. INSPECTION	30		
[5] GEAR REASSEMBLY	38		
[6] REASSEMBLY	42		
1. REASSEMBLY	42		
2. PRE-STROKE ADJUSTMENT	52		
[7] ADJUSTMENT	68		
1. ADJUSTMENT CONDITIONS	68		
2. CONTROLLER UNIT CONTROLS	72		
3. PUMP ADJUSTMENT TOOL FLOW CHART	75		
4. PUMP ADJUSTMENT TOOL MONITOR SCREEN	76		
5. PUMP ADJUSTMENT TOOL MONITOR SCREEN OUTLINE	77		
6. MANUAL OPERATION DISPLAY	78		
7. WORKSHOP DISPLAY	79		
8. ADJUSTMENT	80		
9. MANUAL OPERATION (SECOND TIMING ADJUSTMENT)	99		



[1] Carrying the injection pump

- Never knock or drop the injection pump when carrying it.

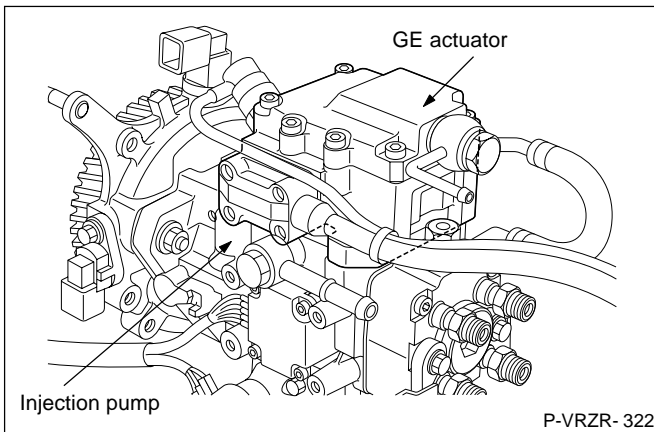


- When carrying the injection pump, hold the pump by the bottom of the pump body.

⚠ CAUTION

Never hold the pump by the GE actuator or the harnesses.

Holding the pump by these components may result in damage or injury.



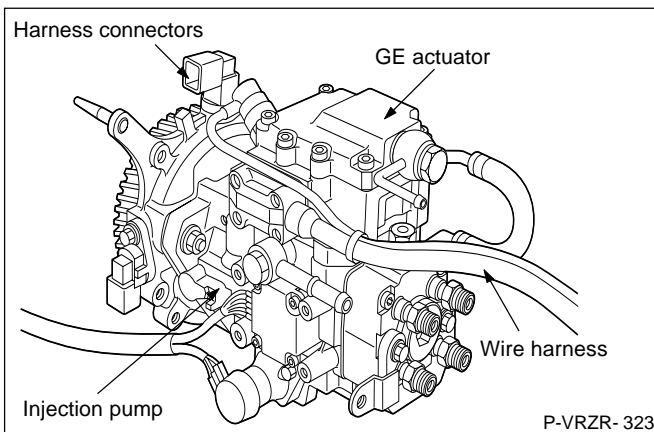
[2] Disassembly and reassembly

- Only the mechanical components of the injection pump body can be disassembled and reassembled.

Advice

Do not disassemble the GE actuator other than directed in this manual.

- The GE actuator consists of electrical components. Do not damage them.

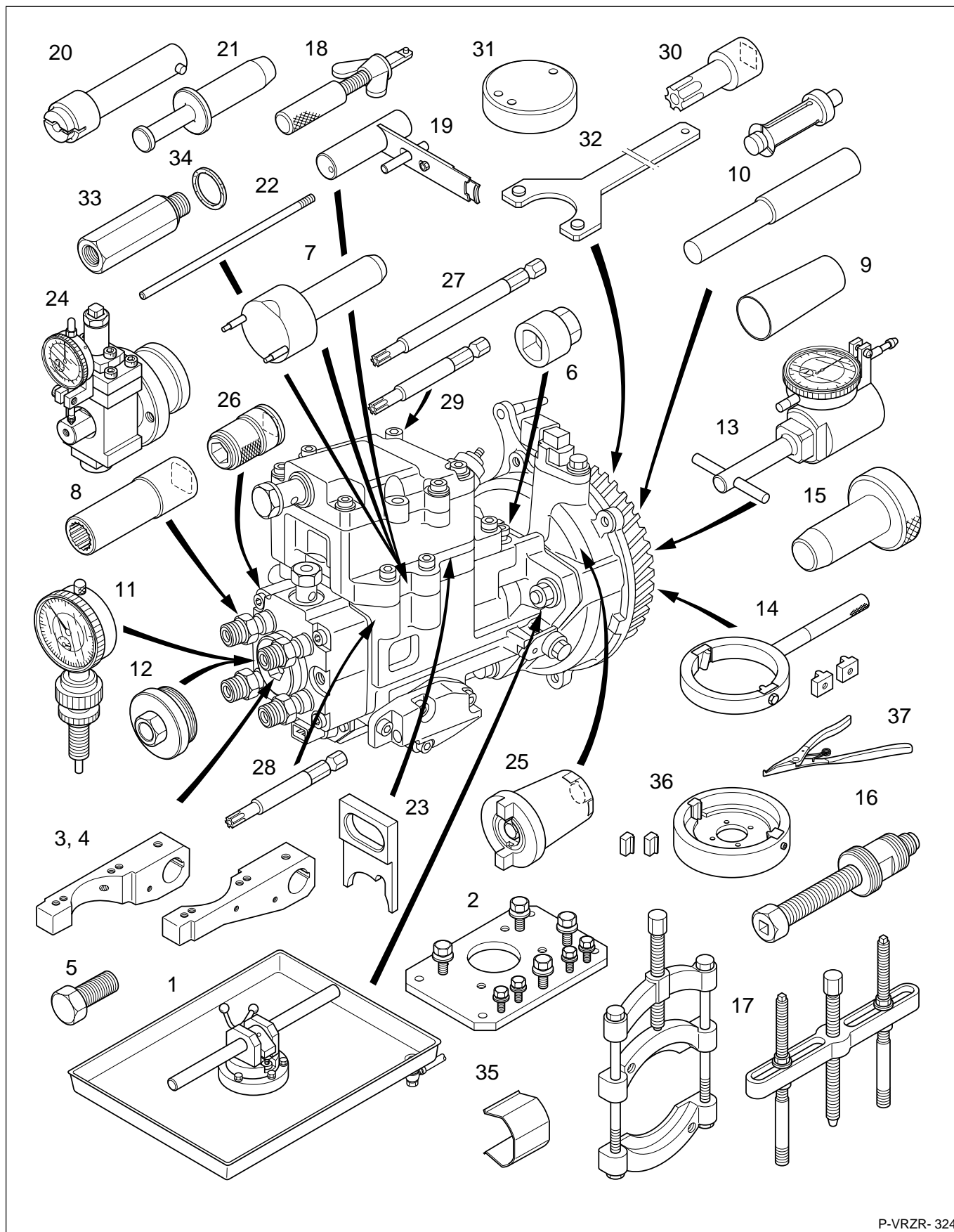


- When cleaning the injection pump, do not clean the GE actuator, the harnesses, or the harness connectors using fuel oil. Use only clean waste cloth.

2 SPECIAL TOOLS

1. DISASSEMBLY, INSPECTION AND REASSEMBLY TOOLS

[1] Tool use locations



P-VRZR- 324

[2] Disassembly, inspection and reassembly tool table

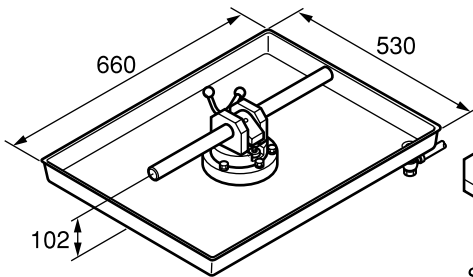
The following special tools (in addition to general tools such as spanners, hammer, etc) are required for VRZ type injection pump disassembly and reassembly.

Key no	RBAJ part no	Bosch part no	Part name	Qty	Remarks
1	157944-8521	9 681 610 317	Universal vise	1	Bracket (used together with key nos 2, 3, 4 and 5)
2	157945-2020	9 681 610 812	Bracket	1	For fixing VRZ pump
3	157944-7100	9 681 610 340	Bracket	1	For fixing bracket (key no 2)
4	157944-7200	9 681 610 797	Bracket	1	For fixing bracket (key no 2)
5	010010-2220	9 442 612 366	Bolt	2	For fixing brackets (key nos 3 and 4)
6	157913-7000	0 986 612 682	Socket wrench	1	For removing and installing regulating valve
7	157928-4320	9 442 612 367	Feed pump holder	1	For removing and installing feed pump assembly
8	157914-3600	9 681 610 678	Socket wrench	1	For removing and installing CPV holder
9	157928-4000	9 442 612 368	Oil seal guide	1	For protecting oil seal (shaft dia: $\phi 25$)
10	157928-4120	9 442 612 299	Extractor	1	For removing oil seal (shaft dia: $\phi 25$)
11	157829-3520	9 681 610 171	Measuring device	1	For measuring rotor's axial play (tool for measuring VE cam lift)
12	157845-8900	9 681 610 626	Adapter	1	Used together with key no 11
13	105782-4530	9 680 610 094	Measuring device	1	For measuring drive shaft play (shaft dia: $\phi 25$)
14	157917-4620	9 681 610 710	Wrench	1	For preventing gear rotation on 4 cylinder pumps
15	157848-2300	9 681 611 027	Oil seal guide	1	For installing pump housing oil seal
16	157926-2421	9 681 610 773	Extractor	1	For removing drive gear and coupling
17	157927-4500	9 443 613 008	Puller	1	For removing drive gear
18	157928-5820	9 443 613 397	Hook	1	For removing drive shaft snapping
19	157928-3120	9 442 612 297	Clip	1	For installing drive shaft snapping
20	157928-3620	9 442 612 298	Holder	1	For removing and installing bearing
21	157928-4200	9 442 612 369	Guide	1	For centering feed pump cover
22	157928-4500	9 442 612 300	Set screw	1	For centering feed pump's threaded holes
23	157928-4700	9 442 612 301	Spacer	1	For positioning ball bearing
24	105782-4540	9 680 610 095	Measuring device	1	For measuring pre-stroke
25	157847-0820	9 442 612 370	Coupling	1	For driving pump (shaft dia: $\phi 25$)
26	157915-9820	9 681 610 687	Holder	1	For SW6.35 bit
27	157915-9201	9 681 610 684	Bit	1	For removing and installing feed pump (T15; used together with key no 26)
28	157915-9301	9 681 610 685	Bit	1	For removing and installing pre-stroke adjustment plate (T20; used together with key no 26)
29	157915-9600	9 681 611 015	Bit	1	For removing and installing outer screws (T30; used together with key no 26)

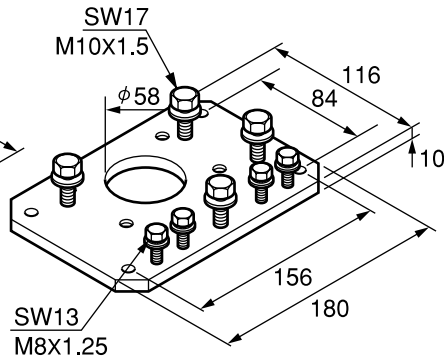
2 SPECIAL TOOLS

Key no	RBAJ part no	Bosch part no	Part name	Qty	Remarks
30	157915-9700	9 681 610 686	Socket	1	For removing and installing pump support bracket (T50)
31	157928-4800	9 442 612 302	Plate	1	For temporarily holding feed pump
32	157917-4920	9 681 610 711	Wrench	1	For turning auxiliary gear
33	157977-8000	9 681 610 829	Adapter	1	For inlet piping
34	026512-1640	9 421 617 041	Gasket	3	For inlet piping
35	157971-0500	9 443 613 408	Clip	1	For fixing plunger
36	157924-8520	9 681 611 028	Base	1	Stand for installing drive gear
37	157928-4400	9 442 612 371	Pliers	1	For removing and installing drive gear snapping

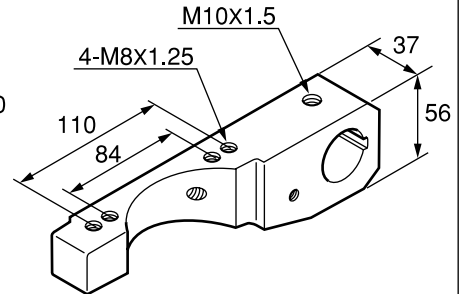
1. 157944-8521
(9 681 610 317)
Universal vise



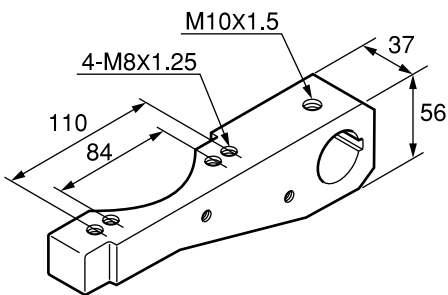
2. 157945-2020
(9 681 610 812)
Bracket



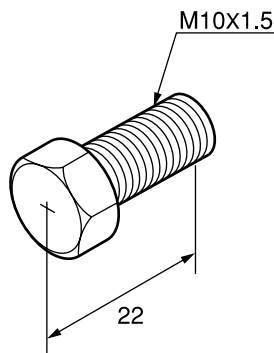
3. 157944-7100
(9 681 610 340)
Bracket



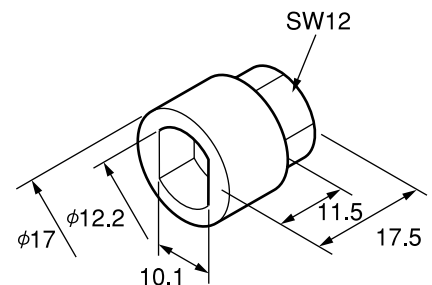
4. 157944-7200
(9 681 610 797)
Bracket



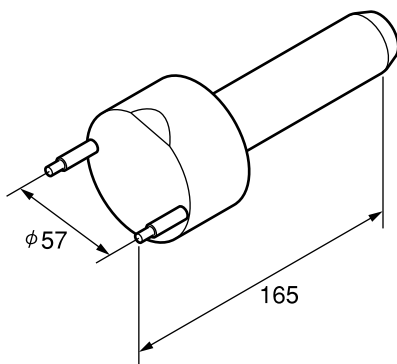
5. 010010-2220
(9 442 612 366)
Bolt



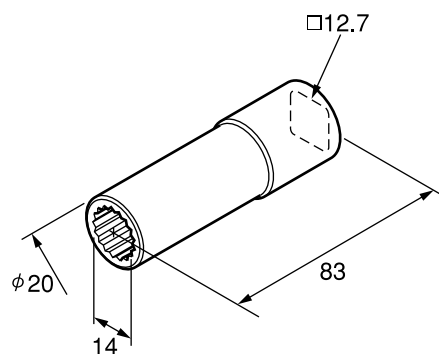
6. 157913-7000
(0 986 612 682)
Socket wrench



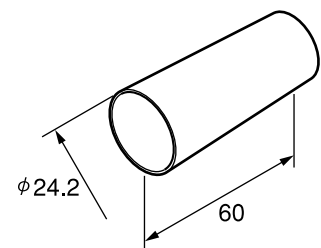
7. 157928-4320
(9 442 612 367)
Feed pump holder



8. 157914-3600
(9 681 610 678)
Socket wrench

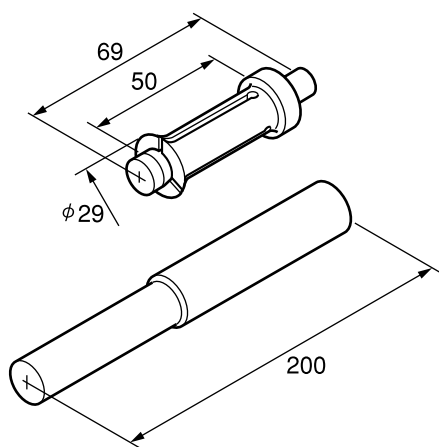


9. 157928-4000
(9 442 612 368)
Oil seal guide

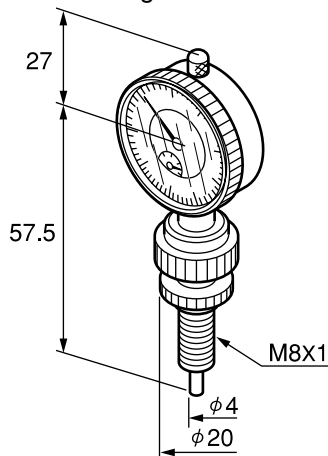


2 SPECIAL TOOLS

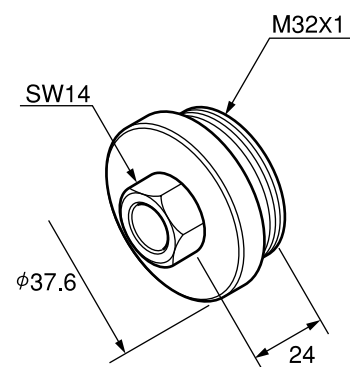
10. 157928-4120
(9 442 612 299)
Extractor



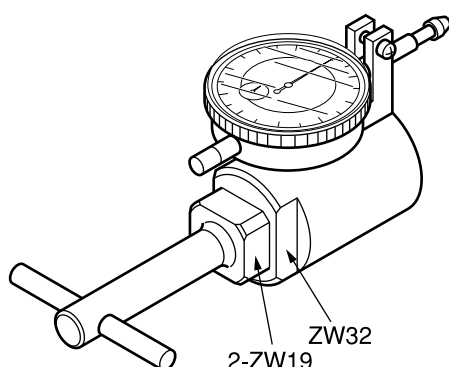
11. 157829-3520
(9 681 610 171)
Measuring device



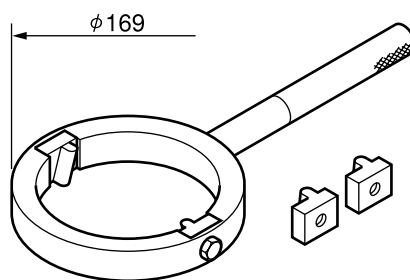
12. 157845-8900
(9 681 610 626)
Adapter



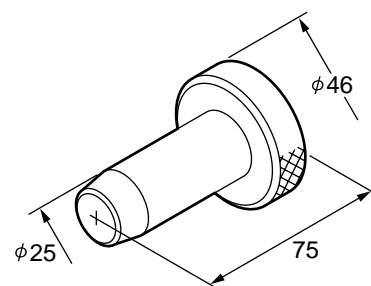
13. 105782-4530
(9 680 610 094)
Measuring device



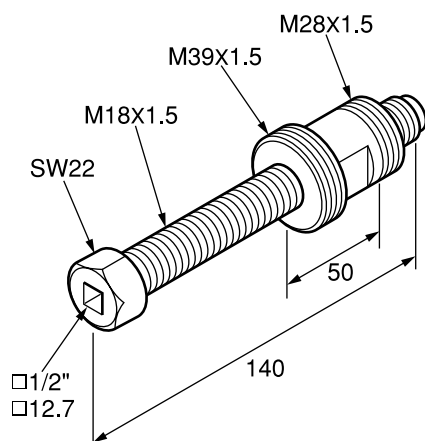
14. 157917-4620
(9 681 610 710)
Wrench



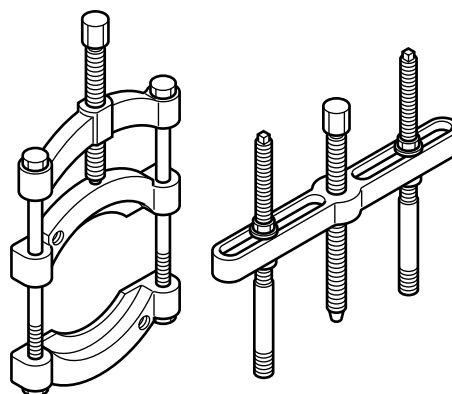
15. 157848-2300
(9 681 611 027)
Oil seal guide



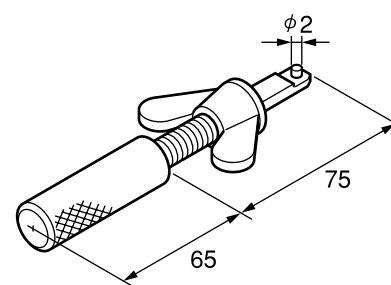
16. 157926-2421
(9 681 610 773)
Extractor



17. 157927-4500
(9 443 613 008)
Puller

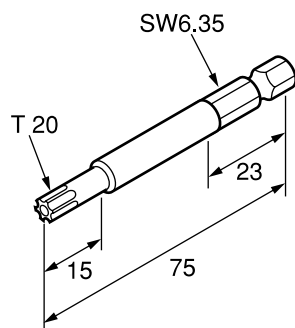


18. 157928-5820
(9 443 613 397)
Hook

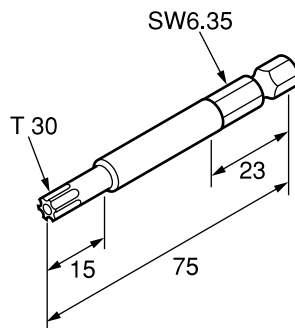


2 SPECIAL TOOLS

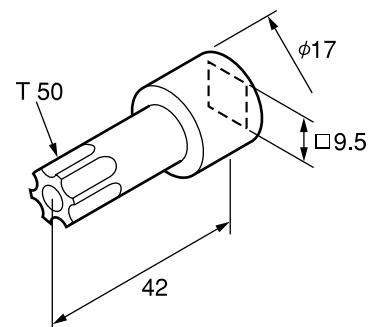
28. 157915-9301
(9 681 610 685)
Bit



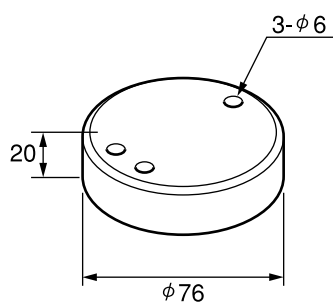
29. 157915-9600
(9 681 611 015)
Bit



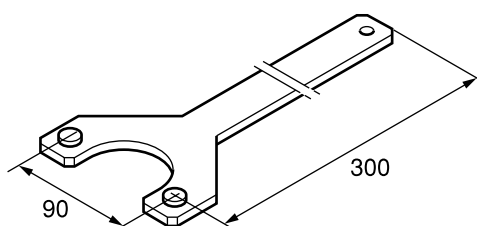
30. 157915-9700
(9 681 610 686)
Socket



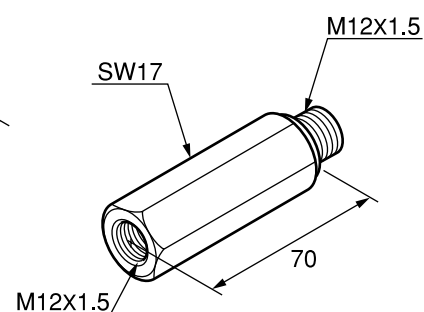
31. 157928-4800
(9 442 612 302)
Plate



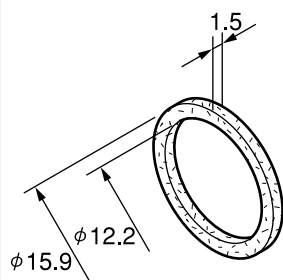
32. 157917-4920
(9 681 610 711)
Wrench



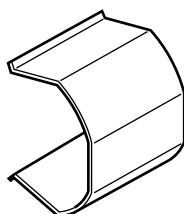
33. 157977-8000
(9 681 610 829)
Adapter



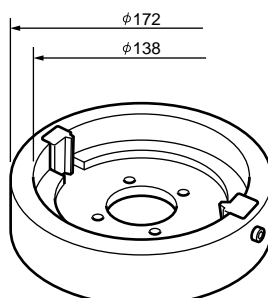
34. 026512-1640
(9 421 617 041)
Gasket



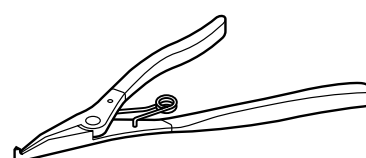
35. 157971-0500
(9 443 613 408)
Clip



36. 157924-8520
(9 681 611 028)
Base

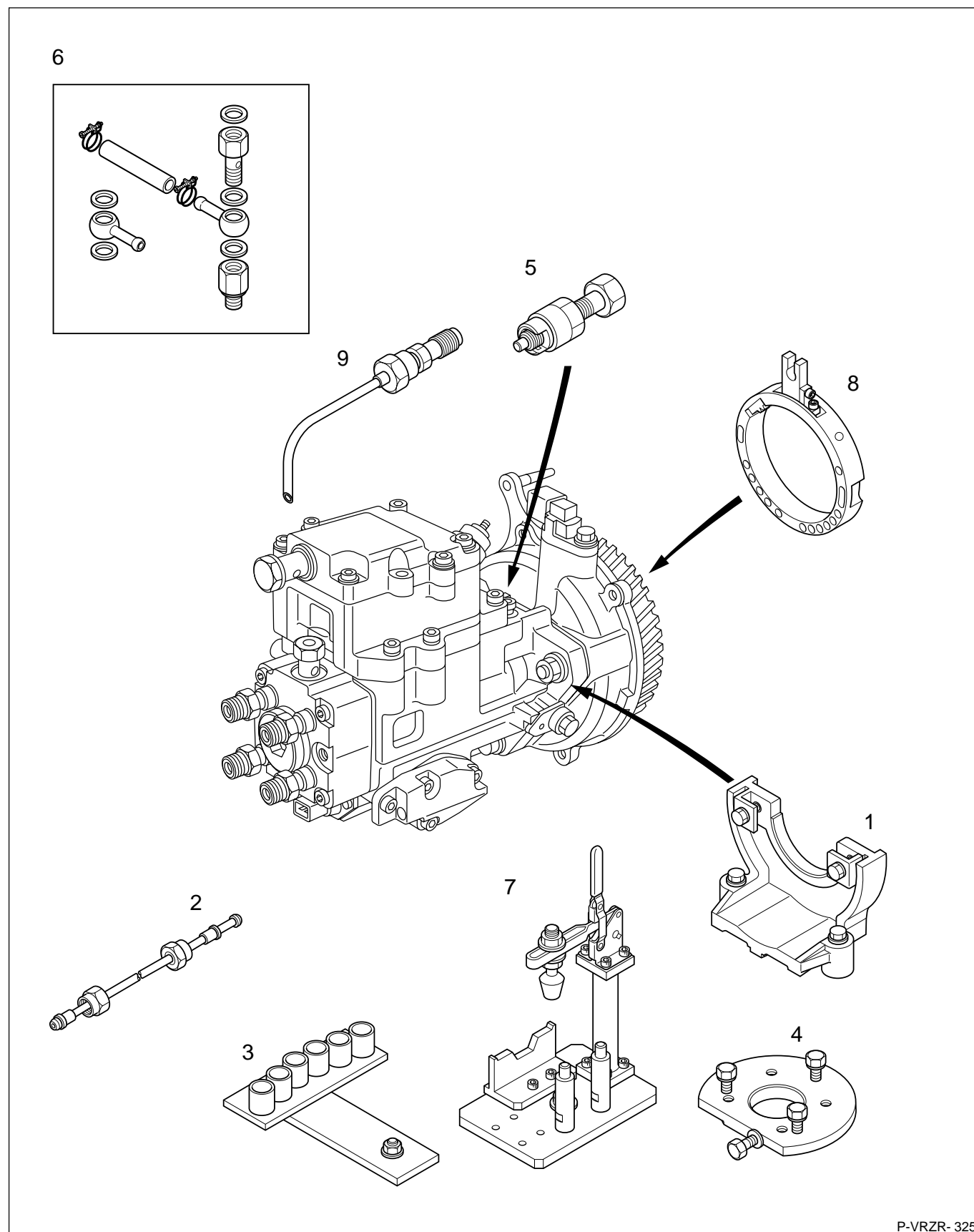


37. 157928-4400
(9 442 612 371)
Pliers



2. ADJUSTMENT TOOLS

[1] Tool use locations



P-VRZR- 325

2 SPECIAL TOOLS

[2] Adjustment tool table

(1) Bosch Automotive System specifications

Key no	RBAJ part no	Bosch part no	Part name	Qty	Remarks
1	105796-0000	1 688 010 129	Fixing stand	1	For driving pump; center height: 125mm
2	157808-4720	9 442 612 278	Injection pipe	4	Inner dia ϕ 1.6 x outer dia ϕ 6 - length 450mm
3	157641-6820	9 443 612 974	Joint assembly	1	The VP44 adjustment tool Bosch part no 0 986 611 876 (key no. 4 in the table below) can also be used instead of this tool.
4	157811-9020	9 681 610 453	Flange	1	For fixing pump
5	157829-0820	9 681 610 336	Adjusting device	1	For adjusting regulating valve pressure
6	157971-1020	9 443 613 442	Piping assembly	1	Test oil overflow piping
7	105781-0890	9 680 610 087	Stand	1	For fixing pump at injection timing adjustment
8	105793-0020	9 681 610 418	Adjusting device	1	For injection timing adjustment
9	157845-9520	9 681 610 630	Pipe assembly	1	For pre-stroke and injection timing adjustment

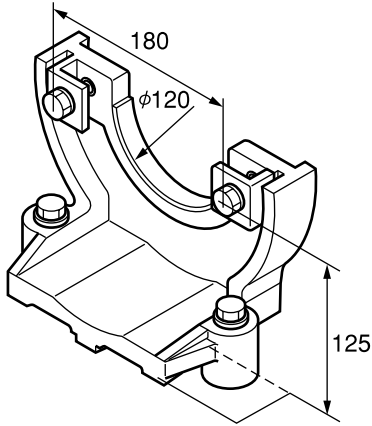
(2) Bosch specifications

Key no	Bosch part no	Part name	Qty	Remarks
1	1 687 010 126	VE pump overflow accessory set	1	Three-way valve
2	1 688 901 035	Nozzle, nozzle holder assembly	4	Bosch type X... for VP44 test device, orifice ϕ 0.5 mm
3	1 687 010 130	Cooling unit	1	Includes injection tubing from nozzle assembly to cooling unit and from cooling unit to flow meter
4	0 986 611 876	Joint assembly	1	With tubes. Used together with adapter below. The joint assembly RBAJ part no. 157641-6820 (key no. 3 in the table above) can also be used instead of this tool.
5	0 986 612 269	Adapter	4	Used together with above joint assembly.

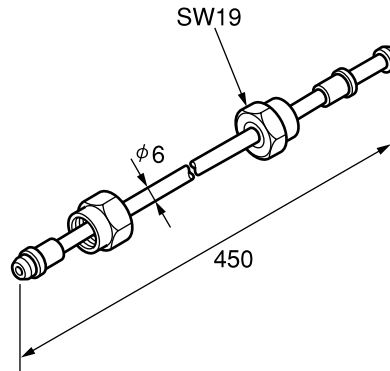
Note:

Center height is the height from the center of the pump test bench's flywheel to the drive stand.

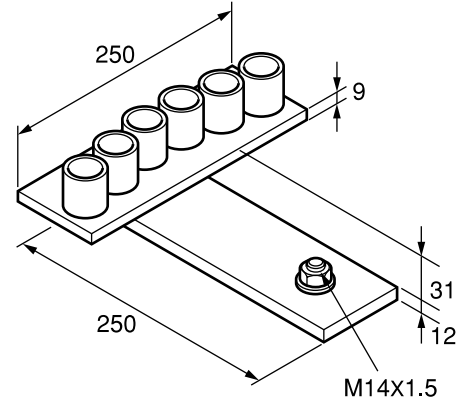
1. 105796-0000
(1 688 010 129)
Fixing stand



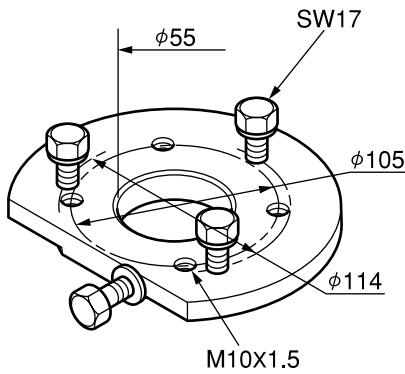
2. 157808-4720
(9 442 612 278)
Injection pipe



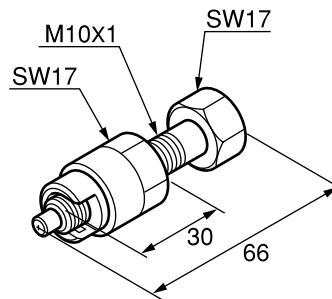
3. 157641-6820
(9 443 612 974)
Joint assembly



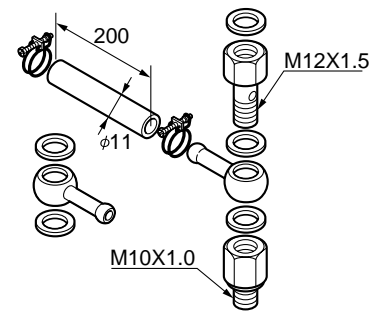
4. 157811-9020
(9 681 610 453)
Flange



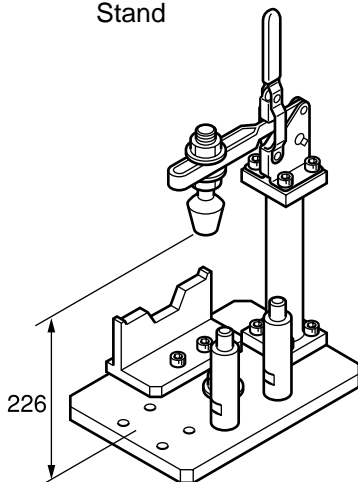
5. 157829-0820
(9 681 610 336)
Adjusting device



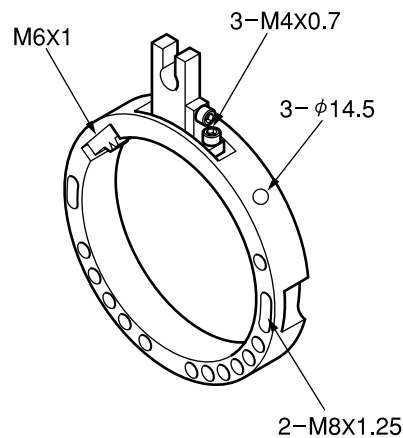
6. 157971-1020
(9 443 613 442)
Piping assembly



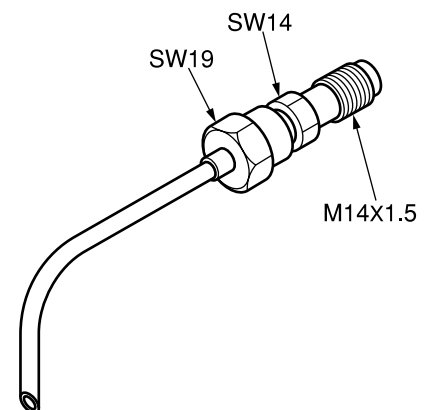
7. 105781-0890
(9 680 610 087)
Stand



8. 105793-0020
(9 681 610 418)
Adjusting device



9. 157845-9520
(9 681 610 630)
Pipe assembly

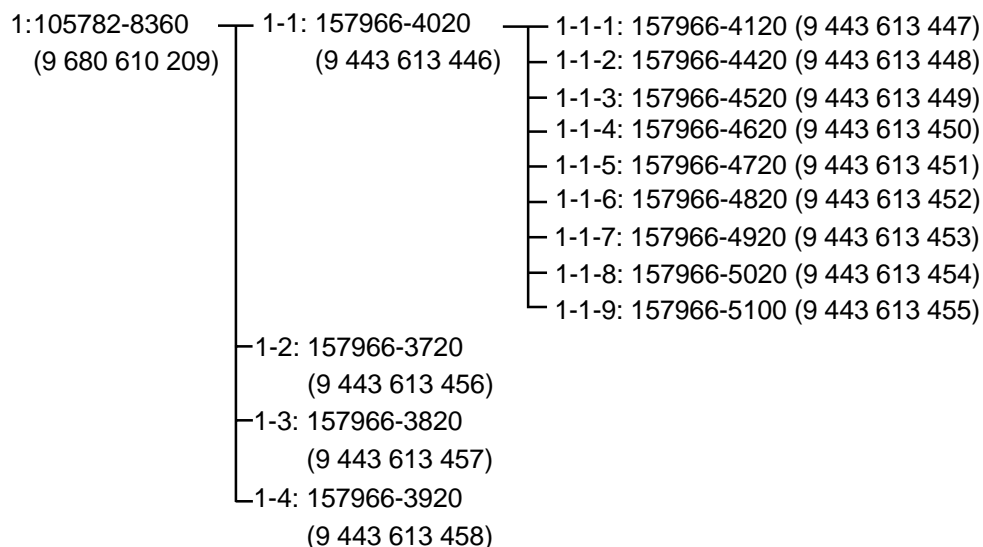


2 SPECIAL TOOLS

[3] Adjustment controller assembly construction:

Note:

The numbers in brackets below are Bosch part numbers.



Note:

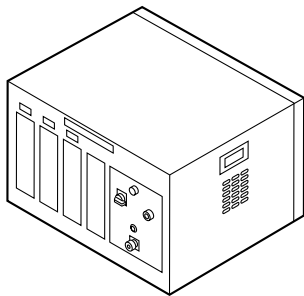
Key number 1 (RBAJ part no.105782-8360, Bosch part no. 9 680 610 209) is used with both VRZ and COVEC-F pumps. With the VRZ, key numbers 1-1 (RBAJ part no. 157966-4020, Bosch part no. 9 443 613 446) and 1-3 (RBAJ part no. 157966-3820, Bosch part no. 9 443 613 457) are used.

Adjustment controller assembly table (for VRZ)

Key no. 1: 105782-8360 (9 680 610 209)

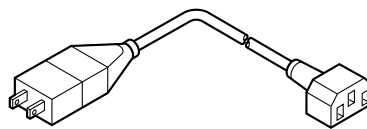
Key no	RBAJ part no	Bosch part no	Part name	Qty	Remarks
1-1	157966-4020	9 443 613 446	CONTROLLER ASSY	1	
1-1-1	157966-4120	9 443 613 447	Controller unit	1	Checker assy
1-1-2	157966-4420	9 443 613 448	Wire harness	1	Power supply (Japan, USA)
1-1-3	157966-4520	9 443 613 449	Wire harness	1	Power supply (EC)
1-1-4	157966-4620	9 443 613 450	Wire harness	1	PC: COM1 ~ MC-02
1-1-5	157966-4720	9 443 613 451	Wire harness	1	PC: COM2 ~ MC-02
1-1-6	157966-4820	9 443 613 452	Wire harness	1	FCV GND harness
1-1-7	157966-4920	9 443 613 453	Main harness	1	Controller-Pump GE
1-1-8	157966-5020	9 443 613 454	Main harness	1	Controller-Pump ROM
1-1-9	157966-5100	9 443 613 455	CD-ROM	1	Software (Overseas Ver.) & (Calibration data) & Manual
1-3	157966-3820	9 443 613 457	ECU assembly (4M41)	1	4M41 throttle

1-1 157966-4020
(9 443 613 446)
CONTROLLER ASSY

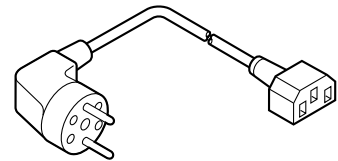


1-1-1 157966-4120
(9 443 613 447)
Controller unit

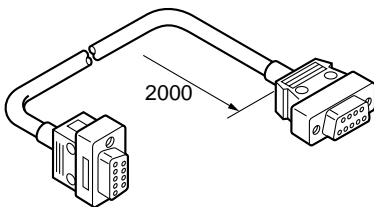
1-1-2 157966-4420
(9 443 613 448)
Wire harness



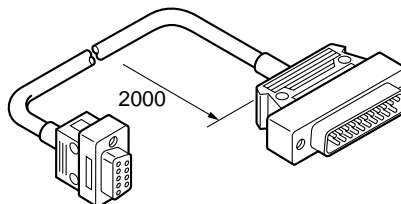
1-1-3 157966-4520
(9 443 613 449)
Wire harness



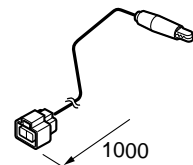
1-1-4 157966-4620
(9 443 613 450)
Wire harness



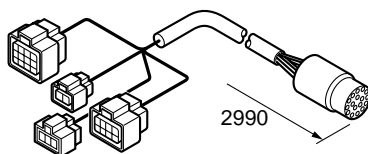
1-1-5 157966-4720
(9 443 613 451)
Wire harness



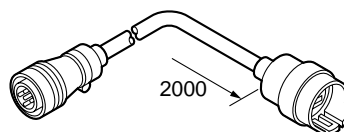
1-1-6 157966-4820
(9 443 613 452)
Wire harness



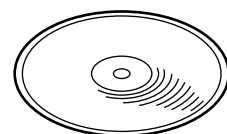
1-1-7 157966-4920
(9 443 613 453)
Main harness



1-1-8 157966-5020
(9 443 613 454)
Main harness

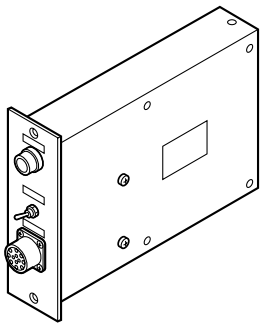


1-1-9 157966-5100
(9 443 613 455)
CD-ROM



2 SPECIAL TOOLS

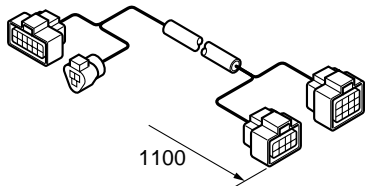
1-3 157966-3820
 (9 443 613 457)
 ECU assembly (4M41)



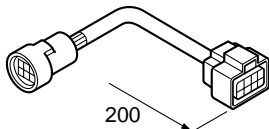
[4] Intermediate harness table

Key no	RBAJ part no	Bosch part no	Part name	Qty	Remarks
1	157966-5720	9 443 613 460	Intermediate harness	1	4M41 VRZ GE
2	157966-2421	9 443 613 462	Intermediate harness	1	For 4M41, 4D56 ROM

1. 157966-5720
(9 443 613 460)
Intermediate harness
(4M41)



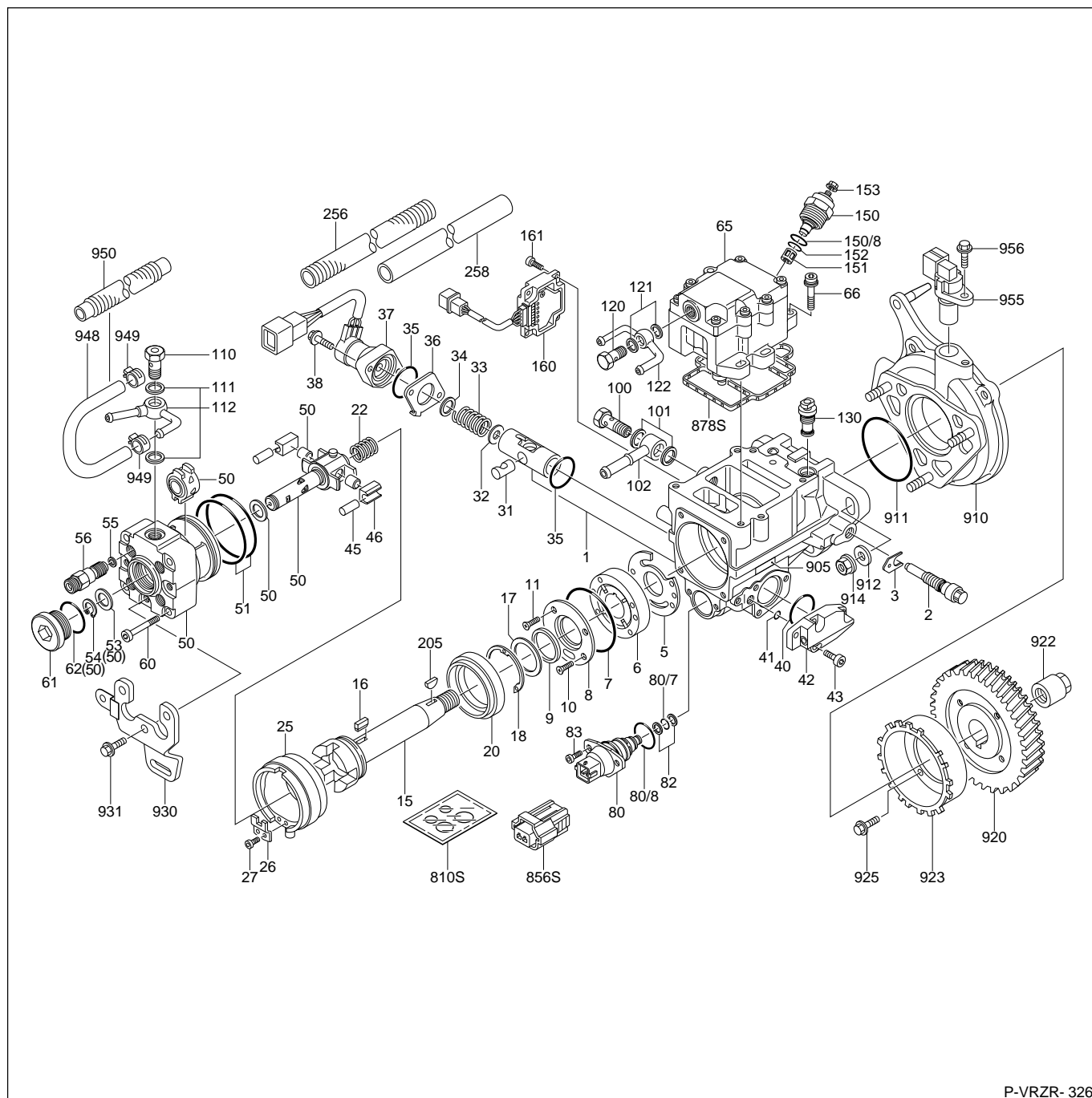
2. 157966-2421
(9 443 613 462)
Intermediate harness
(4M41, 4D56 ROM)



1. PREPARATION

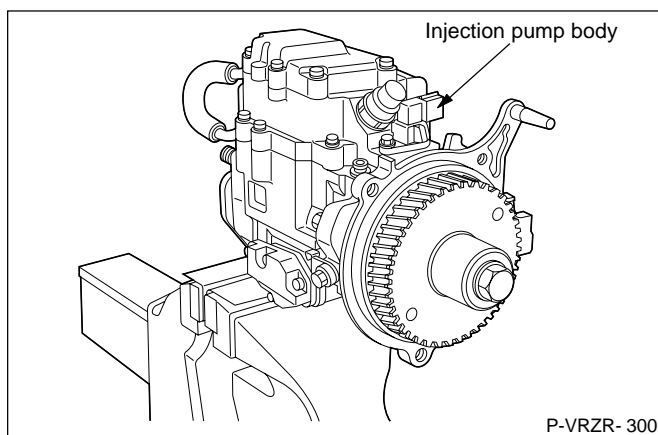
- Clean the outside of the injection pump before disassembly, removing all grease and dirt. Drain the fuel oil from the pump.
- Keep the work bench and workshop clean and tidy.
- Before beginning disassembly, record performance data for later reference to facilitate the diagnosis of malfunctions and defects, if any, in the pump.
- Lay out the disassembled parts neatly and sequentially on the work bench, labelling them if necessary, to facilitate later reassembly.
- Prepare a container of clean fuel oil for plungers, delivery valves and other precision parts.

2. EXPLODED VIEW



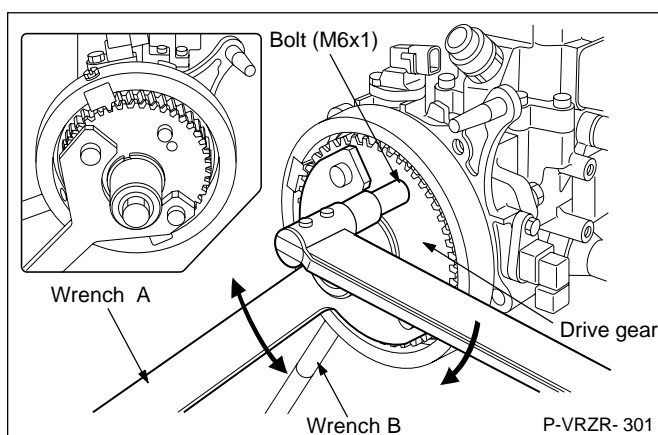
P-VRZR- 326

3 DISASSEMBLY



3. ENGINE DRIVE GEAR REMOVAL

(1) Fix the injection pump bracket in a vise.



(2) Install wrench B so that it can turn the two gears (ie, the main gear and the sub-gear) clockwise.

(3) Turn the main gear and the sub-gear using wrench A until they are aligned. Then, insert a bolt through the two gears and tighten it using a torque wrench. (Tighten temporarily.)

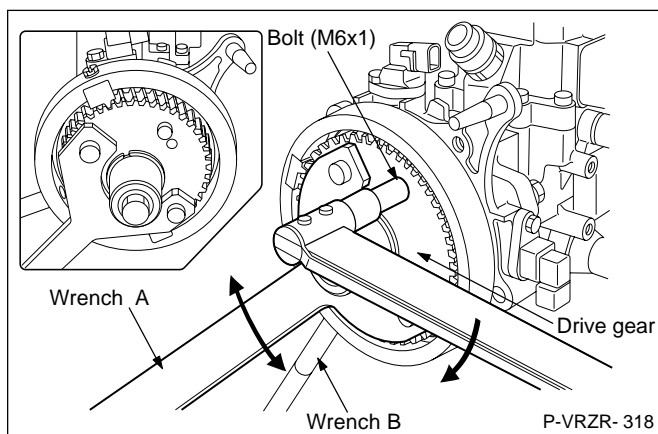
Tool name	Part no	Remarks
Wrench A	157917-4920	
Wrench B	157917-4620	

Note:

The drive gear is divided into the main gear and the sub-gear.

Wrench B is used to prevent drive gear rotation.

Wrench A is used to align the main gear and the sub-gear.



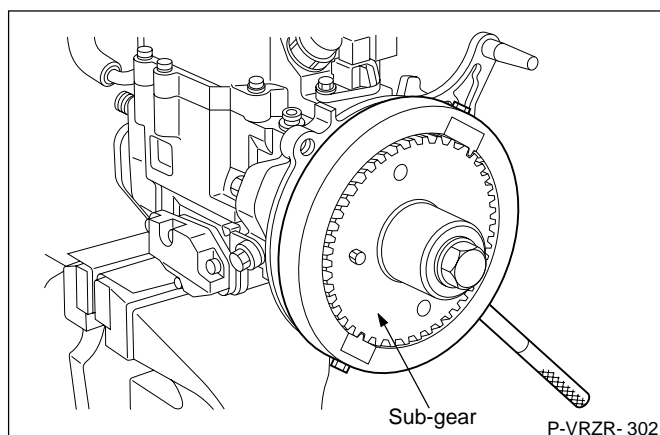
(4) Remove wrenches A and B and the torque wrench from the drive gear.

(5) Install wrench B so that the main gear and the sub-gear are in the center of wrench B.

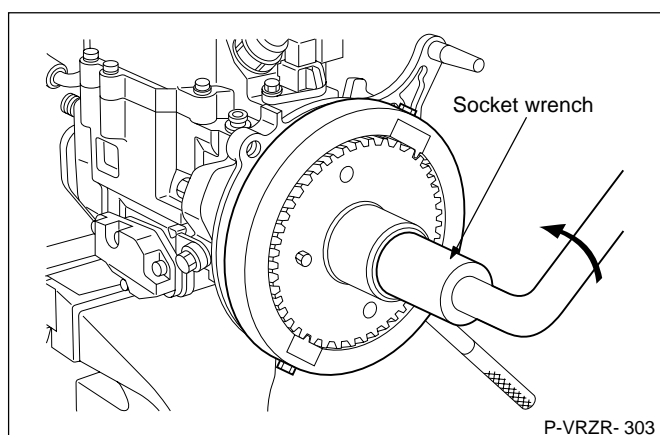
(6) Remove the bolt from the drive gear.

(7) Align the main gear and the sub-gear using wrench A, then install the bolt and tighten to the specified torque.

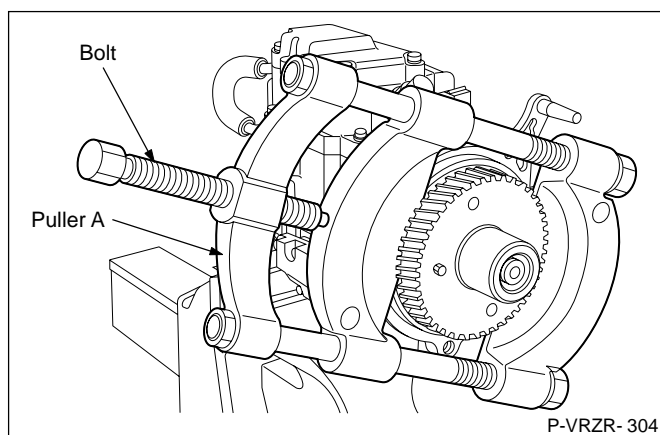
**Specified torque: 9 ~ 13 N·m
{0.9 ~ 1.3 kgf·m}**



(8) Remove wrench A.

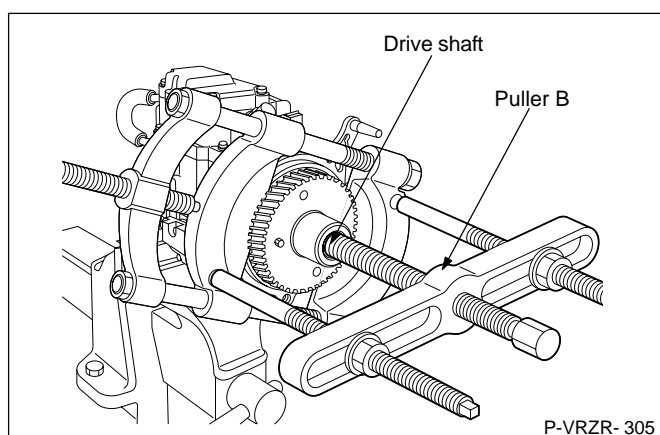


(9) Remove the roundnut (SW21) fixing the drive gear.



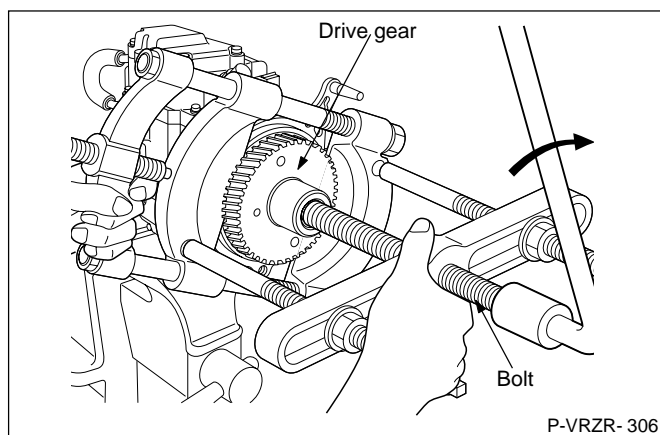
(10) Assemble puller A in the gap between the drive gear and the bracket and loosely fix the bolts.

Tool name	Part no	Remarks
Puller	157927-4500	Parts A and B



(11) Assemble puller B to the drive shaft and puller A.

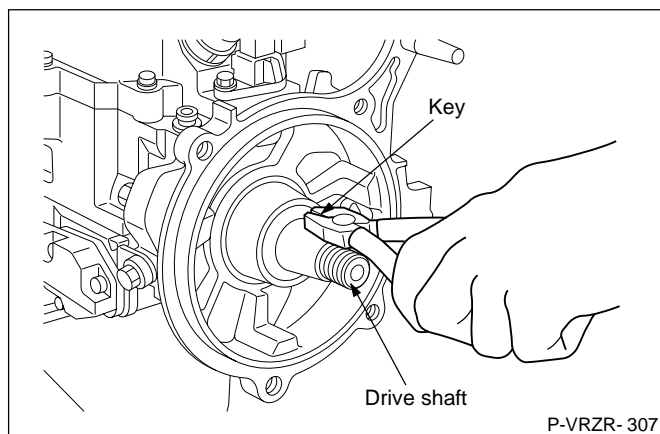
3 DISASSEMBLY



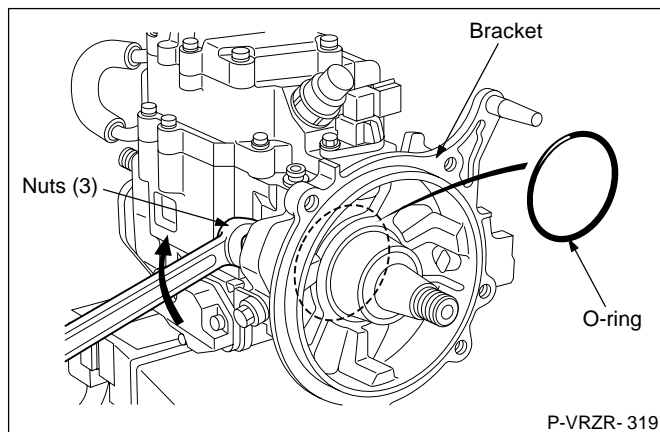
(12) Tighten the puller bolt to remove the drive gear.

Advice

Hold the puller so that it does not drop when the gear is removed from the drive shaft.

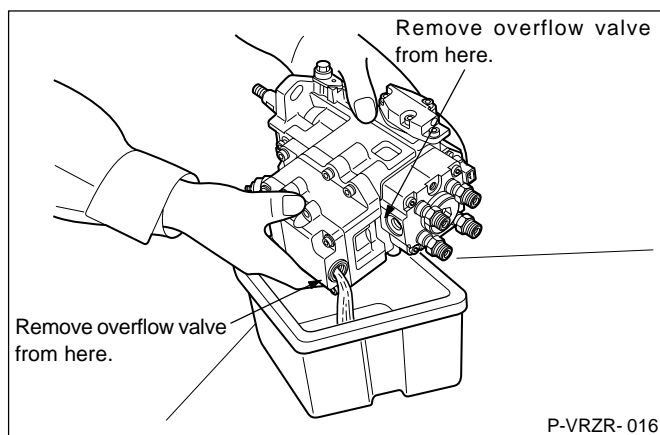


(13) Remove the drive shaft key.



(14) Remove the nuts (at three locations).

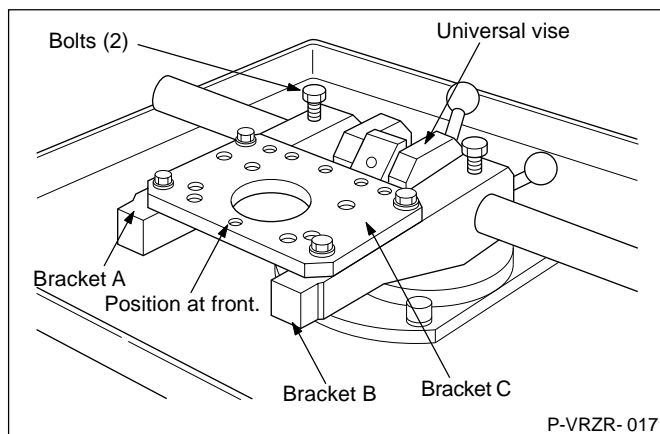
(15) Remove the bracket from the pump housing and then remove the O-ring.



4. DISASSEMBLY

[1] Injection pump installation

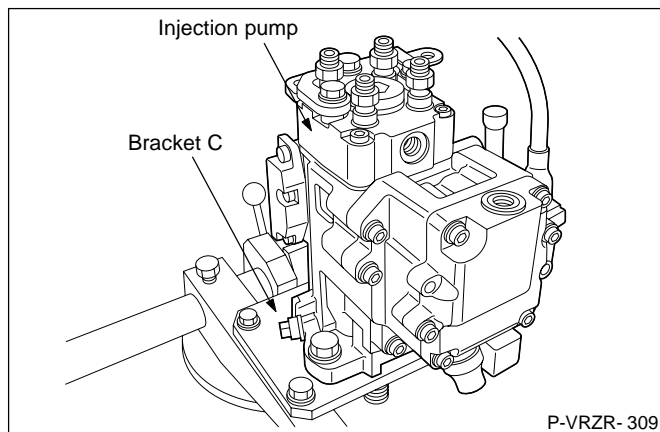
(1) Remove the overflow valves, the bypass hoses and the inlet pipe from the GE actuator and the distributor head and drain any fuel oil from the pump.



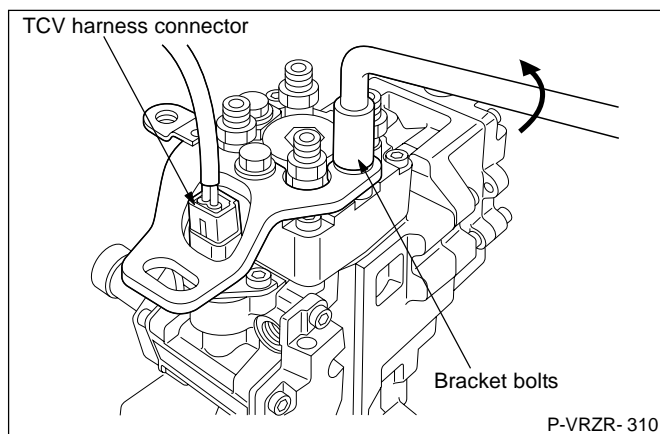
(2) Attach bracket A and bracket B to the universal vise (and fix temporarily).

(3) Attach bracket C to bracket A and bracket B and tighten bracket A's and bracket B's bolts.

Tool name	Part no	Remarks
Universal vise	157944-8521	
Bracket A	157944-7100	
Bracket B	157944-7200	
Bracket C	157945-2020	
Bolt	010010-2220	M10x1.5



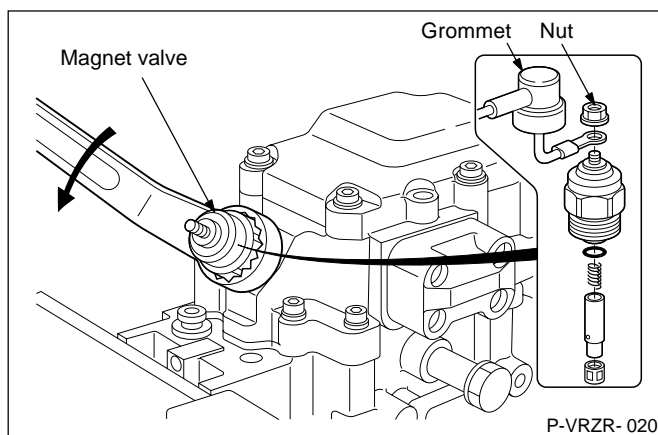
(4) Attach the injection pump to bracket C.



(5) Remove the bracket bolts.

(6) Remove the TCV harness connector.

3 DISASSEMBLY

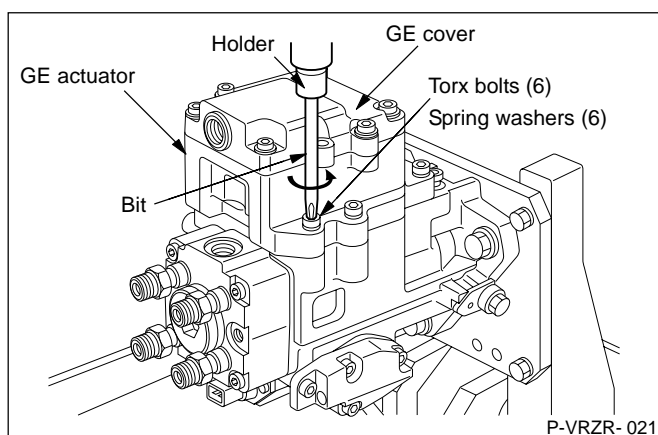


[2] Magnet valve removal

- (1) Remove the magnet valve harness grommet and then remove the harness nut.
- (2) Remove the magnet valve and the filter.

Advice

Do not lose the armature spring.



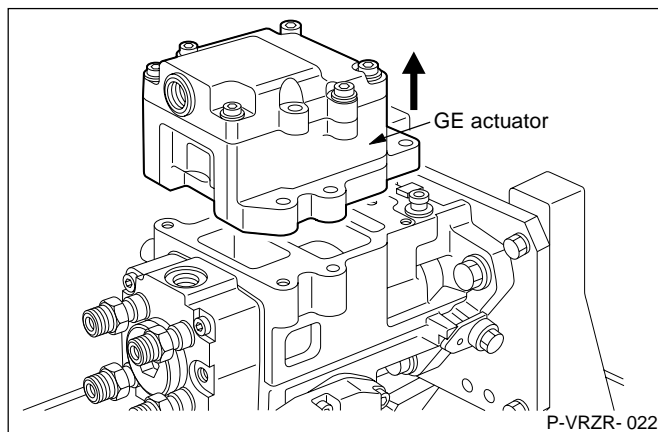
[3] GE actuator removal

- (1) Remove the GE actuator's torx bolts and spring washers.

Tool name	Part no	Remarks
Holder	157915-9820	
Bit	157915-9600	T30

Advice

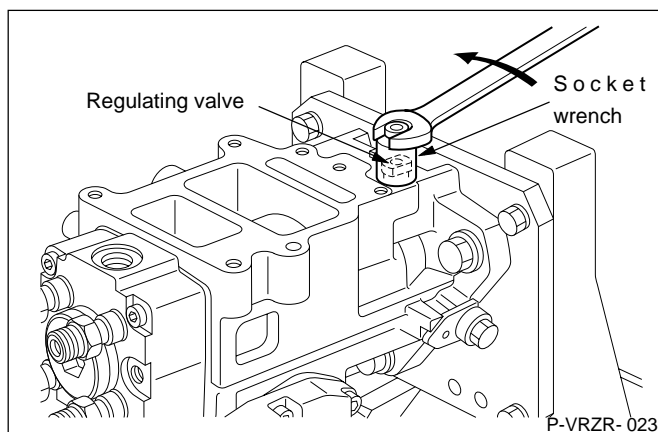
Do not remove the GE cover.



- (2) Remove the GE actuator.

Advice

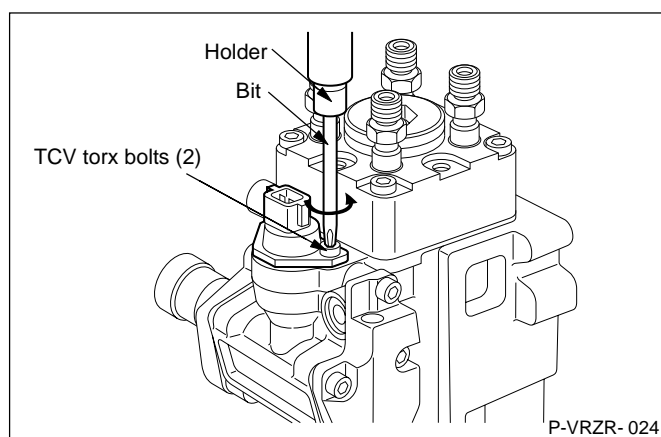
Do not damage the ball pin (refer to the GE actuator on page 35).



[4] Regulating valve removal

Assemble the socket wrench to the regulating valve and then remove the regulating valve.

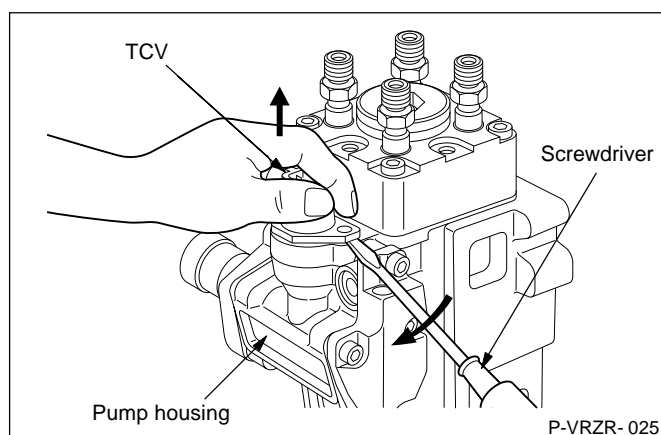
Tool name	Part no	Remarks
Socket wrench	157913-7000	



[5] TCV (timing control valve) removal

(1) Remove the TCV's torx bolts.

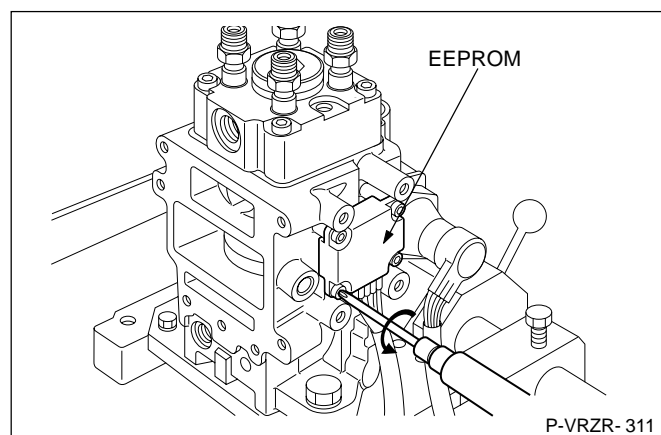
Tool name	Part no	Remarks
Holder	157915-9820	
Bit	157915-9600	T30



(2) Lift the TCV up a little and then insert a screwdriver into the gap to pry up and remove the TCV.

Advice

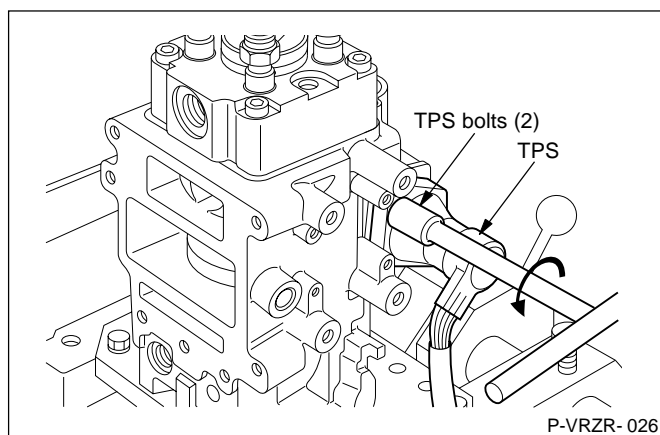
Do not damage the pump housing.



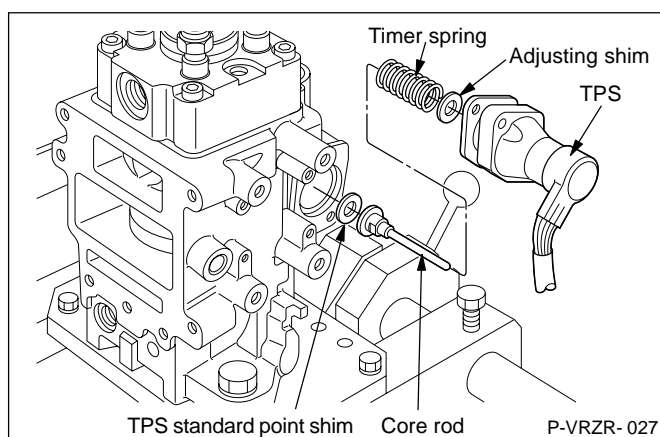
[6] EEPROM, TPS (timer piston sensor) and timer cover removal

(1) Remove the EEPROM.

3 DISASSEMBLY



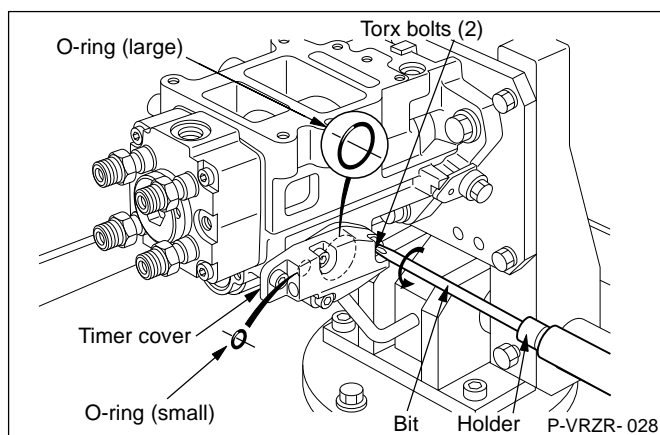
(2) Remove the TPS bolts.



(3) Remove the TPS, the adjusting shim, the timer spring, the core rod and the TPS standard point shim.

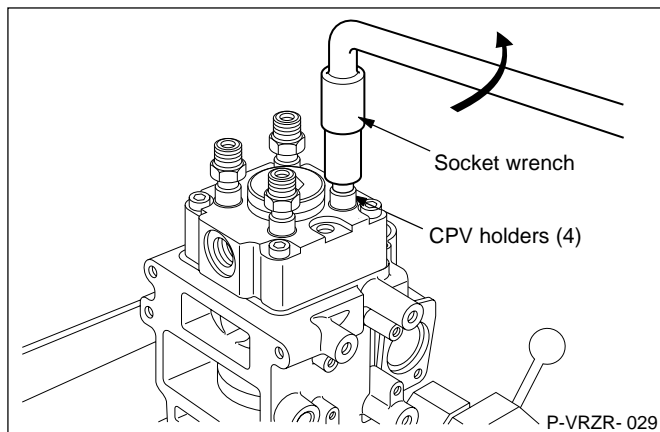
Advice

Label the TPS standard point shim and the timer stroke adjusting shim to avoid mistaking them at reassembly.



(4) Remove the timer cover and the O-rings (large and small).

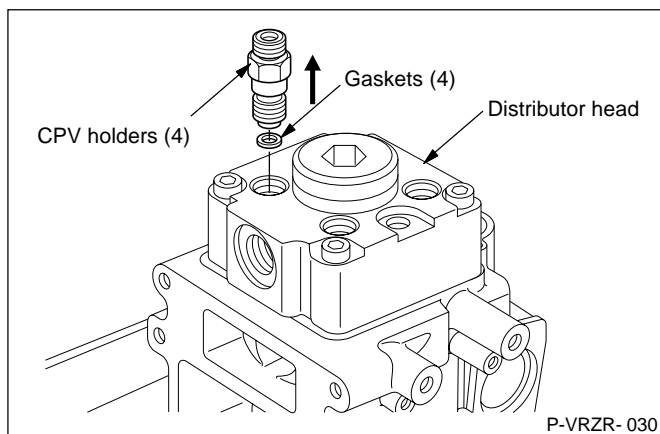
Tool name	Part no	Remarks
Holder	157915-9820	
Bit	157915-9600	T30



[7] CPV (constant pressure valve) holder and plug removal

(1) Loosen the CPV holders.

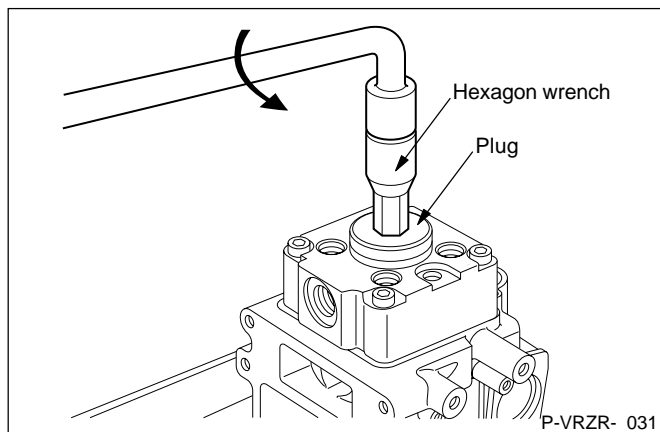
Tool name	Part no	Remarks
Socket wrench	157914-3600	



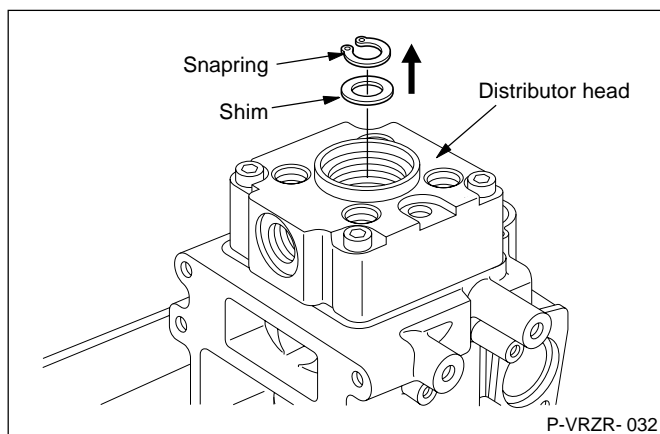
(2) Remove the CPV holders and the gaskets.

Advice

Line up the removed CPV holders in order to match the positions (A, B, C, D) on the distributor head from where they were removed.



(3) Remove the plug using a hexagon wrench (SW14mm).

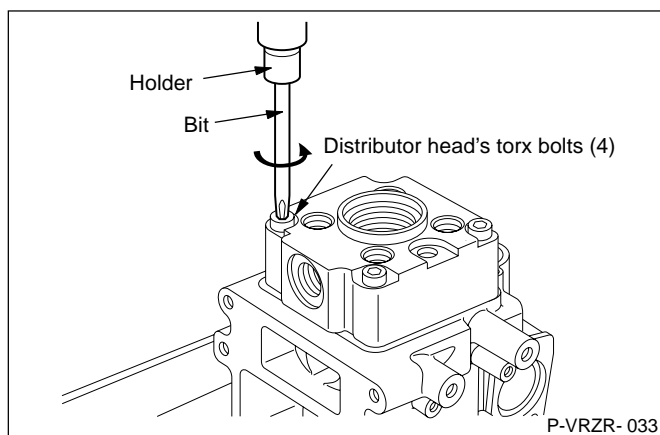


(4) Remove the snapping and shim from the rotor shaft.

Note:

The shim is easier to remove after removing the distributor head assembly.

3 DISASSEMBLY



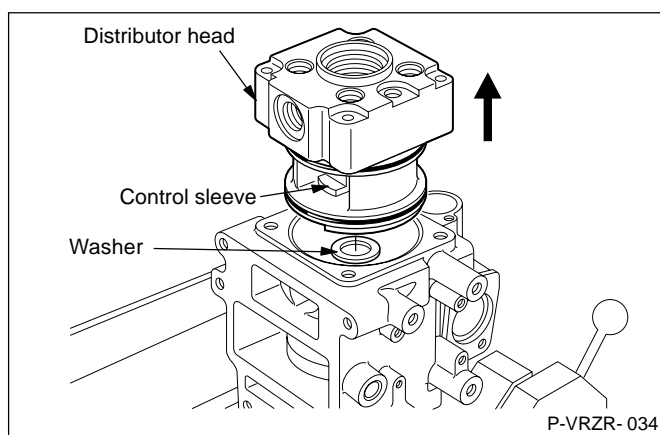
[8] Distributor head removal

(1) Remove the distributor head's torx bolts.

Tool name	Part no	Remarks
Holder	157915-9820	
Bit	157915-9600	T30

Advice

If the distributor head is not loose, tap the sides lightly with a plastic hammer.

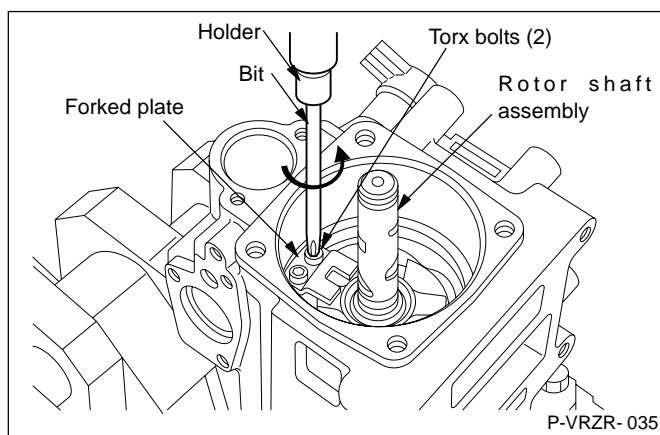


(2) Pull out the distributor head.

Advice

Do not drop the control sleeve.

(3) Remove the washer.



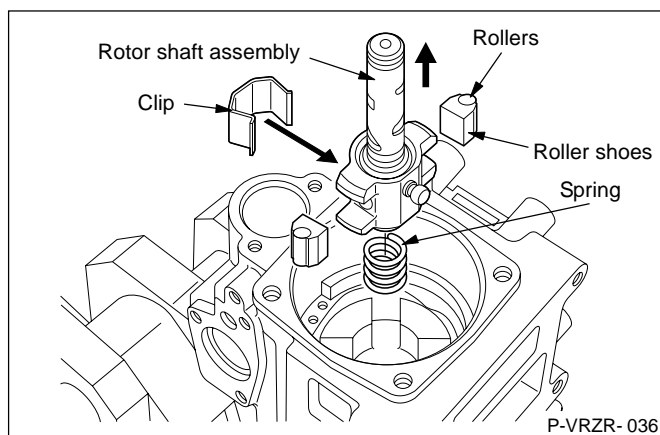
[9] Forked plate and rotor shaft assembly removal

(1) Remove the forked plate.

Tool name	Part no	Remarks
Holder	157915-9820	
Bit	157915-9301	T20

Note:

The force of the rotor shaft spring is acting on the forked plate. Use care during removal.



- (2) Remove the rotor shaft assembly and remove the rollers and roller shoes from the rotor shaft.

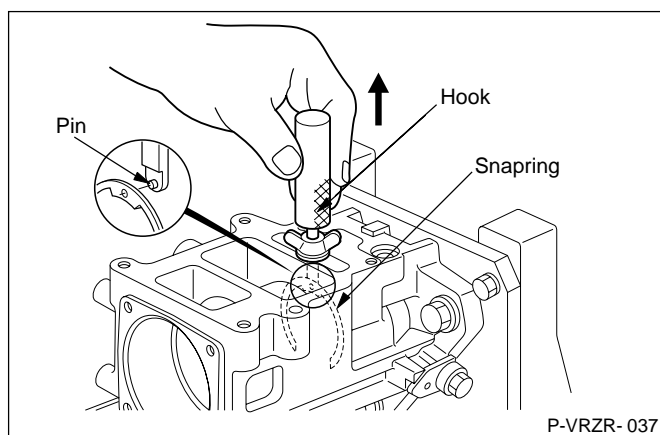
Advice

- **Do not drop the rollers or the roller shoes.**
 - **Do not change the roller and roller shoe combinations.**
- (3) Assemble the clip to prevent the plunger from dropping out of the rotor shaft assembly.

Tool name	Part no	Remarks
Clip	157971-0500	

Advice

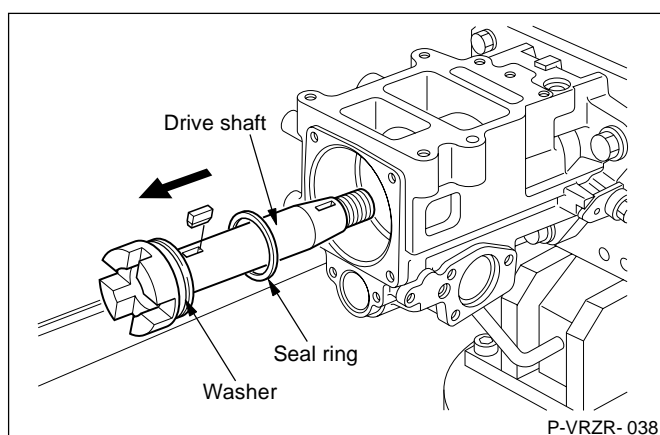
Do not disassemble the plunger from the rotor shaft.



[10] Snapping removal

Insert the hook's pin into the snapping's hole and tighten the butterfly nut to pull out the snapping.

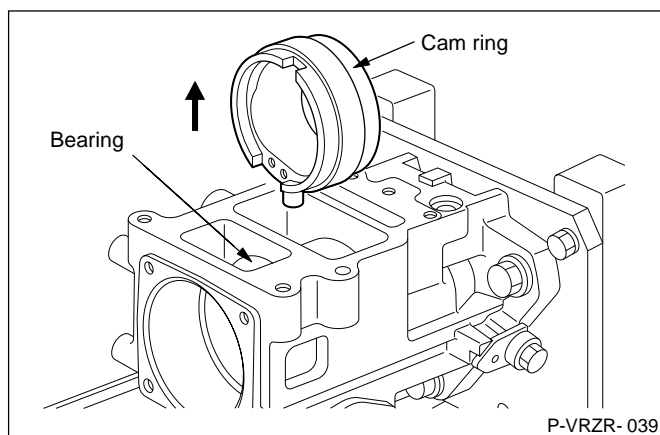
Tool name	Part no	Remarks
Hook	157928-5820	



[11] Drive shaft removal

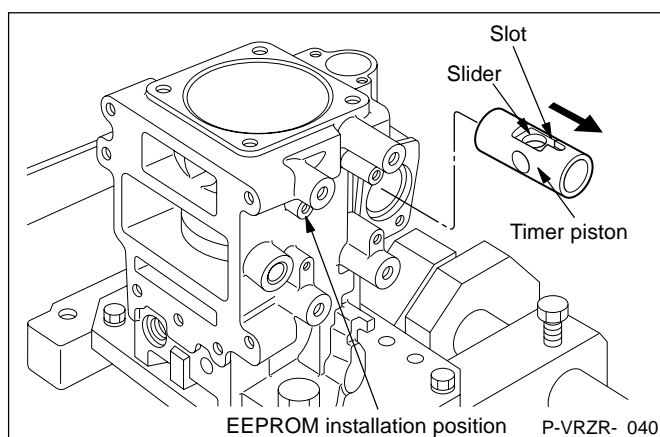
Remove the drive shaft, the washer and the seal ring.

3 DISASSEMBLY



[12] Cam ring removal

Position the bearing on the drive side and remove the cam ring.

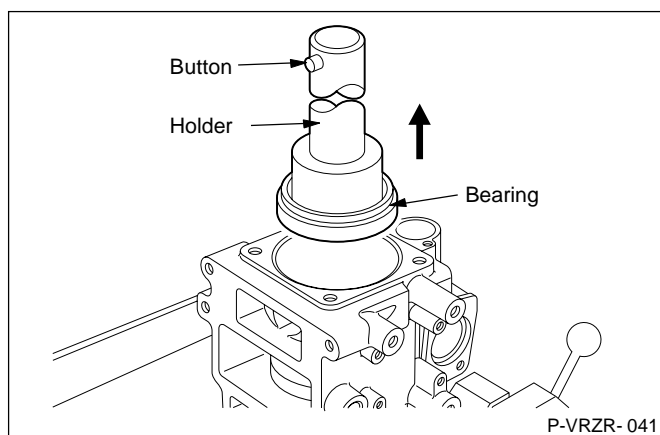


[13] Timer piston removal

Remove the timer piston and the slider.

Advice

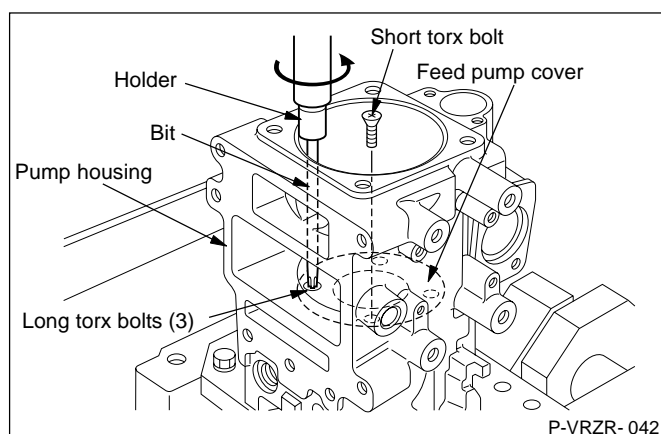
- Do not drop the slider.
- Assemble the timer piston so that the slot is positioned toward the EEPROM installation position.



[14] Bearing removal

Insert the holder into the bearing, push the holder button and remove the bearing.

Tool name	Part no	Remarks
Holder	157928-3620	



[15] Feed pump removal

(1) Remove the feed pump's torx bolts.

Tool name	Part no	Remarks
Holder	157915-9820	
Bit	157915-9201	T15

Advice

Use care because the torx bolt heads are easily broken.

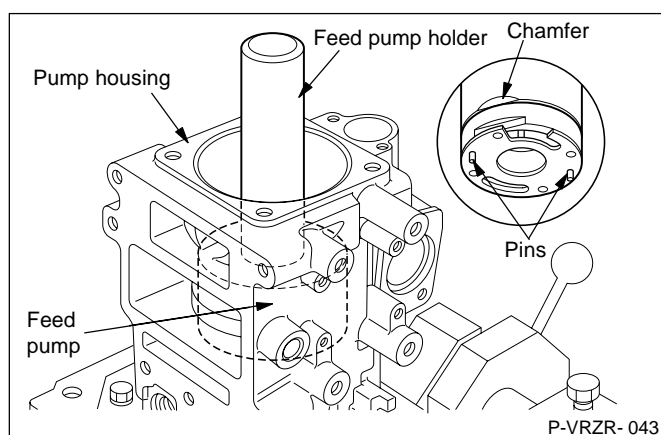
Note:

Of the four torx bolts, only the three long ones are screwed into the feed pump's pump housing.

For feed pump	Part no	Remarks
Short torx bolt	149916-0400 (9 443 612 874)	1
Long torx bolt	149916-0300 (9 443 612 873)	3

(2) Remove the feed pump cover.

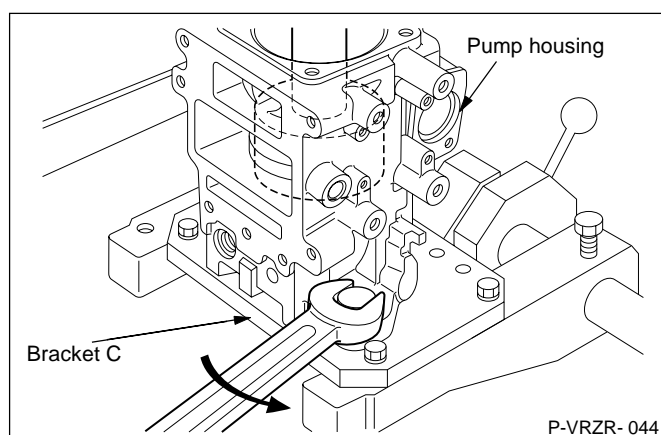
(3) Remove the feed pump O-ring.



(4) Position the feed pump holder chamfer toward the GE actuator.

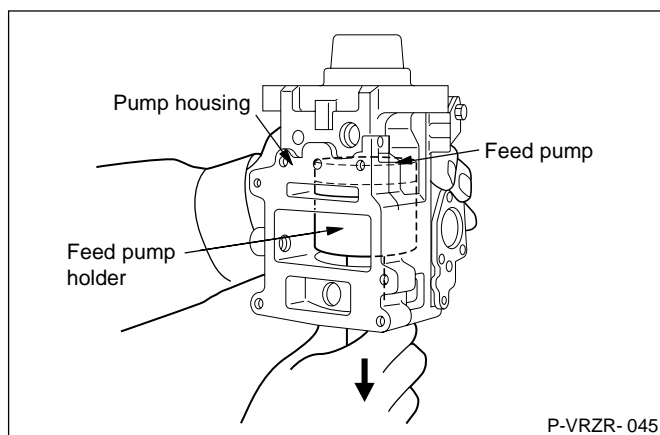
(5) Push the feed pump holder into the pump housing, aligning the holder's two pins with the feed pump holes.

Tool name	Part no	Remarks
Feed pump holder	157928-4320	



(6) Remove the pump housing assembled with the feed pump holder from bracket C.

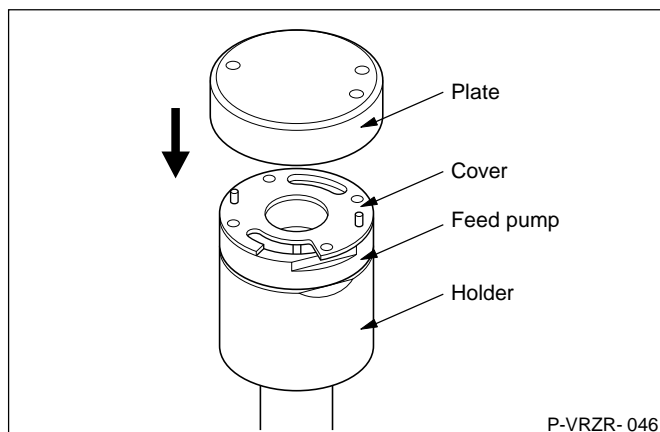
3 DISASSEMBLY



- (7) Hold the feed pump holder and turn the pump housing upside down.
- (8) Remove the feed pump holder with the feed pump from the bottom of the pump housing.

Advice

Remove the rotor assembly and the feed pump cover together with the feed pump holder.



- (9) Position the plate on the cover and turn the feed pump holder right side up.

Tool name	Part no	Remarks
Plate	157928-4800	

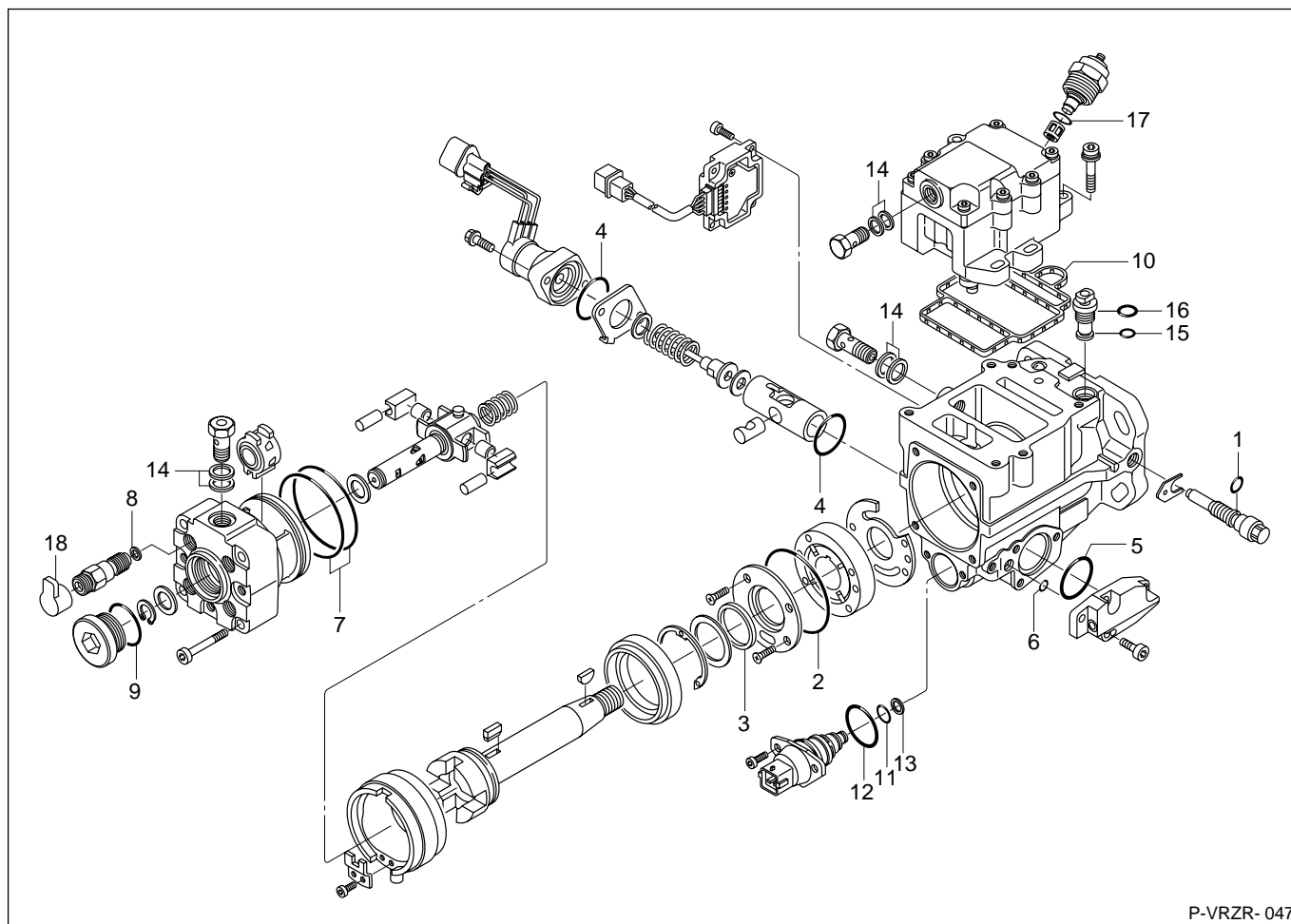
Advice

Always store the feed pump in the assembled state.

1. PREPARATION

Check all disassembled parts for wear and damage and repair or replace any parts that cannot be reused with new parts.

Always replace all gaskets and O-rings, etc, with new parts. Do not reuse them.

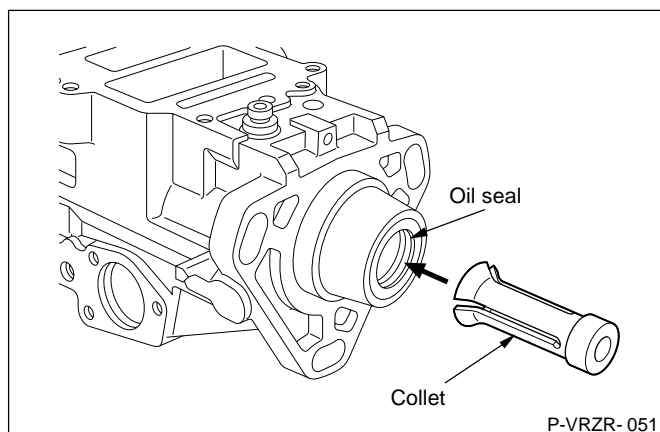
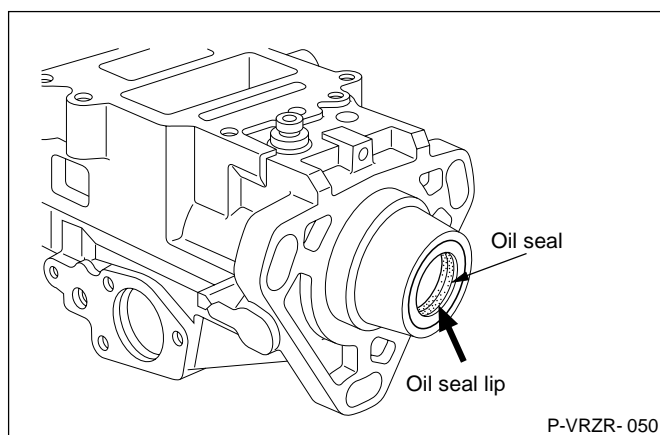
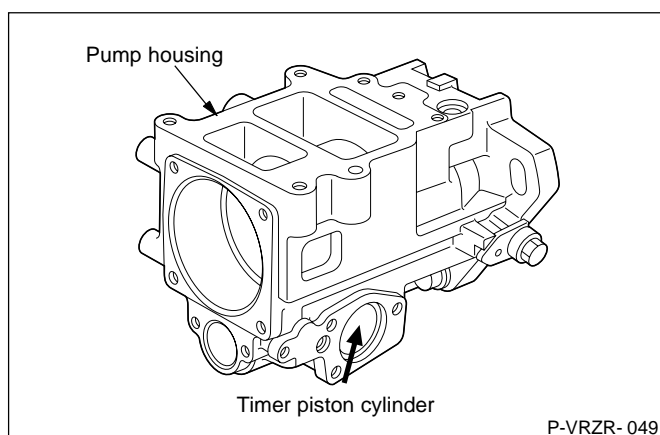
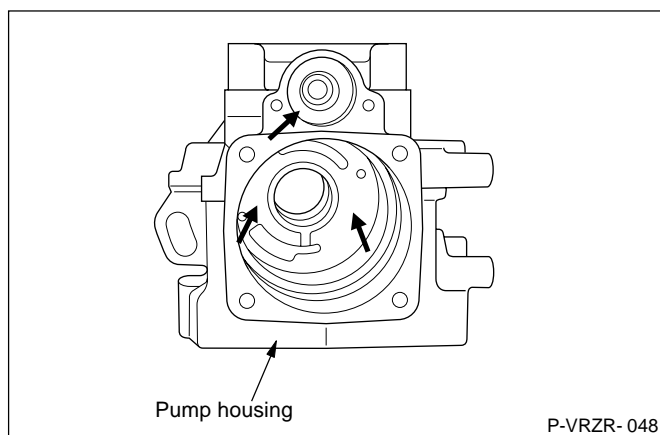


P-VRZR- 047

Repair kit part no: 149960-0020 (Bosch part no. 9 443 612 894)

Key no	RBAJ part no	Bosch part no	Part name	Qty	Application
1	149911-0800	9 443 613 478	O-ring	1	FBB holder
2	149911-0000	9 443 612 857	O-ring	1	Feed pump
3	149912-0200	9 443 612 864	Seal ring	1	Drive shaft
4	149911-0100	9 443 612 858	O-ring	2	TPS
5	149911-0200	9 443 612 859	O-ring	1	Timer cover
6	149911-0300	9 443 612 860	O-ring	1	Timer cover
7	146600-0000	9 461 610 413	O-ring	2	Head housing
8	146433-0100	9 461 610 239	Gasket	6	CPV assembly
9	146600-0500	9 461 610 418	O-ring	1	Head plug
10	149912-0800	9 443 612 865	Seal ring	1	GE housing
11	161440-3800	9 443 610 357	O-ring	1	TCV (small)
12	161440-3700	9 443 610 356	O-ring	1	TCV (large)
13	149913-0100	9 443 612 866	Back-up ring	1	TCV
14	139512-0500	9 411 611 625	Gasket	6	In and out (t = 1.6)
15	146600-0600	9 461 610 419	O-ring	1	Regulating valve
16	146600-0700	9 461 610 420	O-ring	1	Regulating valve
17	149912-0500	9 443 612 771	Seal ring	1	Magnet valve
18	029921-4020	9 442 610 255	Cap	6	CPV holder

4 COMPONENT INSPECTION



2. INSPECTION

[1] Pump housing

(1) Replace the pump housing if it is worn due to the action of the feed pump rotor, the plate or the TCV.

(2) Replace the pump housing if the timer piston cylinder is damaged or worn.

(3) If the regulating valve is blocked with dirt, etc, clean it using compressed air. If it cannot be cleaned, replace the pump housing.

Advice

When replacing the pump housing, replace it with the service kit. The service kit contains a pump housing and a timer piston.

Tool name	Part no	Remarks
Service kit	149500-0420 (9 443 613 486)	

[2] Oil seal

Replace the oil seal if the lip is damaged or worn.

Advice

- Refer to '[3] Oil seal removal' below for the removal procedure.
- Refer to '[4] Oil seal installation' below for the installation procedure.

[3] Oil seal removal

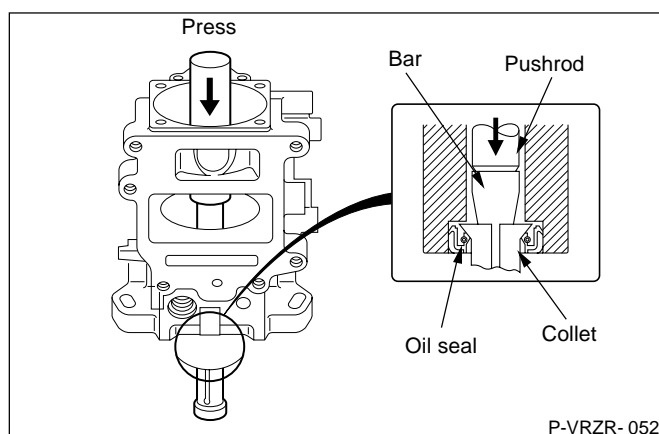
(1) Insert the collet into the oil seal.

Tool name	Part no	Remarks
Collet	157928-4100	For ϕ 25 shaft dia
Extractor	157928-4120	For ϕ 25 shaft dia

Note:

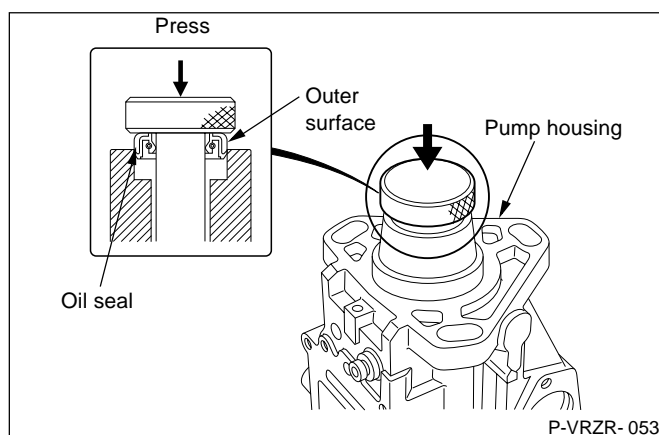
The collet, bar and pushrod (see next page) are part of the extractor.

4 COMPONENT INSPECTION



- (2) Insert the bar into the collet from the pump housing side.
- (3) Hold the pushrod against the bar and push it using a press to remove the oil seal.

Tool name	Part no	Remarks
Bar	157925-2800	For $\phi 25$ dia shaft
Pushrod	157926-1000	



[4] Oil seal installation

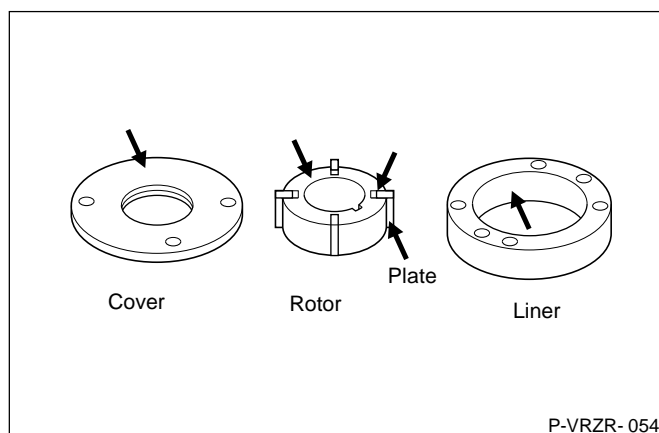
- (1) Apply wax sealant (L101; manufactured by NOK) to the outside surface of a new oil seal.

Tool name	Part no	Remarks
Guide	157848-2300	

- (2) Pressfit the new oil seal into the pump housing until it is level with the surface of the pump housing.

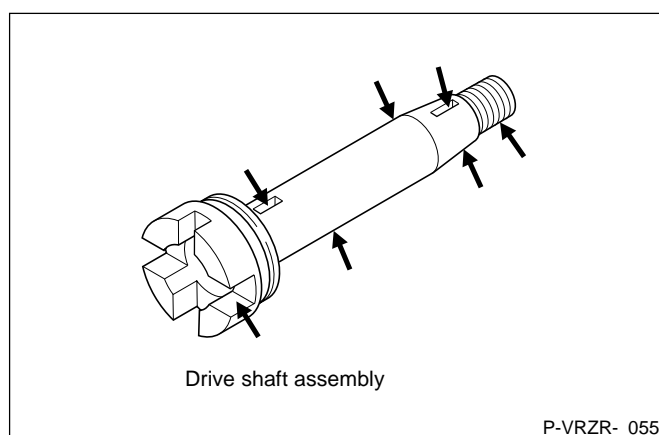
Advice

Do not apply excessive force when pressfitting the oil seal.



[5] Feed pump assembly

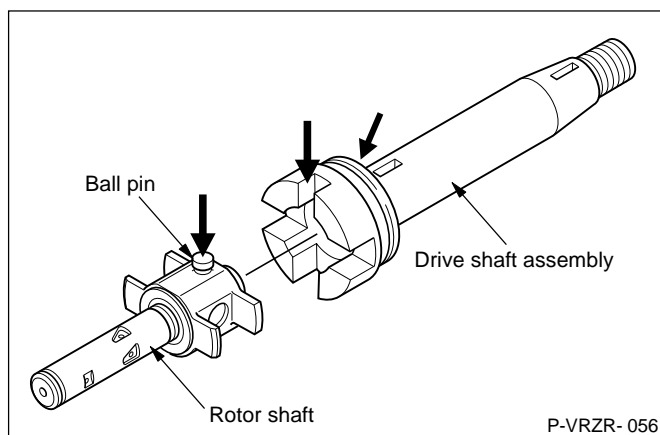
- (1) Replace the feed pump assembly if the inside surface of the liner is peeling or gnawed due to plate contact.
- (2) Replace the feed pump assembly if the inside edge of the liner is marked.
- (3) Replace the feed pump assembly if the rotor or plate is rusted or gnawed.



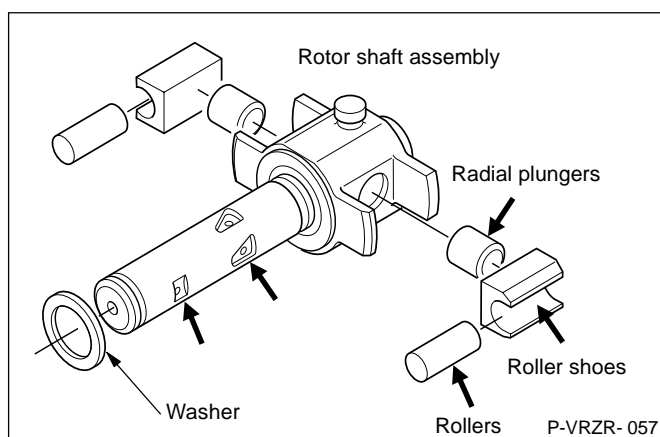
[6] Drive shaft assembly

- (1) Replace the drive shaft assembly if the drive key or the feed pump's drive side key groove is damaged.
- (2) Replace the drive shaft assembly if the taper is scratched or worn.
- (3) Replace the drive shaft assembly if the thread is damaged.
- (4) Replace the drive shaft assembly if the shaft or oil seal contact surface is worn.
- (5) Replace the drive shaft assembly if the washer contact surface is peeling, gnawed or scorched.

4 COMPONENT INSPECTION

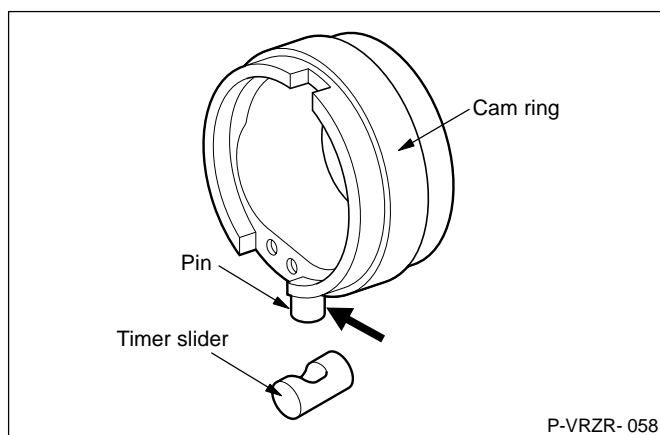


- (6) Replace the drive shaft assembly if there is any play between the rotor shaft's ball pin and the drive shaft.



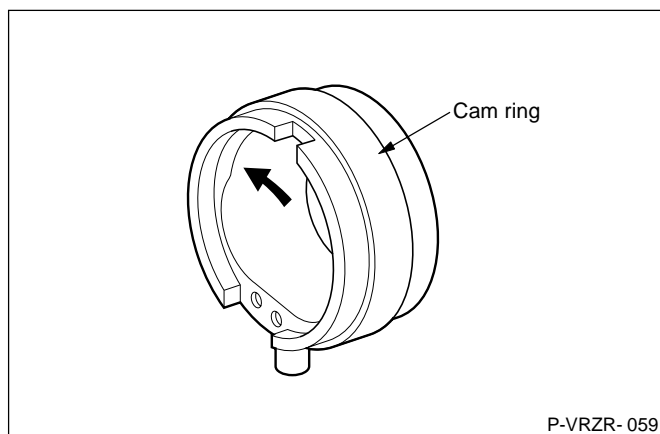
[7] Rotor shaft assembly

- (1) Replace the distributor head assembly if any of the rotor shaft assembly's sliding parts are peeling, gnawed or scorched.
- (2) Replace the washer with a new one if it is worn.

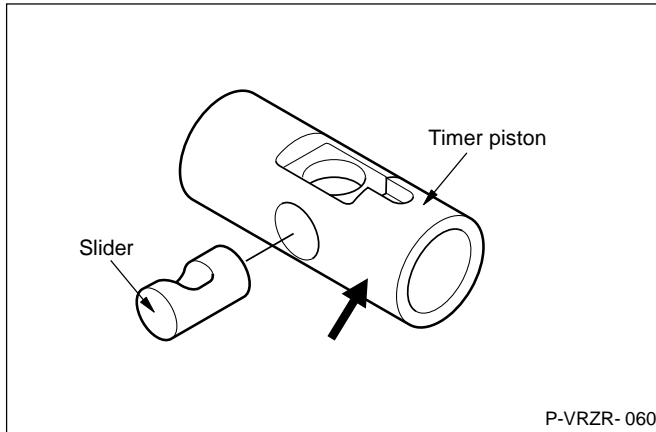


[8] Cam ring

- (1) Replace the cam ring if the cam ring pin is worn.
- (2) Replace the cam ring if there is any play between the cam ring pin and the timer slider.



- (3) Replace the cam ring if the cam ring's cam profile is peeling or scorched.



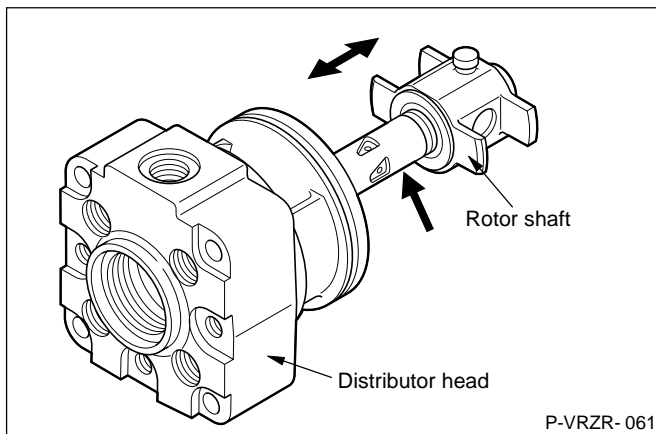
[9] Timer piston

- (1) Replace the piston if the outside surface is worn or scratched.
- (2) Replace the slider if it is worn.

Advice

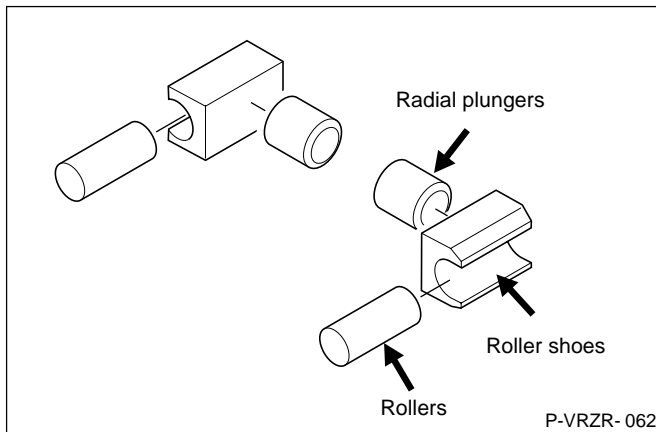
When replacing the timer piston, replace it with the service kit. The service kit contains a pump housing and a timer piston.

Tool name	Part no	Remarks
Service kit	149500-0420 (9 443 613 486)	

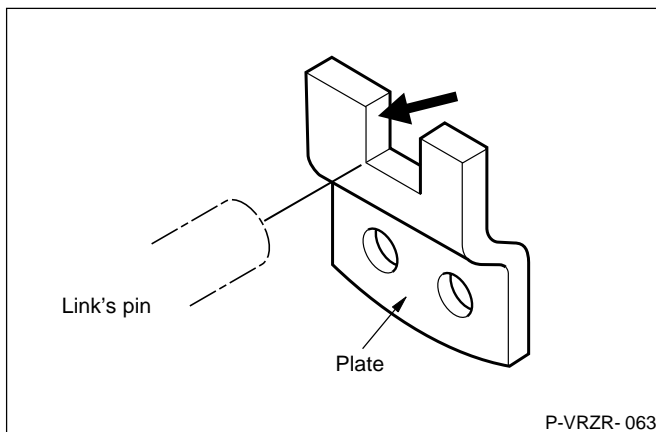


[10] Distributor head assembly

- (1) Wash the distributor head assembly in clean light oil and lightly move the rotor shaft through its stroke to confirm that it moves smoothly.
If the rotor shaft does not move smoothly, replace the distributor head assembly.

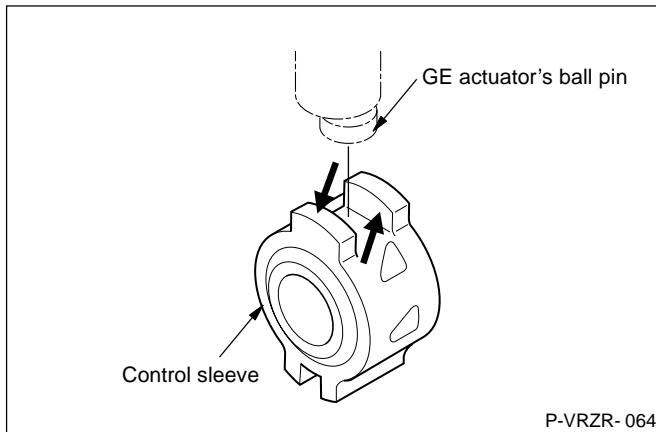


- (2) Inspect the plungers. If they are worn or damaged, replace the distributor head assembly.
- (3) Inspect the rollers and the roller shoes. Replace them with new ones if they are worn, peeling, scorched or gnawed.

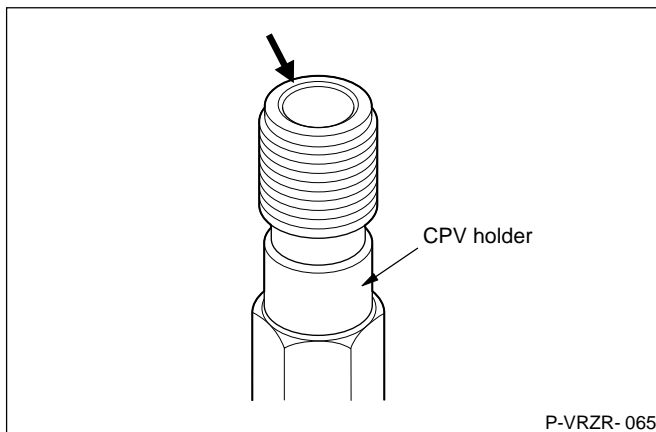


- (4) Replace the distributor head assembly if there is any play between the cam ring's plate and the link's pin.

4 COMPONENT INSPECTION

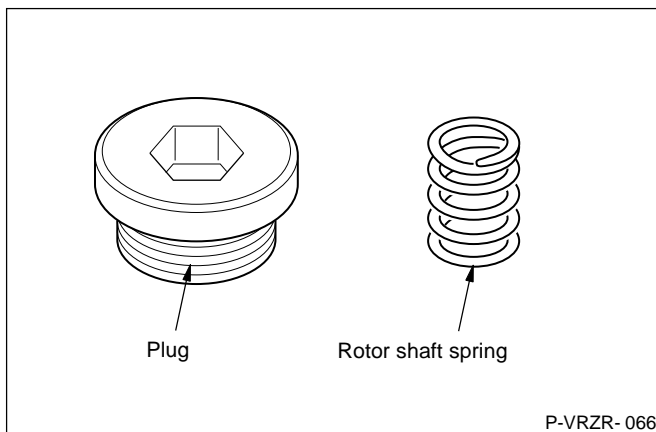


- (5) Assemble the GE actuator's ball pin to the control sleeve groove. If there is any play, replace the distributor head assembly.



[11] CPV (constant pressure valve) holder

Replace the CPV holder if the CPV holder seat is scratched.

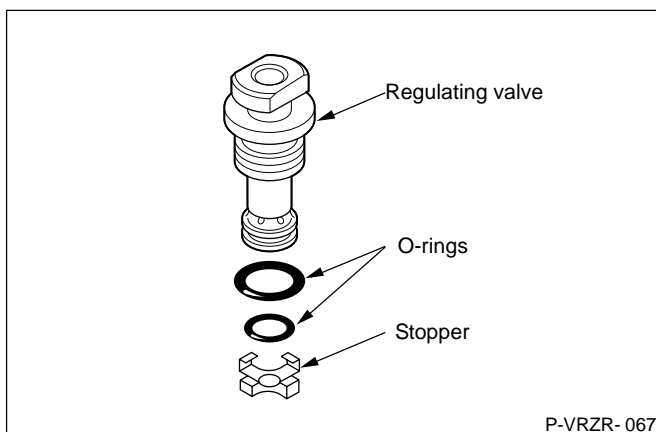


[12] Plug and rotor shaft spring

- (1) Replace the rotor shaft spring if it is rusted or damaged.
- (2) Replace the plug with a new one if it is burred or the thread is damaged.

Advice

Always replace the O-ring assembled to the plug with a new one.

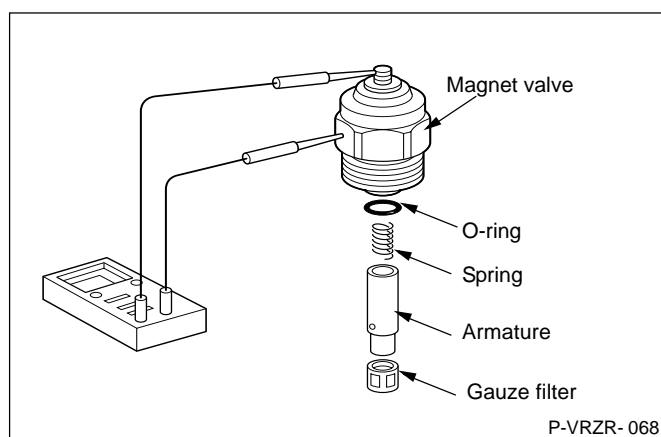


[13] Regulating valve

Replace the regulating valve assembly if the piston inside the regulating valve is sticking.

Advice

- **Always replace the O-rings with new ones.**
- **Do not disassemble the regulating valve unless necessary.**



[14] Magnet valve

- (1) Replace the magnet valve assembly if the armature is scorched or cracked.
- (2) Replace the magnet valve assembly if the spring is damaged or rusted.

Advice

Always replace the O-ring with a new one.

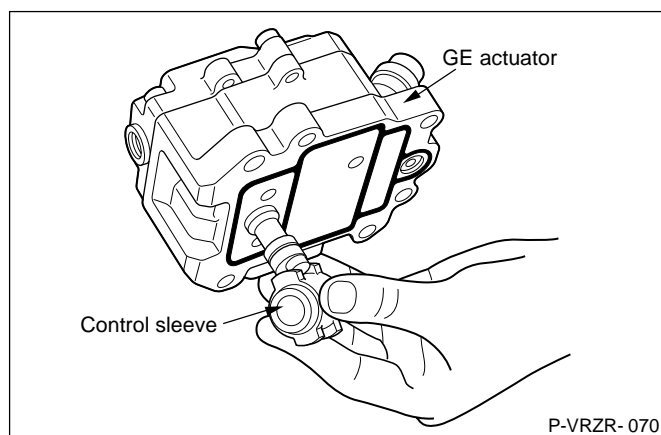
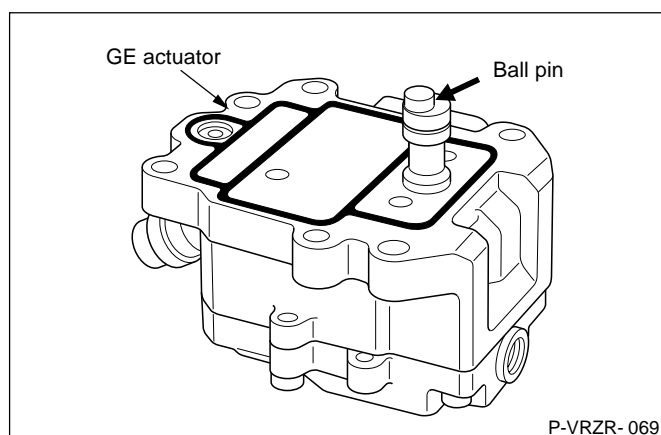
- (3) Check the magnet valve resistance and replace the magnet valve assembly if the resistance is not as specified.

Terminal nos	Resistance (Ω)	Ambient temperature (°C)
1 - GND	8.0±1.2	23±5

- (4) Clean the gauze filter.

[15] GE actuator

- (1) Replace the GE actuator if the ball pin is worn or if the plating is damaged or peeling.

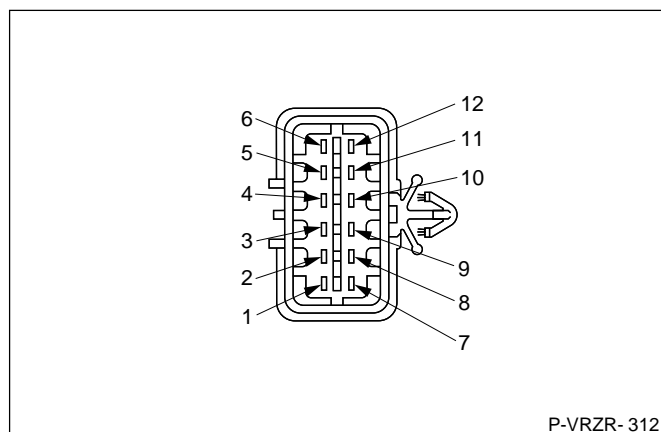


- (2) Assemble the GE actuator's ball pin in the control sleeve groove and confirm that there is no play.

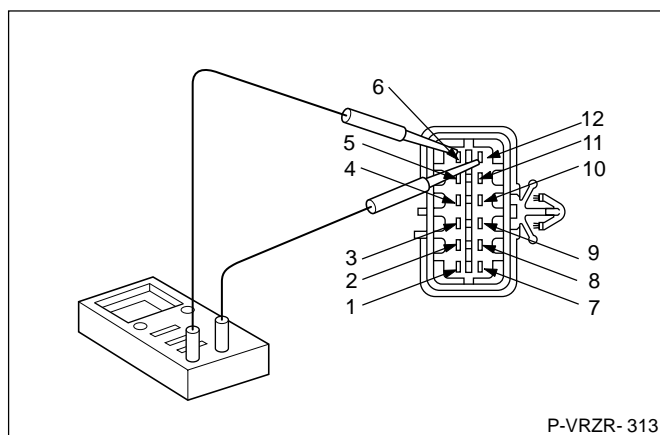
If there is any play between the ball pin and the control sleeve, replace the GE actuator or the distributor head assembly or both.

GE actuator terminals (reference)

Terminal no.	Name	Remarks
1	FCV	Black, magnet valve
2	Blank	-
3	Blank	-
4	CSP (OSC)	Yellow
5	TCV (+)	Red
6	GE (+)	White
7	TF (+)	Blue, fuel temperature (+)
8	CSP (MDL)	Red
9	TCV (-)	Black
10	GE (-)	Green
11	TF (-)	Grey, fuel temperature (-)
12	CSP (GND)	Black



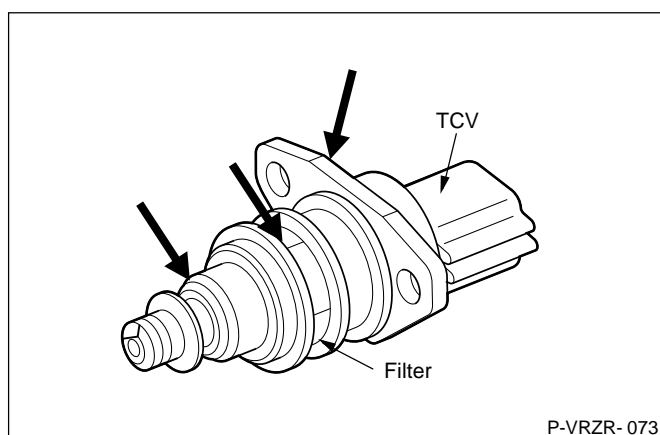
4 COMPONENT INSPECTION



- (3) Measure the resistances between each of the terminals.

Reference values:

Terminal nos	Resistance (Ω)	Ambient temperature ($^{\circ}\text{C}$)
6 - 10	0.71 ± 0.25	23 ± 5
8 - 12	5.9 ± 0.3	23 ± 5
4 - 8	5.9 ± 0.3	23 ± 5
4 - 12	11.8 ± 0.6	23 ± 5
7 - 11	$2.0 \pm 0.6k$	23 ± 5

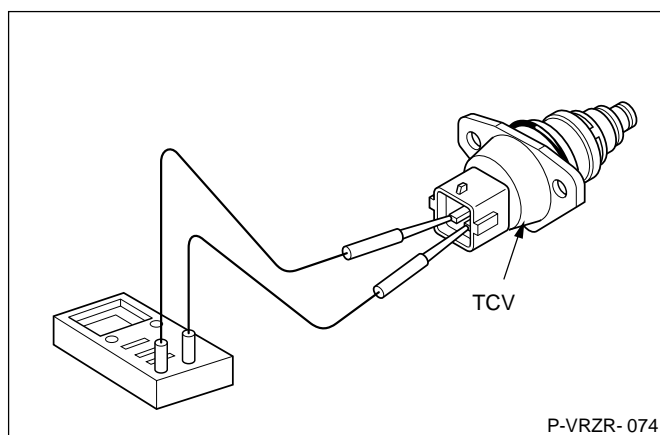


[16] TCV (timing control valve)

- (1) Replace the TCV if the TCV or O-ring is scratched or worn.
- (2) Check the filter for dirt. If it is dirty, clean it using compressed air.

Advice

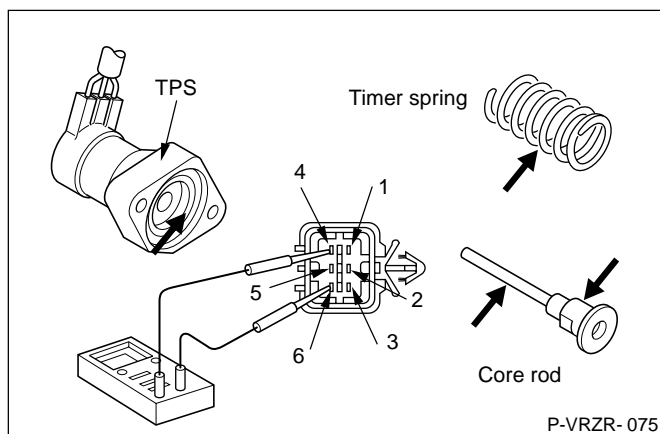
Do not twist or break the O-ring or backup ring.



- (3) Measure TCV resistance.

Reference values:

Terminal nos	Resistance (Ω)	Ambient temperature ($^{\circ}\text{C}$)
5 - 9	11.0 ± 0.8	23 ± 5

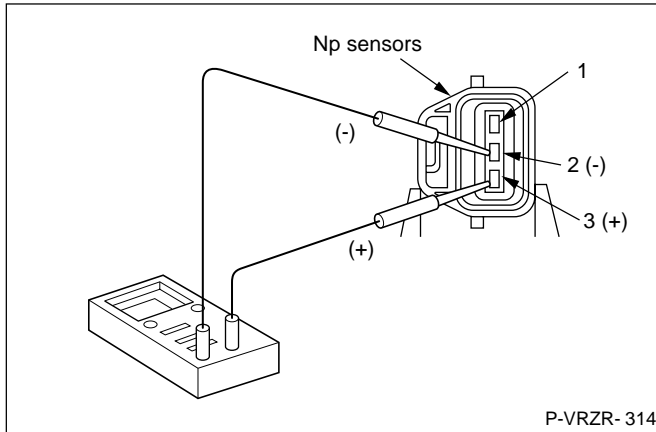


[17] TPS (timer piston sensor)

- (1) Replace the TPS if the inside of the TPS or the core rod is bent or damaged.
- (2) Replace the TPS if the timer spring is worn or the seats are not centered.
- (3) Measure TPS resistances.

Reference values:

Terminal nos	Resistance (Ω)	Ambient temperature ($^{\circ}\text{C}$)
1 - 3	82.0 ± 5.7	25 ± 10
2 - 3	82.0 ± 5.7	25 ± 10



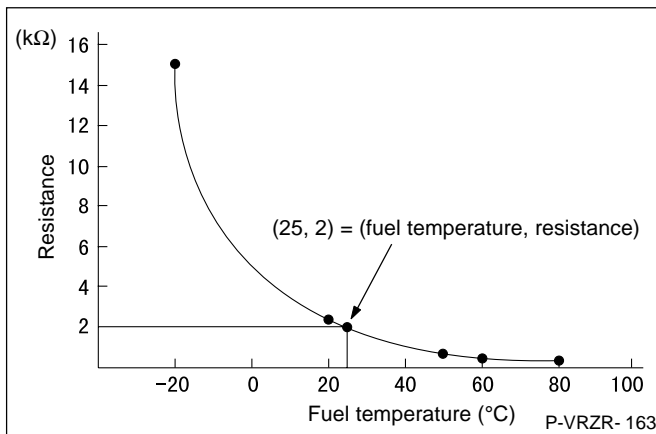
[18] Np sensors

Measure the Np sensors' resistances.

Terminal nos	Resistance (Ω)	Remarks
2 - 3	2.15k	Main
2 - 3	2.15k	Backup

Advice

When using a digital circuit tester, resistances cannot be measured unless you hold the minus probe against the No. 2 terminal and the plus probe against the No. 3 terminal.



[19] Fuel temperature sensor

Measure fuel temperature sensor resistances.

See page 35 for GE actuator terminals.

Reference values:

Terminal nos	Resistance (Ω)	Fuel temperature ($^{\circ}\text{C}$)
7 - 8	2	25

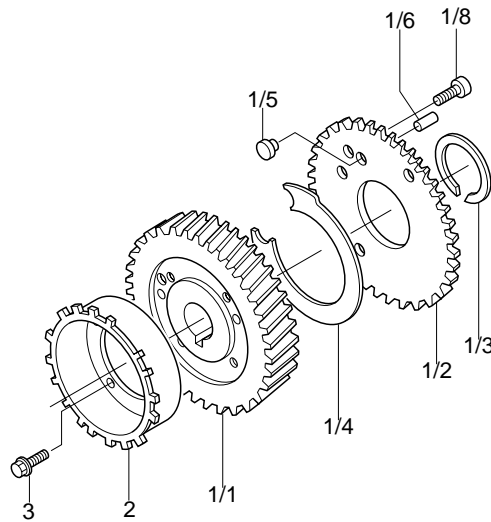
5 GEAR REASSEMBLY

DRIVE GEAR

⚠ CAUTION

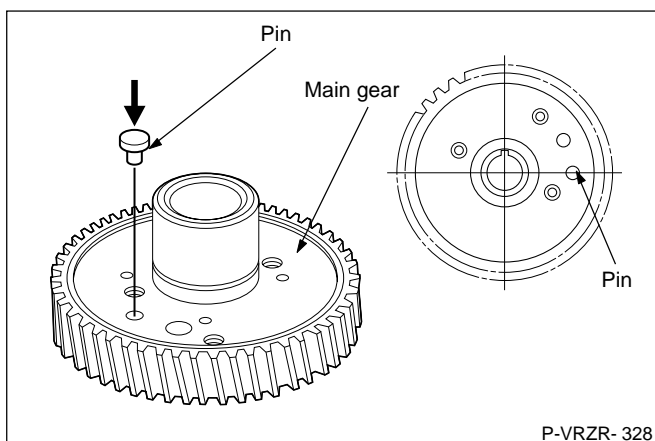
Individual parts of the main gear (key nos. 1/1 to 1/8) cannot be replaced. [This is because the pin (1/6) is pressfitted through the sub-gear (1/2) to the main gear (1/1), and disassembly is not possible once the drive gear has been assembled.] The pulse plate (key no. 2), however, can be reused or replaced.

The drive gear is not assembled when supplied. The following describes the assembly procedure.



P-VRZR- 327

Key no	RBAJ part no	Bosch part no	Part name	Qty
1/1	149931-1910	9 443 613 479	Main gear	1
1/2	149931-2000	9 443 613 480	Sub-gear	1
1/3	149931-1600	9 443 613 481	Snapring	1
1/4	149931-1200	9 443 613 482	Spring	1
1/5	149931-1300	9 443 613 483	Pin	2
1/6	149931-1400	9 443 613 484	Pin	1
1/8	149917-1500	9 443 613 485	Socket head bolt	1
2	149931-0600	9 443 612 889	Pulse plate	1
3	149917-1400	9 443 612 878	Bolt	4

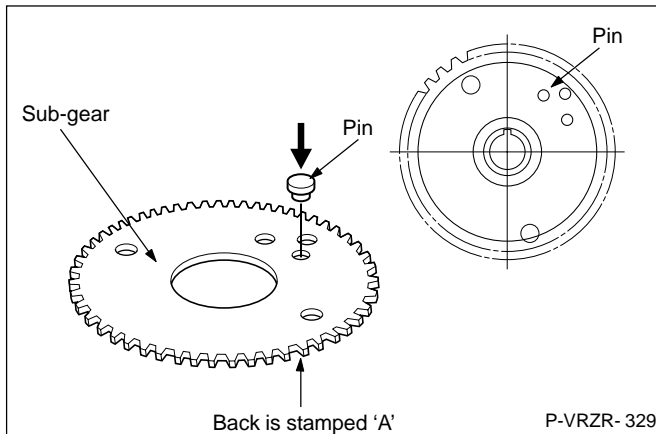


P-VRZR- 328

(1) Fully pressfit the pin to the main gear.

Part name	Part no (Mitsubishi part no)	Remarks
Pin	149931-1300 (ME204193)	
Main gear	149931-1910 (ME204369X)	

5 GEAR REASSEMBLY

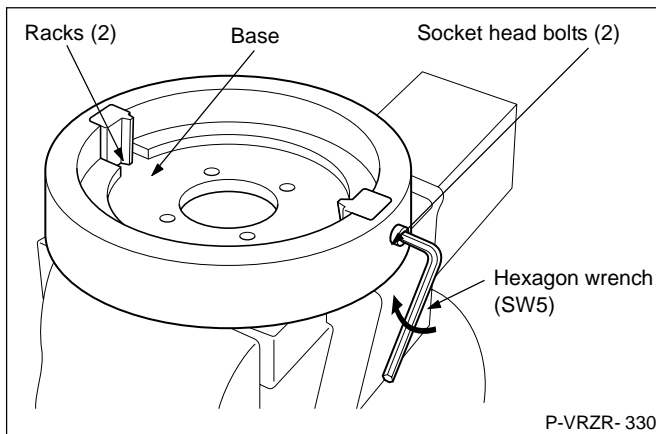


(2) Fully pressfit the pin to the sub-gear.

Advice

Pressfit the pin to the face of the gear without the mark 'A.'

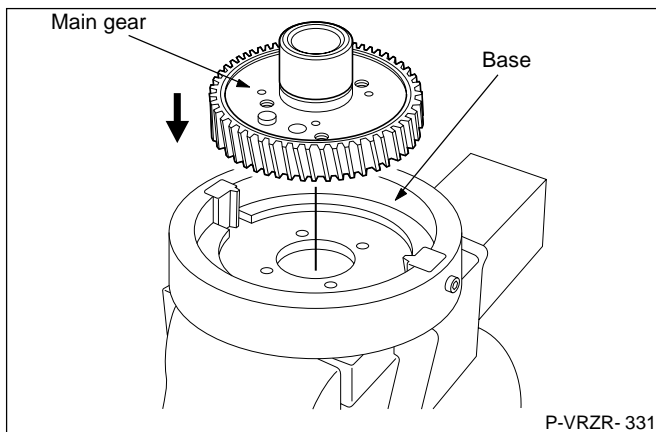
Part name	Part no (Mitsubishi part no)	Remarks
Pin	149931-1300 (ME204193)	
Sub-gear	149931-2000 (ME204370)	



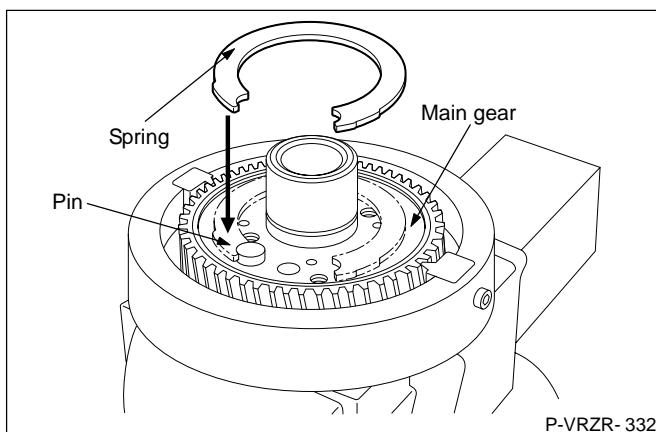
(3) Fix the base in a vise.

(4) Install the racks to the base using the socket head bolts.

Tool name	Part no	Remarks
Base	157924-8520	The racks are included with the base.
Rack	157917-4300	Use the racks with the '4M41' stamping.



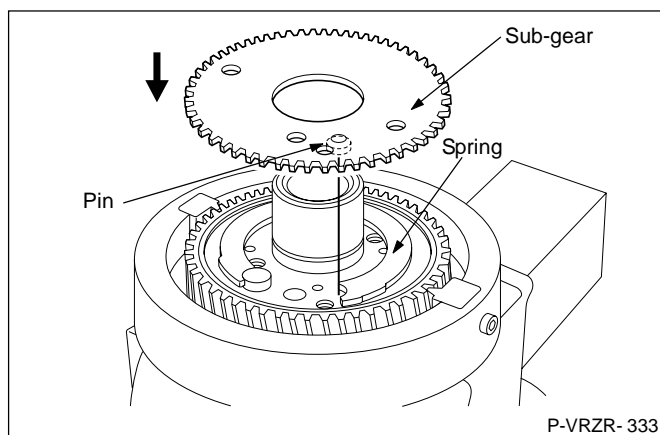
(5) Align the main gear with the racks and attach it to the center of the base.



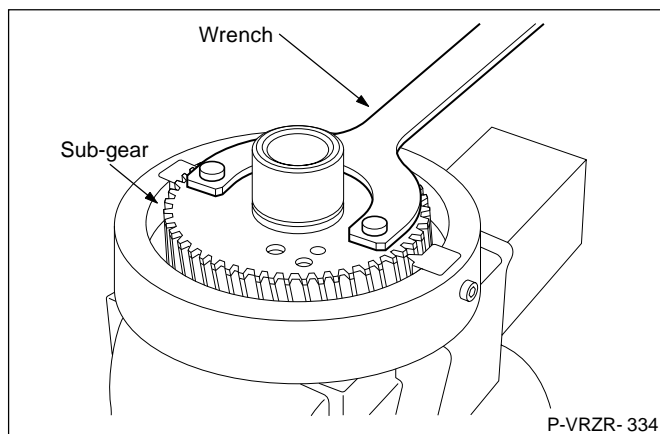
(6) Align the spring with the main gear's pin.

Part name	Part no (Mitsubishi part no)	Remarks
Spring	149931-1200 (ME204192)	

5 GEAR REASSEMBLY

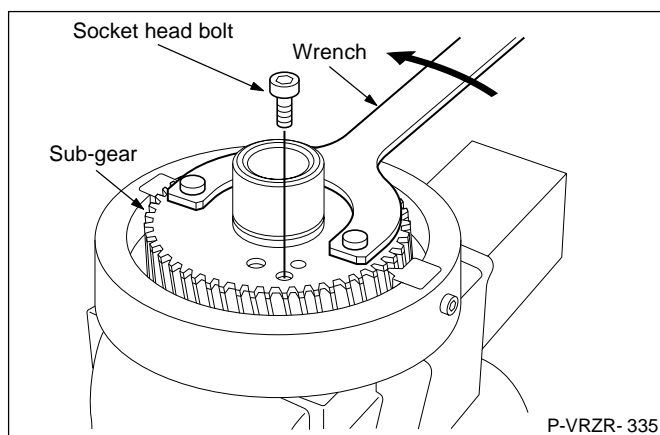


- (7) Attach the sub-gear to the main gear. At this time, hook the sub-gear's pin to the spring.



- (8) Align the wrench with the sub-gear's holes and attach it to the sub-gear.

Tool name	Part no	Remarks
Wrench	157917-4920	



- (9) Turn the wrench counterclockwise to align the main gear's teeth with the sub-gear's teeth.

- (10) Screw in the socket head bolt (SW5) to tighten the sub-gear to the main gear.

**Specified torque: 9 ~ 13 N·m
{0.9 ~ 1.3 kgf·m}**

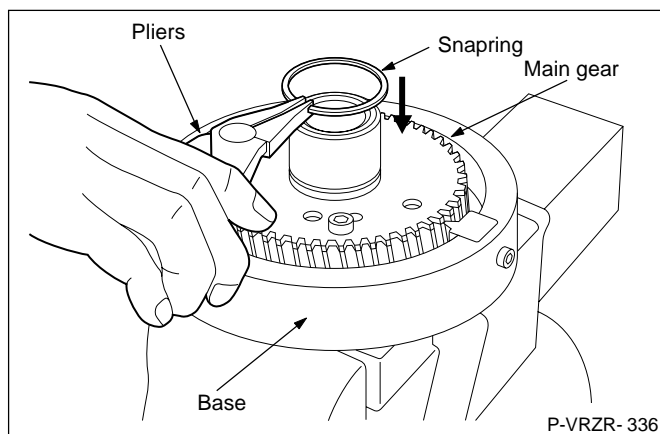
Part name	Part no (Mitsubishi part no)	Remarks
Socket head bolt	149917-1500 (ME204287)	SW5

⚠ CAUTION

Socket head bolts cannot be reused.

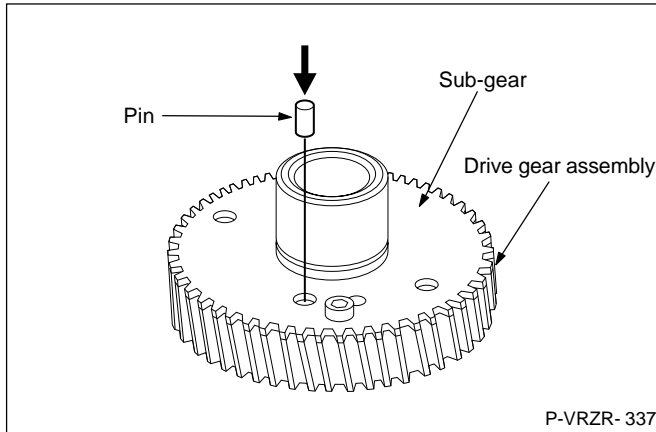
- (11) Hold the snapping open using pliers and install it in the main gear's snapping groove.

Tool name	Part no	Remarks
Pliers	157928-4400	



Part name	Part no (Mitsubishi part no)	Remarks
Snapping	149931-1600 (ME204236)	

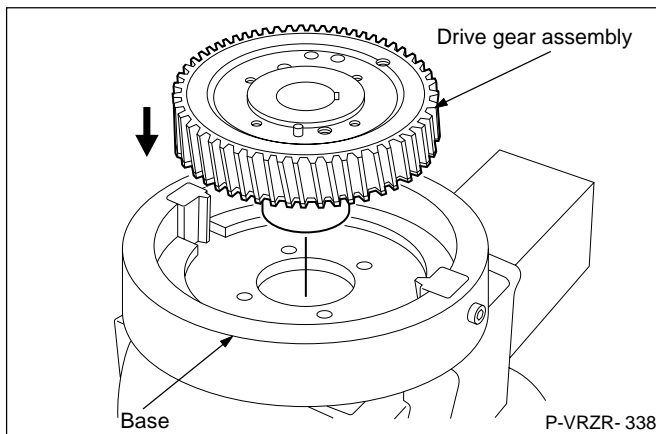
5 GEAR REASSEMBLY



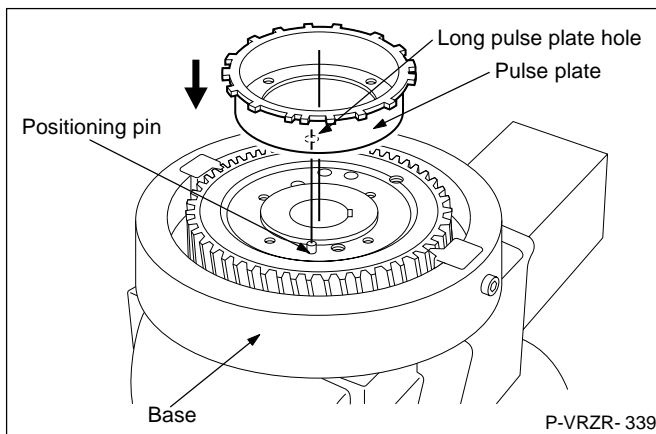
- (12) Remove the drive gear assembly from the base and pressfit the pin until it is level with the face of the sub-gear.

Specified position: 0 ~ 1 mm from face of sub-gear

Part name	Part no (Mitsubishi part no)	Remarks
Pin	149931-1400 (MF472404)	

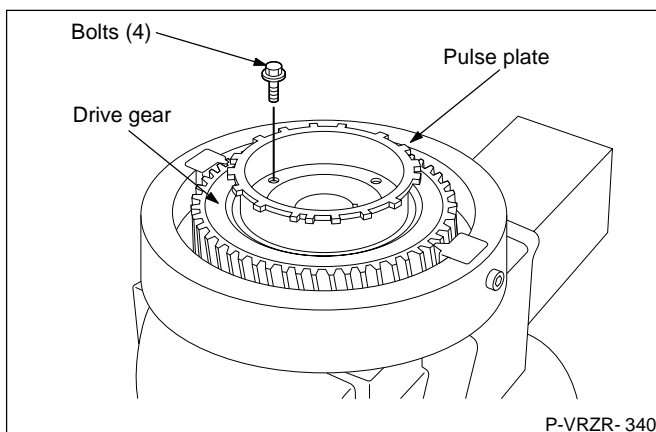


- (13) Turn the drive gear assembly upside down, align it with the racks and attach it to the center of the base.



- (14) Align the pulse plate's long hole with the drive gear's positioning pin and attach it to the drive gear.

Part name	Part no (Mitsubishi part no)	Remarks
Pulse plate	149931-0600 (ME203076)	



- (15) Screw in the bolts (SW7) and tighten the pulse plate to the drive gear.

**Specified torque: 4 ~ 5 N·m
{0.4 ~ 0.5 kgf·m}**

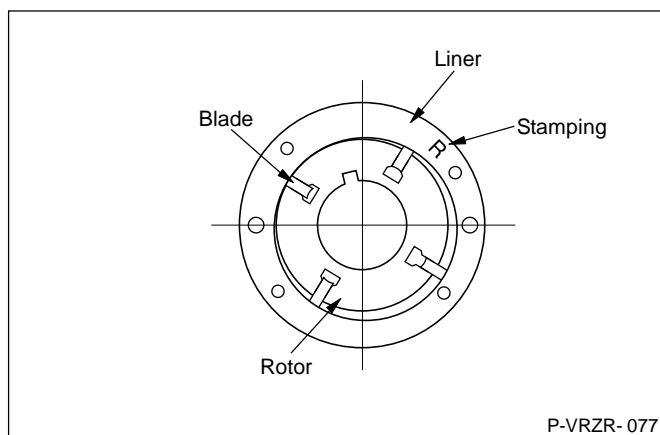
Part name	Part no (Mitsubishi part no)	Remarks
Bolts	149917-1400 (MF472404)	4; not reuseable

⚠ CAUTION

Bolts cannot be reused.

The above completes reassembly of the drive gear for the 4M41 model engine.

6 REASSEMBLY



The reassembly of the VRZ type injection pump is basically the reverse of the disassembly procedure. The following describes the standard reassembly procedure.

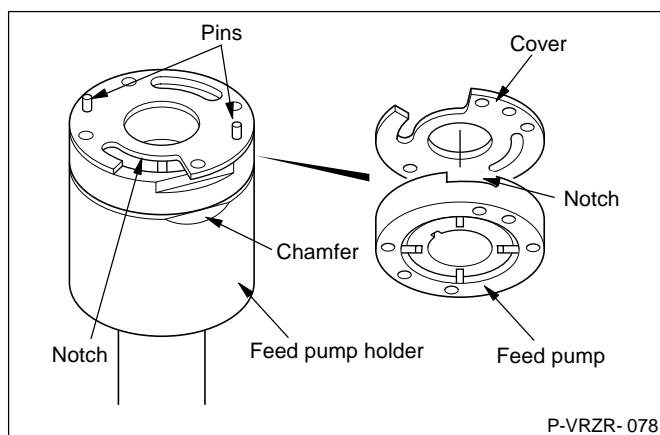
Always replace gaskets and O-rings with new ones.

1. REASSEMBLY

[1] Feed pump assembly reassembly

Advice

- Confirm that the blades' grooves are positioned toward the inside.
- Blade and rotor orientation cannot be changed.
- The feed pump's liner is marked with an 'R' for clockwise injection pump rotation or an 'L' for counterclockwise injection pump rotation. Install the liner so that the applicable mark can be seen when the liner is viewed from the head side.

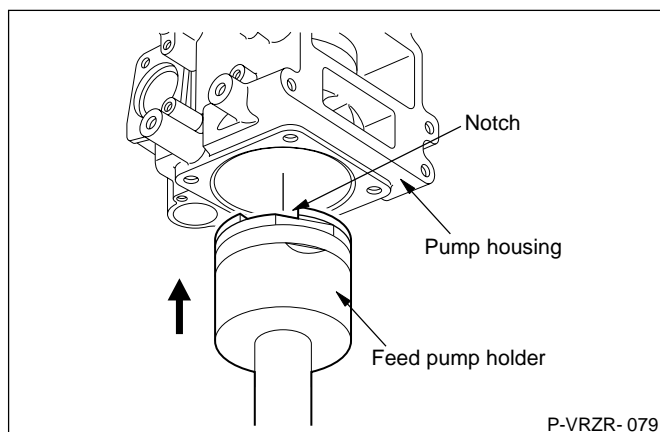


- (1) Position the feed pump assembly and the cover on the feed pump holder. Assemble the holder pins in the feed pump holes (2).

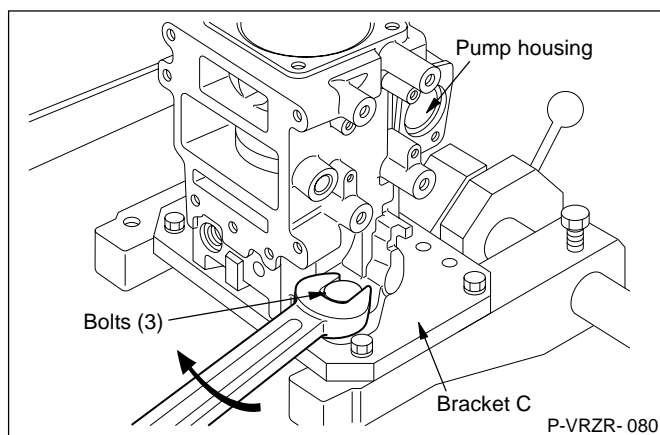
Tool name	Part no	Remarks
Feed pump holder	157928-4320	

Advice

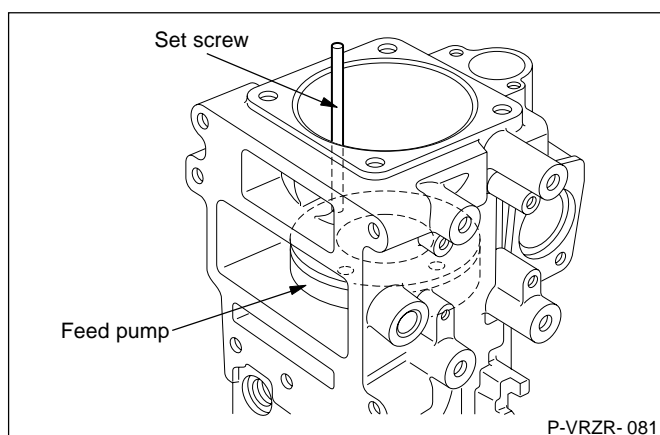
Align the feed pump cover notch with the feed pump holder chamfer.



- (2) Position the feed pump cover notch toward the GE actuator side and insert the feed pump assembly into the pump housing until the feed pump is contacting the housing.
- (3) Hold the feed pump holder so that it does not move and turn the pump housing upside down.



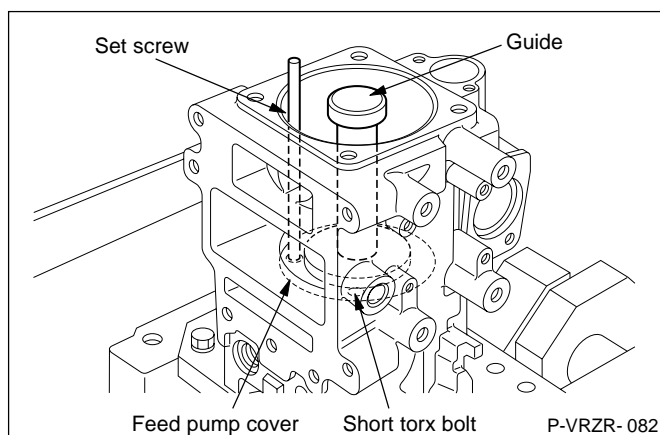
- (4) Attach the pump housing to bracket C and remove the feed pump holder.



- (5) Screw the set screw into the pump housing. (The set screw is used as a guide when positioning the feed pump cover.)

Tool name	Part no	Remarks
Set screw	157928-4500	

- (6) Assemble the feed pump O-ring to the feed pump. (Refer to page 29 for the O-ring key number.)



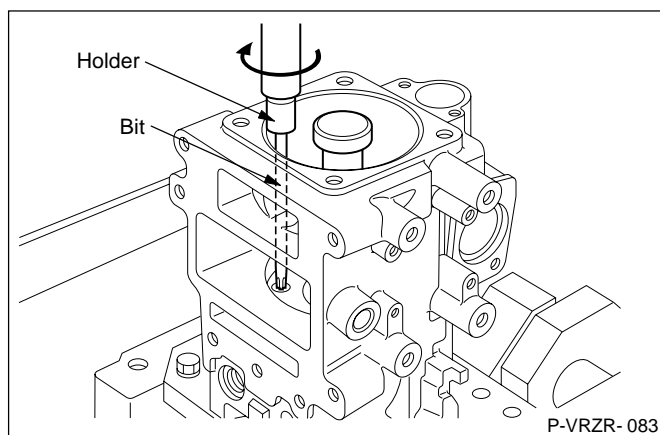
- (7) Align the feed pump cover hole with the set screw and assemble the cover to the feed pump.

- (8) Insert the guide into the feed pump.

Tool name	Part no	Remarks
Guide	157928-4200	

- (9) Temporarily tighten two of the four torx bolts.

6 REASSEMBLY



- (10) Remove the set screw and install the other two torx bolts.
- (11) Tighten the four torx bolts uniformly. (One of the four torx bolts does not screw into the pump housing.)

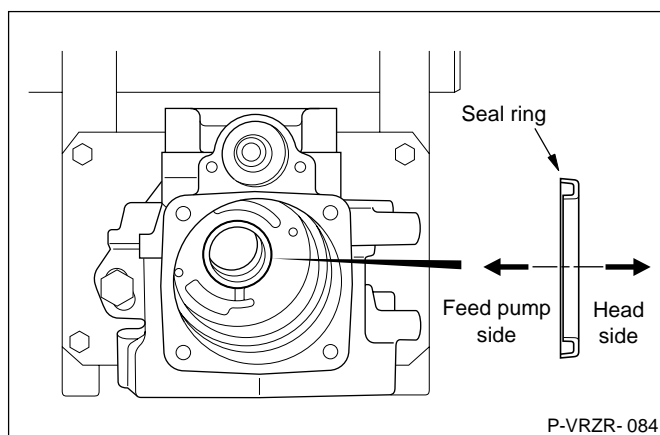
Specified torque: 3.0 ~ 4.0 N·m
{0.3 ~ 0.4 kgf·m}

For feed pump	Part no	Remarks
Short torx bolt	149916-0400 (9 443 612 874)	1
Long torx bolt	149916-0300 (9 443 612 873)	3

Tool name	Part no	Remarks
Holder	157915-9820	
Bit	157915-9201	T15

Advice

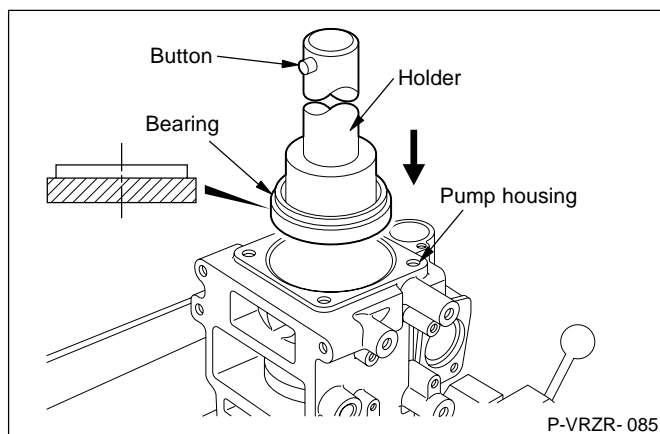
Move the rotor backward and forward and left and right with your finger and check that it moves smoothly. If it does not move smoothly, loosen the feed pump cover and then retighten it to the specified torque.



- (12) Insert the seal ring into the feed pump cover.

Advice

Be careful with the assembly orientation of the seal ring and ensure it is securely assembled to the feed pump cover.



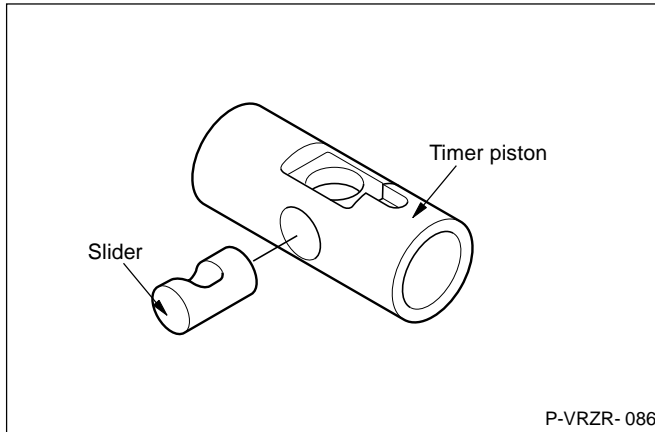
[2] Bearing reassembly

- (1) Assemble the holder to the bearing and press the holder button (to hold the bearing).
- (2) Install the bearing in the pump housing.

Tool name	Part no	Remarks
Holder	157928-3620	

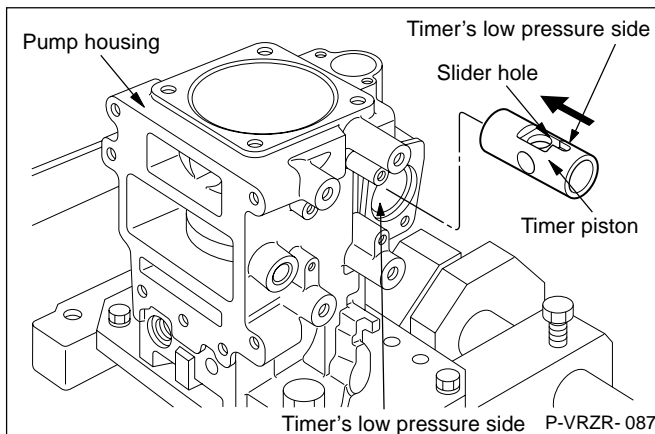
Advice

Ensure the bearing is positioned correctly.



[3] Timer piston reassembly

(1) Assemble the slider in the timer piston.



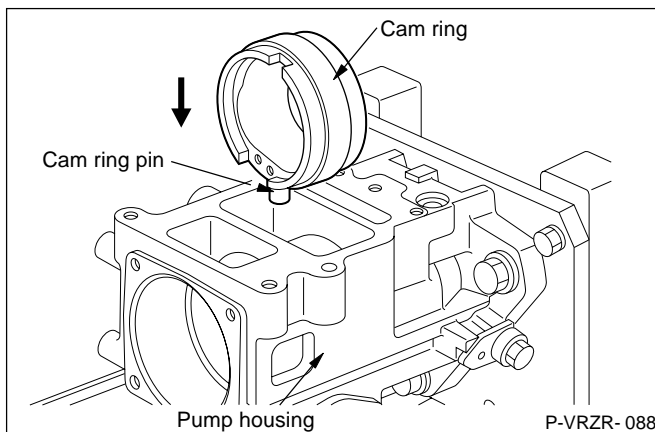
(2) Assemble the timer piston and slider in the pump housing.

Advice

- **Align the slider hole with the timer piston hole.**
- **The slider is assembled in the timer with the hole positioned toward the GE actuator side.**

Note:

The timer piston's low pressure side is positioned toward where the Q adjustment ROM is installed.



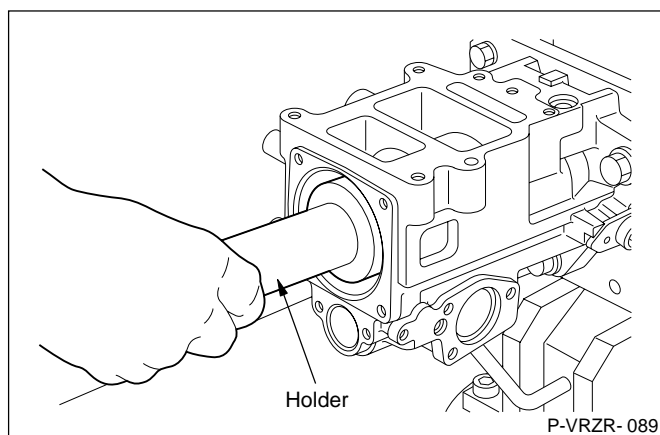
[4] Cam ring reassembly

Assemble the cam ring in the pump housing.
At this time, insert the cam ring pin into the timer piston's slider hole.

Advice

Confirm that the timer piston slides smoothly.

6 REASSEMBLY



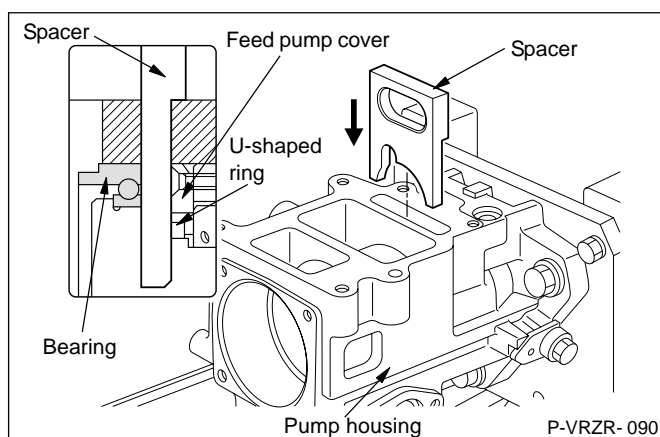
[5] Drive shaft reassembly

- (1) Insert the holder into the bearing.
- (2) Press the holder button to hold the bearing and pull the bearing into the head.

Advice

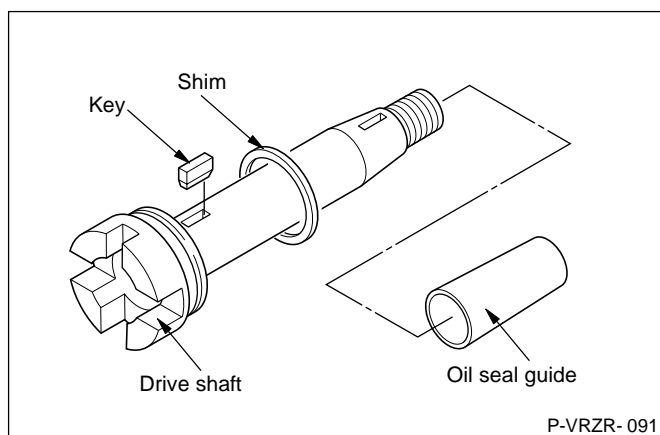
Pull the bearing into the head so that a gap remains between the feed pump cover and the bearing.

Tool name	Part no	Remarks
Holder	157928-3620	



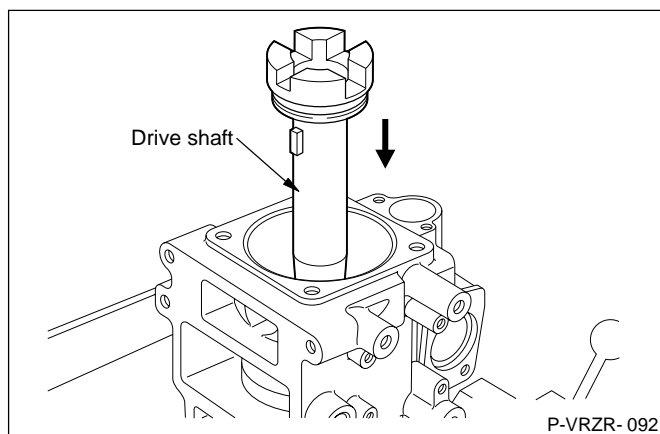
- (3) Insert the spacer into the pump housing.

Tool name	Part no	Remarks
Spacer	157928-4700	



- (4) Assemble the shim and the feed pump's drive side key on the drive shaft.
- (5) Assemble the oil seal guide on the drive shaft thread.

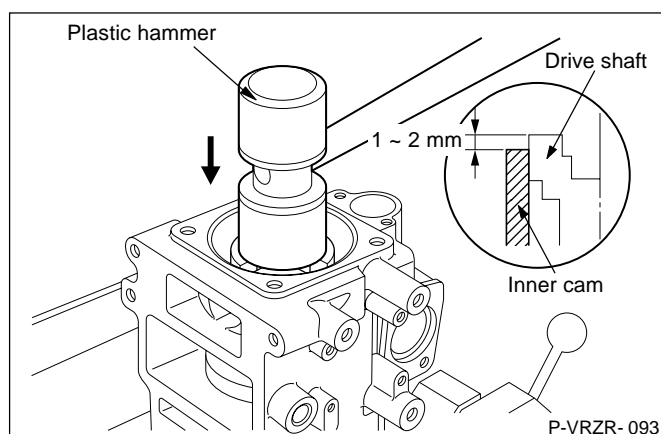
Tool name	Part no	Remarks
Oil seal guide	157928-4000	For $\phi 25$ dia shaft



- (6) Confirm that the seal ring is inserted into the feed pump cover (see bottom figure of page 44).
- (7) Align the drive shaft key with the feed pump rotor key groove and insert the drive shaft into the feed pump.

Advice

Insert the drive shaft gently into the feed pump while turning it clockwise and counter clockwise to align the key with the key groove.



- (8) Lightly tap the drive shaft using a plastic hammer to assemble the drive shaft with the end fully protruding from the drive side.

Advice

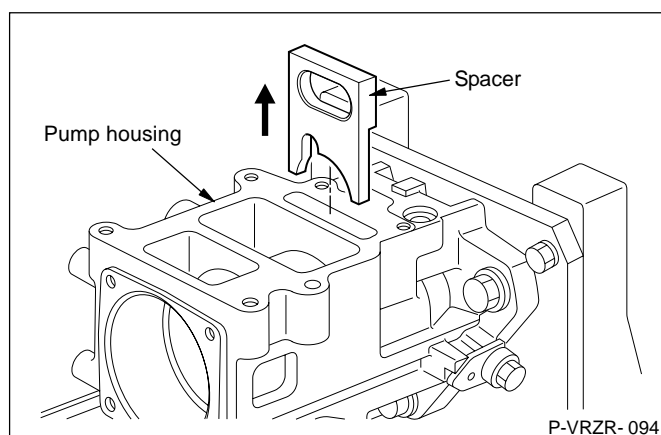
- When tapping the drive shaft with the plastic hammer, ensure no burrs or dirt remain on the shaft.
- Insert the drive shaft so that the end of the drive shaft is 1 ~ 2 mm higher than the end of the inner cam (when viewed from above).
- After assembling the drive shaft, confirm that the shaft rotates smoothly.

[6] Snapping reassembly

- (1) Remove the spacer from the pump housing.

Advice

Confirm that the drive shaft's snapping groove can be seen through the housing window.

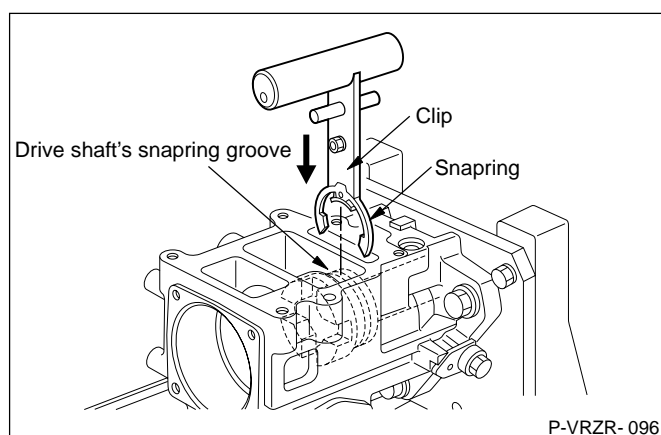
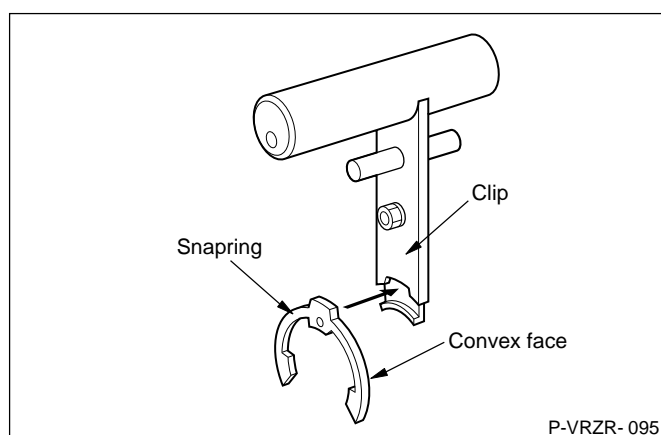


- (2) Assemble the snapping to the clip.

Tool name	Part no	Remarks
Clip	157928-3120	

Advice

Position the snapping on the clip with the convex face toward the clip.



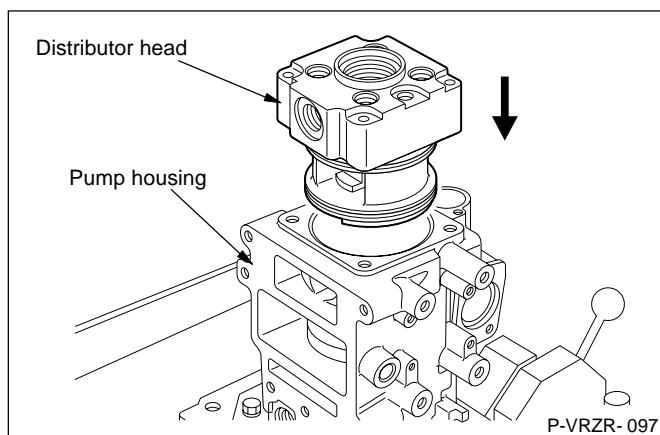
- (3) Position the snapping in the drive shaft's ring groove and push it straight down.

- (4) Remove the clip from the snapping and use the end of the clip to push the snapping fully into the groove.

Advice

Confirm that the snapping is fully inserted into the groove and that the drive shaft can be rotated.

6 REASSEMBLY

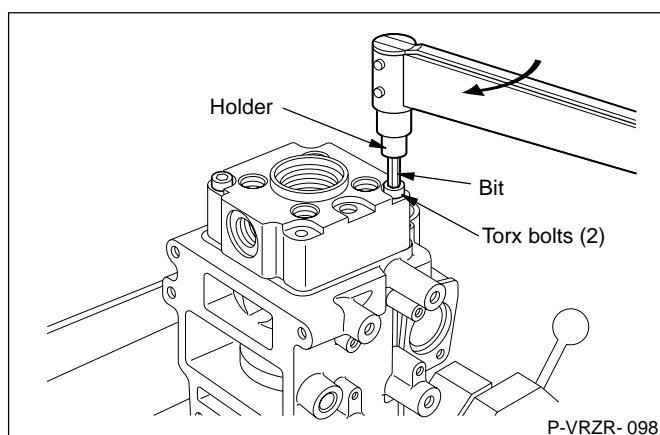


[7] Adjusting drive shaft axial play

- (1) Position the distributor head on the pump housing.

Advice

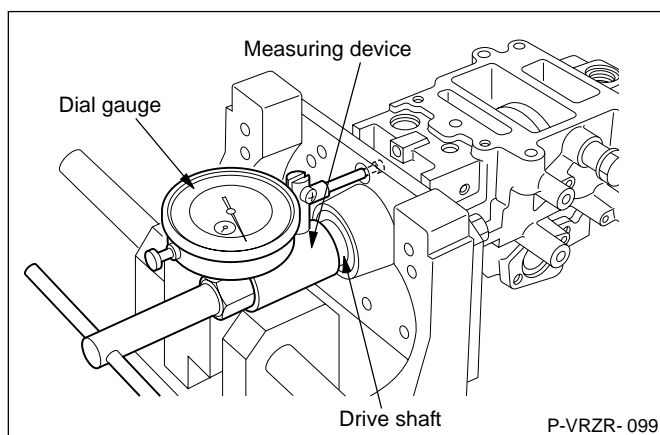
Do not assemble the O-ring or the control sleeve at this time.



- (2) Install and tighten two diametrically opposed torx bolts of the four to install the distributor head.

**Specified torque: 10.0 ~ 14.0 N·m
{1.0 ~ 1.4 kgf·m}**

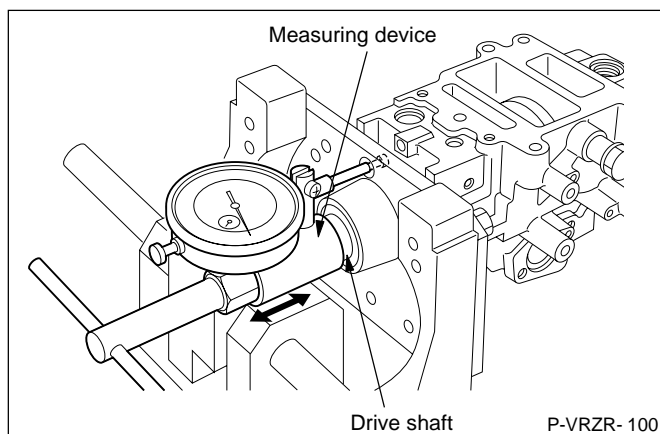
Tool name	Part no	Remarks
Holder	157915-9820	
Bit	157915-9600	T30



- (3) Attach the measuring device to the drive shaft.

- (4) Attach the dial gauge to the measuring device.

Tool name	Part no	Remarks
Measuring device	105782-4530	



- (5) Measure the drive shaft's axial play.

**Specified value: 0.1±0.05 mm
(with the head assembly installed)**

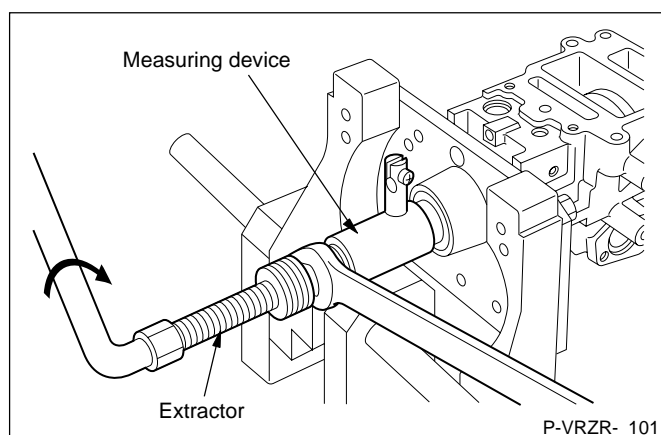
- (6) If not as specified, select shims from the table on the following page and exchange the shims until the axial play is as specified. (Refer to page 49.)

Advice

If the axial play varies greatly from the specified value, repeat procedure [5] on page 46 and [6] on page 47.

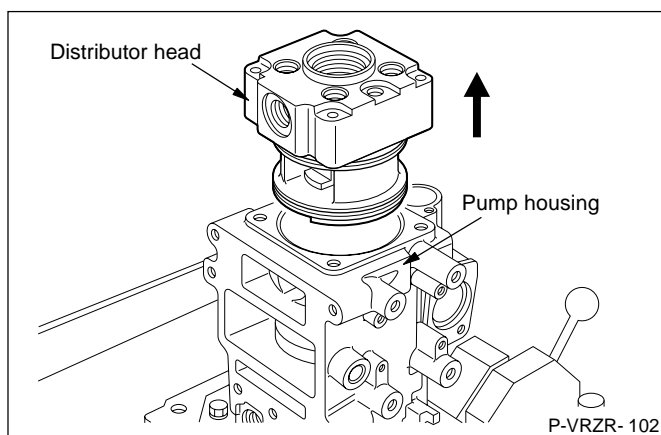
Shims

RBAJ part no	Bosch part no	Thickness (mm)
149602-0000	9 443 612 809	1.90
149602-0100	9 443 612 810	1.95
149602-0200	9 443 612 811	2.00
149602-0300	9 443 612 812	2.05
149602-0400	9 443 612 813	2.10
149602-0500	9 443 612 814	2.15
149602-0600	9 443 612 815	2.20
149602-0700	9 443 612 816	2.25
149602-0800	9 443 612 817	2.30
149602-0900	9 443 612 818	2.35
149602-1000	9 443 612 819	2.40

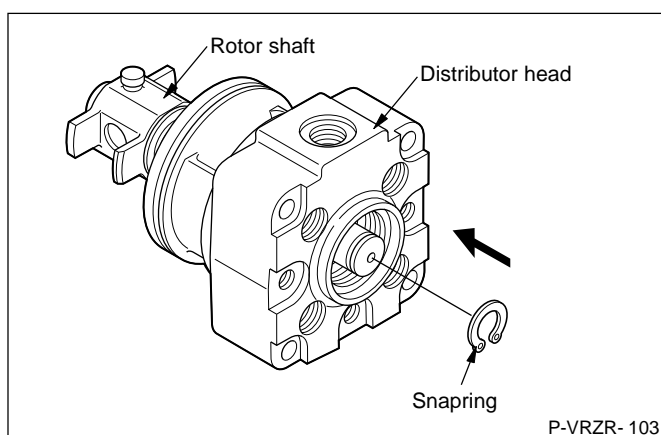


- (7) Remove the dial gauge.
- (8) Remove the measuring device handle and attach the extractor.
- (9) Screw in the extractor to remove the measuring device.

Tool name	Part no	Remarks
Extractor	157926-2421	



- (10) Remove the torx bolts from the distributor head.
- (11) Remove the distributor head from the pump housing.



[8] Selecting the rotor shaft shim

Purpose

The rotor shaft's axial play is measured and then the play is adjusted to the specified value using the shim.

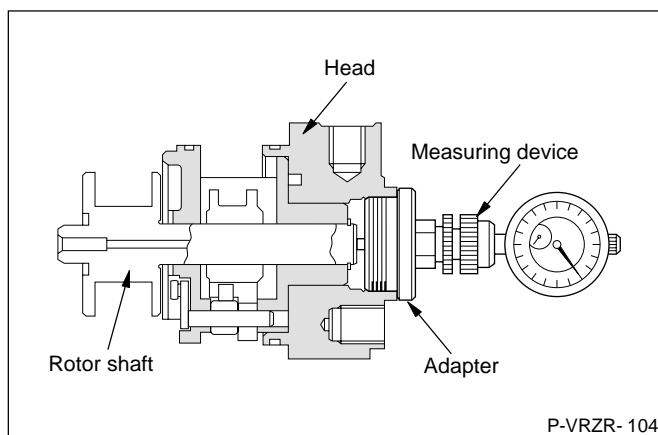
Procedure 1 Adjusting the dial gauge's '0' point

- (1) Insert the rotor shaft into the distributor head.
- (2) Install the snapping in the rotor shaft's snapping groove.

Advice

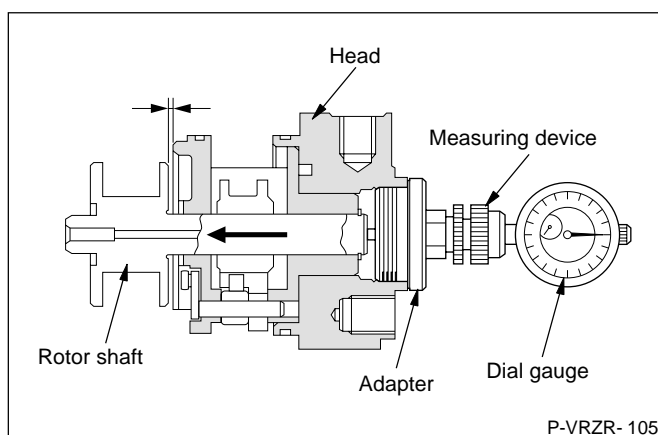
Do not assemble the shim at this time.

6 REASSEMBLY

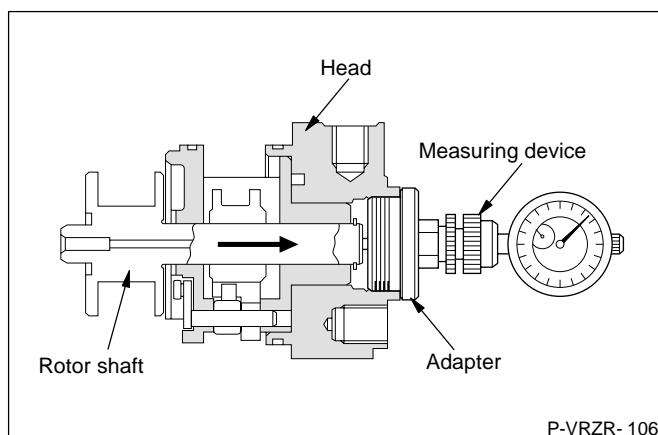


- (3) Attach the adapter to the head and then attach the measuring device to the adapter.

Tool name	Part no	Remarks
Adapter	157845-8900	
Measuring device	157829-3520	For measuring VE cam lift



- (4) Pull the rotor shaft fully to the left and set the dial gauge to the '0' position.

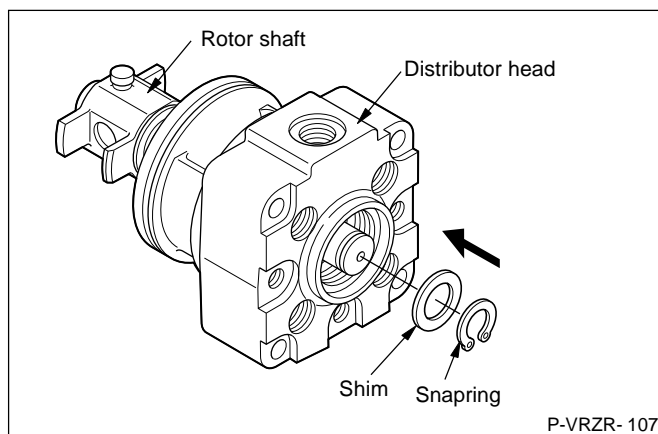


Procedure 2 Calculating the shim thickness

- (1) Push the rotor shaft fully to the right and measure the full stroke from the dial gauge.

Advice

The rotor shaft's groove must not catch on the head.

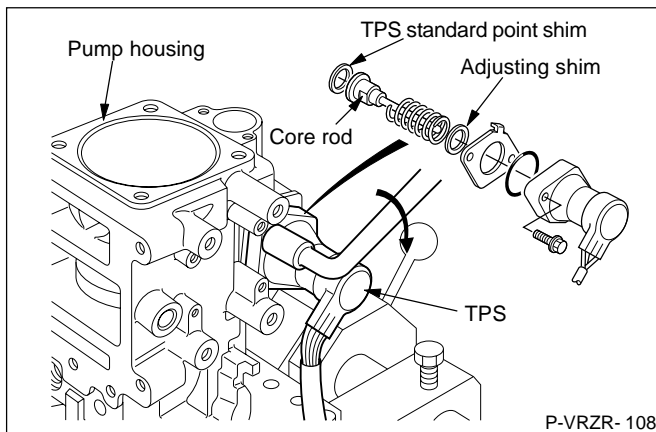


- (2) Select a shim using the formula below.
Shim thickness = full stroke – 0.2 (mm)

RBAJ part no (key no. 53)	Bosch part no	Thickness (mm)
149720-0000	9 443 612 851	2.1
149720-0100	9 443 612 852	2.2
149720-0200	9 443 612 853	2.3
149720-0300	9 443 612 854	2.4

- (3) Install the selected shim and the snapping to the rotor shaft.
- (4) After inserting the shim, confirm that the stroke is as specified. If not as specified, repeat Procedure 1 and Procedure 2.
- Specified stroke: 0.2±0.1 mm**

- (5) Remove the dial gauge and adapter from the head.
- (6) Remove the snapping.



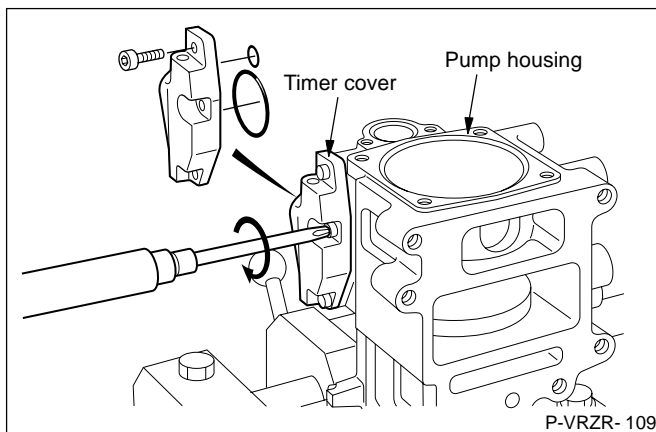
[9] TPS and timer cover reassembly

- (1) Assemble the TPS to the pump housing.

Specified torque: 7.0 ~ 10.0 N·m
{0.7 ~ 1.0 kgf·m}

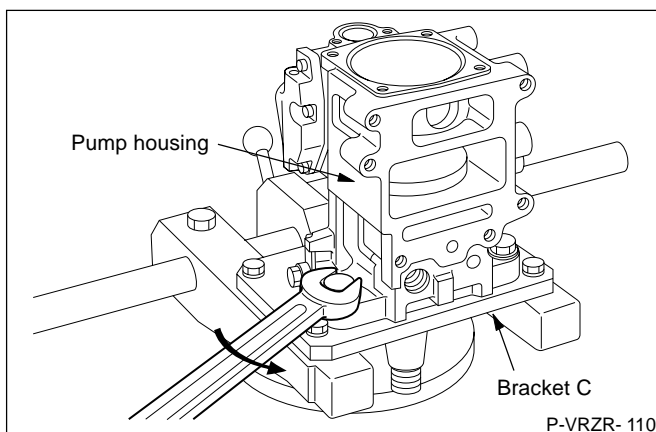
Advice

Do not mistake the positions of the TPS standard point shim and the adjusting shim.



- (2) Assemble the O-rings (at two locations) and then assemble the high pressure side timer cover on the pump housing.

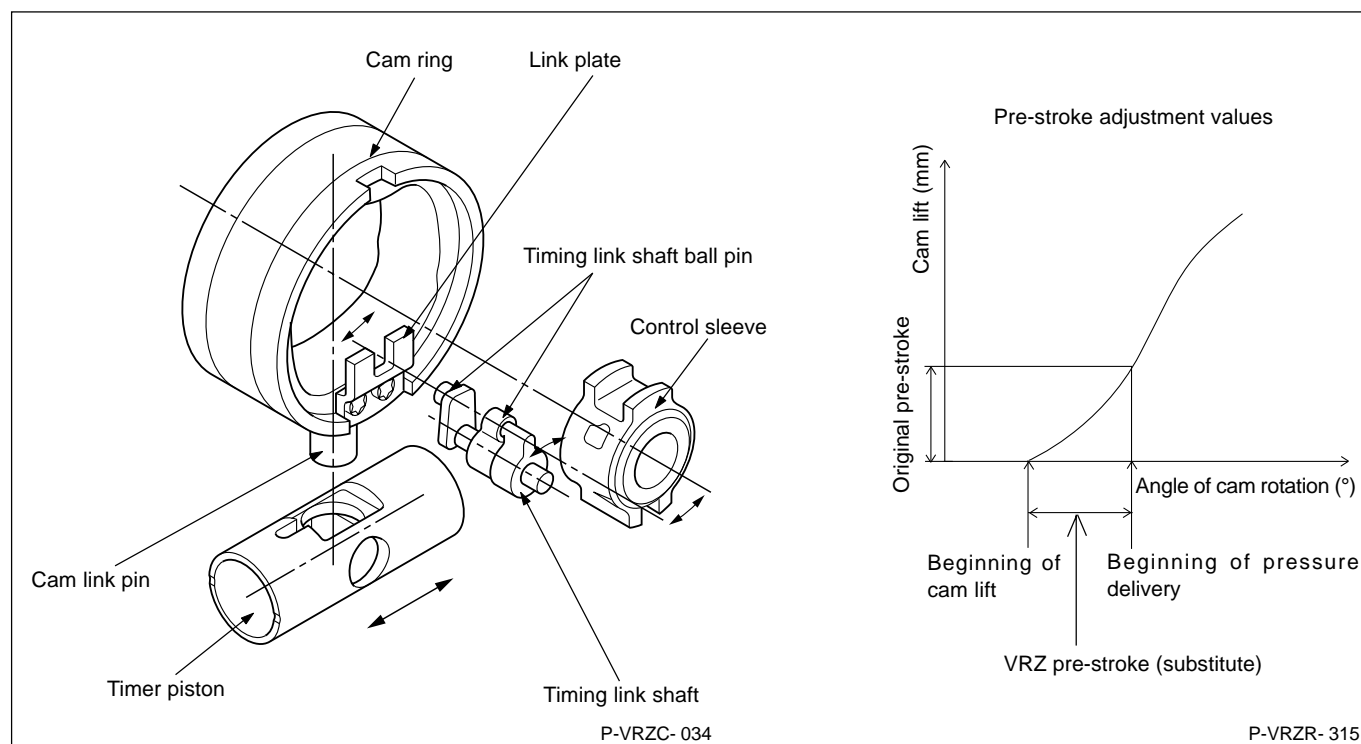
Specified torque: 7.0 ~ 10.0 N·m
{0.7 ~ 1.0 kgf·m}



[10] Pump removal

Remove the pump housing from bracket C.

2. PRE-STROKE ADJUSTMENT



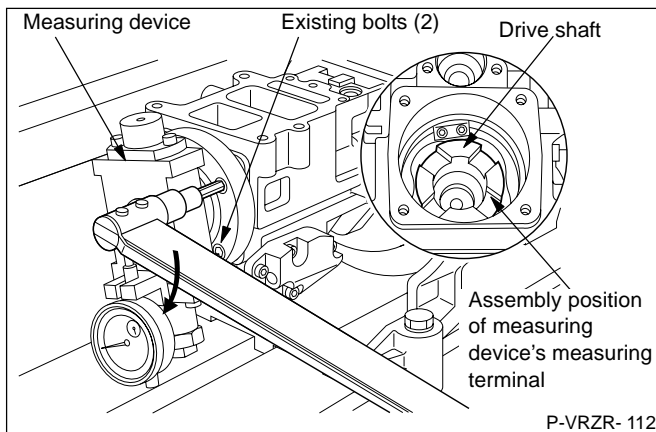
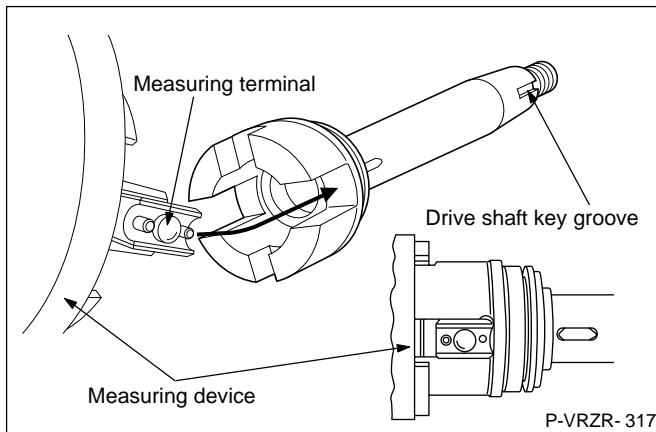
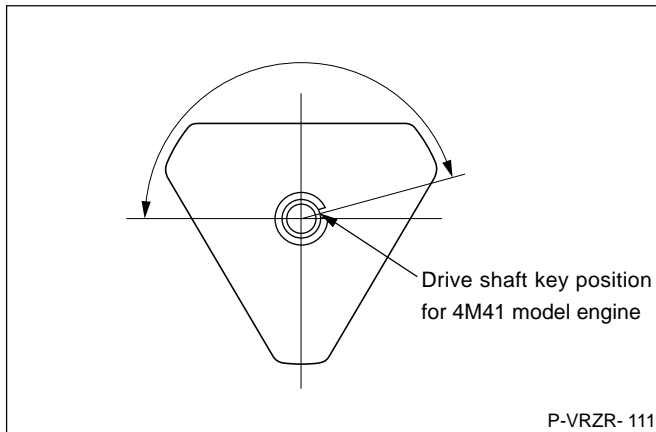
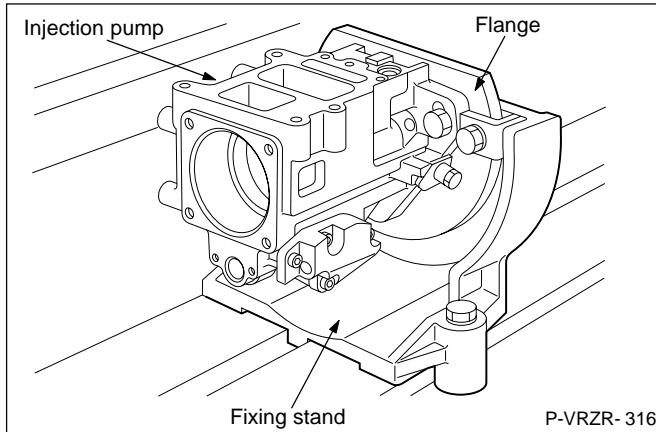
Fundamentally, pre-stroke is the amount of lift from the cam's bottom dead center position to the beginning of pressure delivery position. With the VRZ pump, however, because it is not possible to measure the cam lift with the pump assembled, the cam angle is instead measured from the beginning of cam lift position to the beginning of pressure delivery position.

The beginning of pressure delivery position can be changed by changing the phase (ie, the angle) between the cam link and the control sleeve, which are connected by the timing link shaft.

Consequently, by changing the position of the link plate groove, we can change the phase of the cam link and the control sleeve to adjust the pre-stroke (ie, substituting the angle instead).

Pre-stroke adjustment sequence

- (1) Attach the measuring device to the pump.
- (2) Align the measuring device's measuring terminal with the standard cylinder B's cam position.
- (3) Find the cam's bottom dead center position using the dial gauge, then zero the dial gauge.
- (4) Rotate the pump in the specified direction of rotation and set the cam lift to 0.70 mm using the dial gauge.
- (5) Set the '0' point using the KMA device to display cam lift as an angle.
- (6) Turn the pump back 10° in the direction opposite to the specified direction of rotation. Turn the pump 5° in the specified direction of rotation (to prevent backlash).
- (7) Confirm that the dial gauge displays 0 mm.
- (8) Using the KMA device, reset the '0' point. (Using the KMA device, begin cam lift.)



[1] Measuring device installation

⚠ CAUTION

The pump test bench drive motor must be turned OFF.

Injury or damage may result if the pump test bench drive motor is turned ON.

- (1) Temporarily attach the fixing stand to the pump test bench and attach the injection pump to the fixing stand.

Tool name	Part no	Remarks
Fixing stand	105796-0000	For 20NP
Flange	157811-9020	For VRZ

- (2) Align the key groove with the standard cylinder B's pressure delivery cam position as shown at left.

- (3) Align the drive shaft key groove and the measuring device's measuring terminal.

Note:

- The pre-stroke can be measured on any cylinder. Because the pump is set at the standard cylinder B, however, measure the pre-stroke for this cylinder.
- If the drive shaft key groove and the measuring device's measuring terminal are not aligned, pre-stroke cannot be adjusted from cylinder B when the rotor shaft is assembled.

- (4) Install the pre-stroke measuring device.

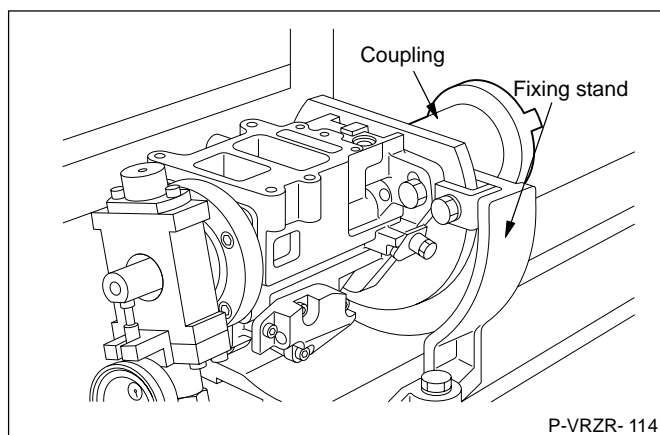
**Specified torque: 10.0 ~ 14.0 N·m
{1.0 ~ 1.4 kgf·m}**

Tool name	Part no	Remarks
Measuring device	105782-4540	

Advice

- Align the drive shaft's key groove and the measuring device's measuring terminal with the drive shaft.
- Ensure the end of the measuring device is securely assembled to the drive shaft groove.

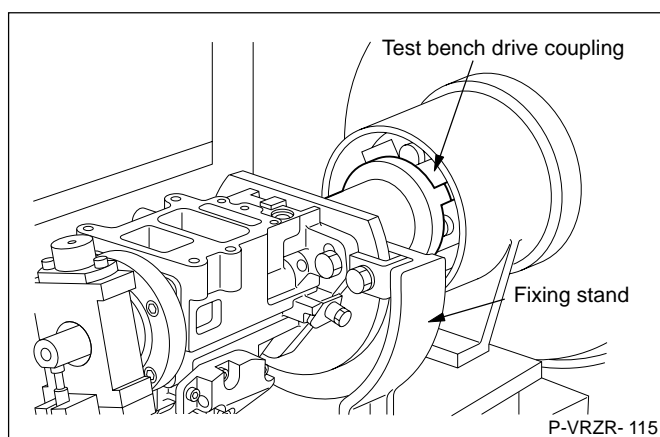
6 REASSEMBLY



- (5) Assemble the key to the drive shaft. Align the coupling with the key, assemble it to the drive shaft and then fix it using the nut.

Tool name	Part no	Remarks
Coupling	157847-0820	Shaft dia $\phi 25$

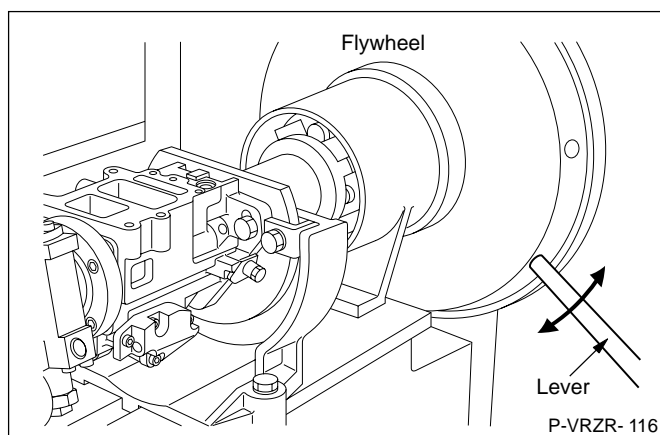
**Specified torque: 167 ~ 185 N·m
{17.0 ~ 19.0 kgf·m}**



- (6) Move the fixing stand to assemble the coupling teeth to the pump test bench drive coupling.

Advice

Ensure approximately 1 mm axial clearance between the coupling and the drive coupling.



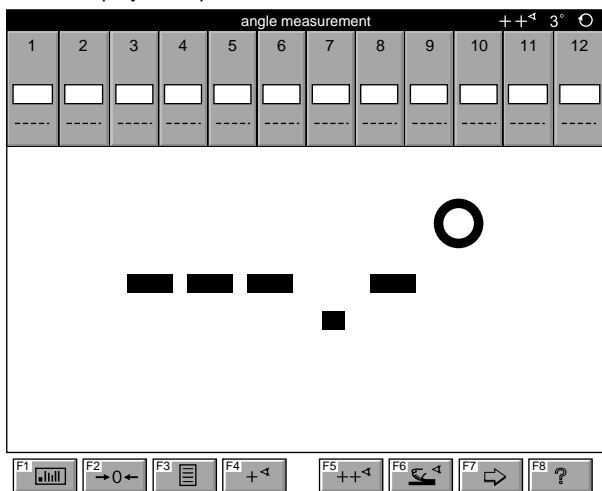
- (7) Securely tighten the fixing stand installation bolts and nuts and the drive coupling socket head bolt to fix the injection pump to the pump test bench.
- (8) Turn the pump test bench flywheel using the lever to confirm that the injection pump rotates smoothly.

⚠ CAUTION

Remove the lever after operating the flywheel.

Operating the test bench without removing the lever can cause serious injury and damage the test bench.

Monitor display example

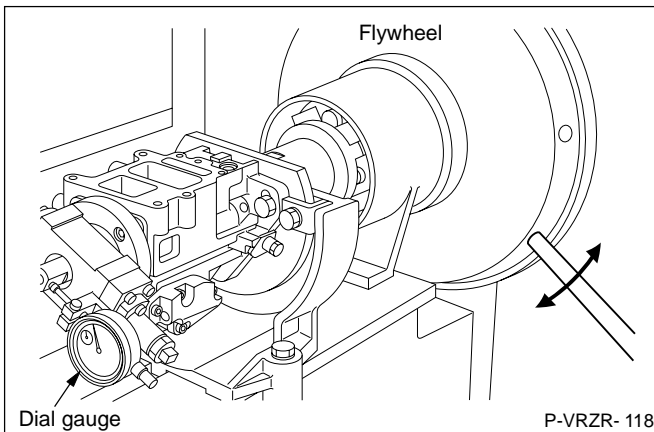


P-VRZR-164

[2] Setting the '0' point for pre-stroke adjustment

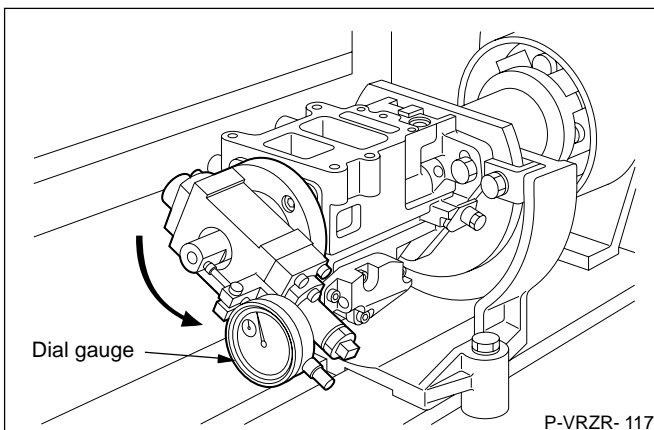
- (1) Turn the pump test bench's main switch ON and set the KMA (continuous measuring device) as described below. [Refer to the KMA (continuous measuring device operation manual): Publication No EC18E-11091.]

Select the 'angle measurement display' →
Press F6 → Select 'Settings' →
Press 'Enter' → Set the direction of rotation
→ Press F2



P-VRZR-118

- (2) Turn the pump test bench flywheel in the direction of pump rotation to find the standard cylinder's bottom dead center position on the measuring device dial gauge. (Refer to the data sheet for the standard cylinder.)

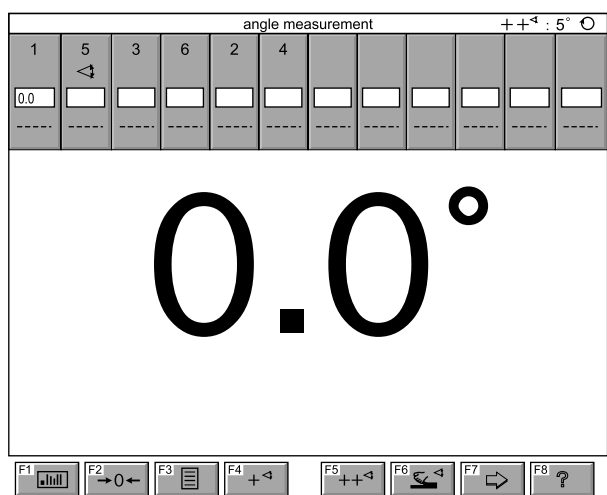


P-VRZR-117

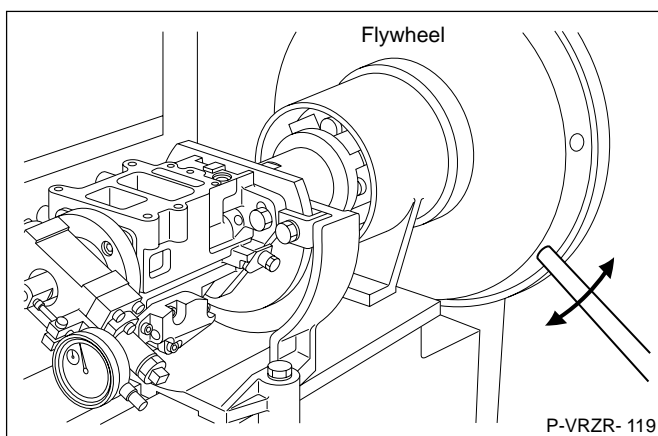
- (3) Zero the dial gauge.
- (4) Turn the flywheel in the direction of rotation so that the dial gauge reading is 0.7 mm.

6 REASSEMBLY

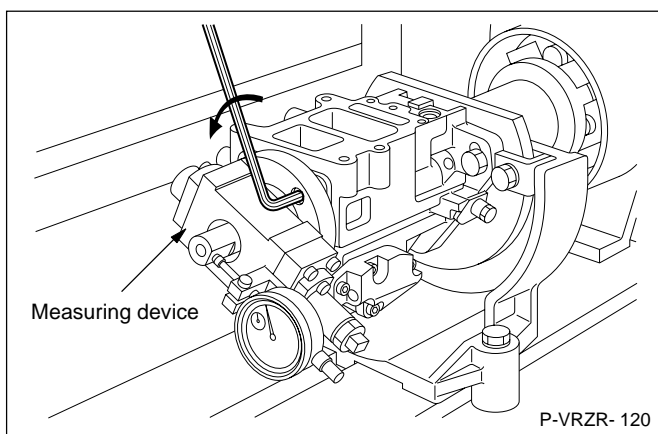
Monitor display example



P-VRZR- 165



P-VRZR- 119



P-VRZR- 120

- (5) Set the continuous measuring device as described below.

Press F2 → Press both shift keys (press both shift keys at the same time to activate angle control) → the monitor will display the dialog 'position control unit error: control circuit open' → Press Enter → the monitor display will change to(---.-°) → Press F6 → Select 'zero point setting' → Press Enter. (The pump test bench angle measurement is now set at '0.')

- (6) To absorb backlash, turn the flywheel back at least 10° and then set the angle measurement display at 355° (ie, turn the flywheel back 5°).

- (7) Check that the dial gauge reading is 0mm.

- (8) Set the continuous measuring device as described below.

Press F6 → Select 'zero point setting' → Press Enter.

(The pump test bench angle measurement is now set at '0.')

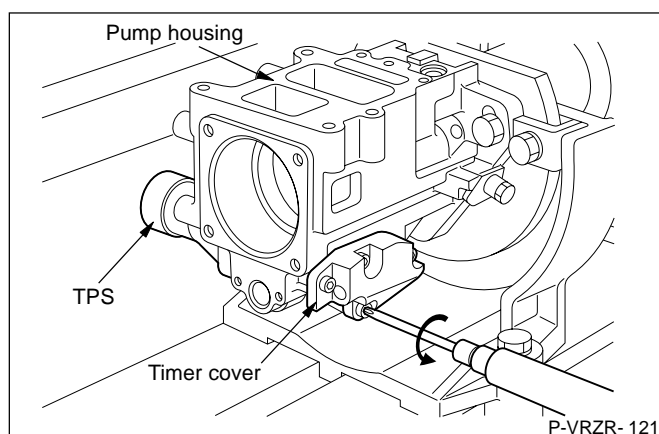
Advice

Do not alter the continuous measuring device angle measurement menu after this.

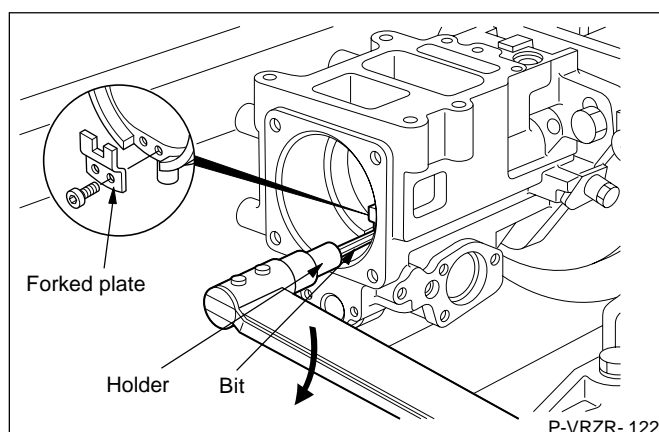
Note:

The beginning of cam lift position is now set.

- (9) Remove the measuring device.



- (10) Remove the TPS from the pump housing.
- (11) Remove the timer cover from the pump housing.



[3] Component reassembly

(1) Rotor shaft reassembly

- (1) Select a forked plate as described below and then assemble the plate.

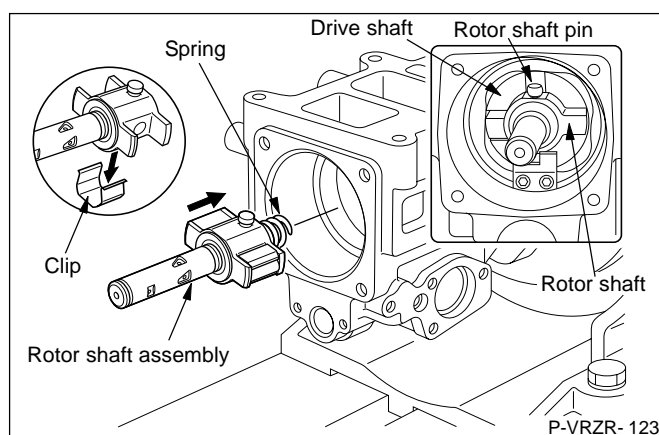
Selecting a forked plate

Head assembly	Cam ring	Forked plate marked G
Replaced	Replaced	Replaced
Replaced	Not replaced	Replaced
Not replaced	Replaced	Replaced
Not replaced	Not replaced	Do not replace (use the installed forked plate)*

* If the installed forked plate fork is worn, assemble a forked plate marked 'G.' (Refer to the table on page 67.)

**Specified torque: 3.0 ~ 5.0 N·m
{0.3 ~ 0.5 kgf·m}**

Tool name	Part no	Remarks
Holder	157915-9820	
Bit	157915-9301	T20



- (2) Rotate the drive shaft so that the rotor shaft pin is positioned toward the GE actuator as shown at left.

Note:

The rotor shaft does not contact the forked plate.

- (3) Remove the clip from the rotor shaft.

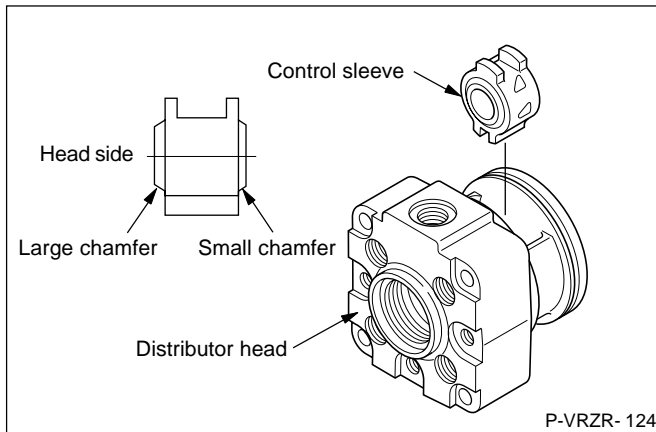
Tool name	Part no	Remarks
Clip	157971-0500	

- (4) Assemble the radial plungers, the roller shoes and the rollers to the rotor shaft.
- (5) With the spring assembled to the rotor shaft, assemble the rotor shaft assembly to the drive shaft groove.

Advice

Do not drop the roller shoes or the rollers.

6 REASSEMBLY

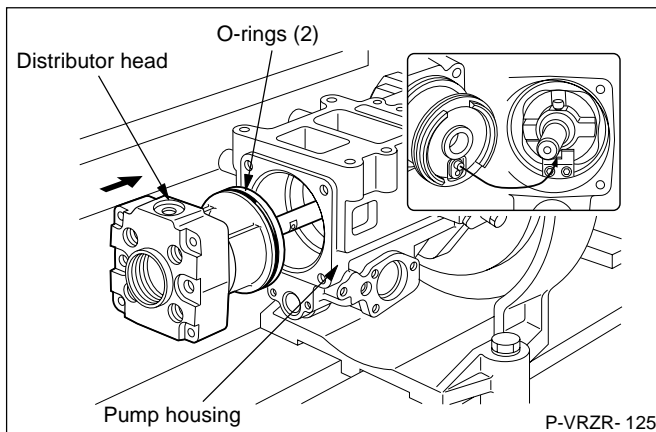


(2) Distributor head assembly reassembly

- (1) Assemble the O-ring on the distributor head.
- (2) Assemble the control sleeve in the distributor head.

Advice

The face with the larger chamfer is positioned toward the head.



- (3) Assemble the distributor head assembly to the rotor shaft.
- (4) Tighten diagonally opposed torx bolts to loosely install the distributor head.

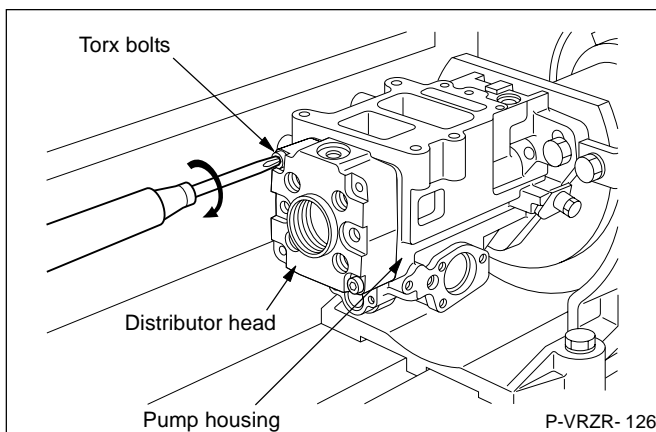
Advice

Do not tighten the distributor head assembly. Leave it loose.

- (5) Assemble the distributor head assembly to the pump housing.

Advice

Move the timer piston to align the forked plate groove with the distributor head assembly pin.

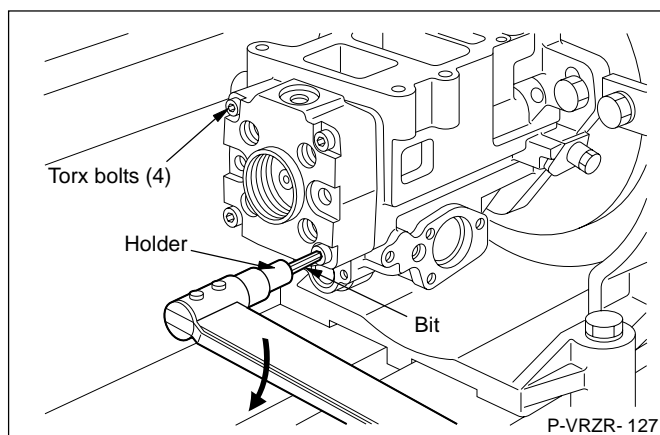


- (6) Move the timer piston and confirm that the control sleeve rotates, and then gradually tighten two diametrically opposed torx bolts.
- (7) If the timer piston does not move smoothly, loosen the torx bolts and repeat procedure (6) above.

Note:

If the timer piston does not move smoothly, the control sleeve will not move smoothly, the pin may not engage the plate when the head is tightened, and either the plate or the pin may be damaged.

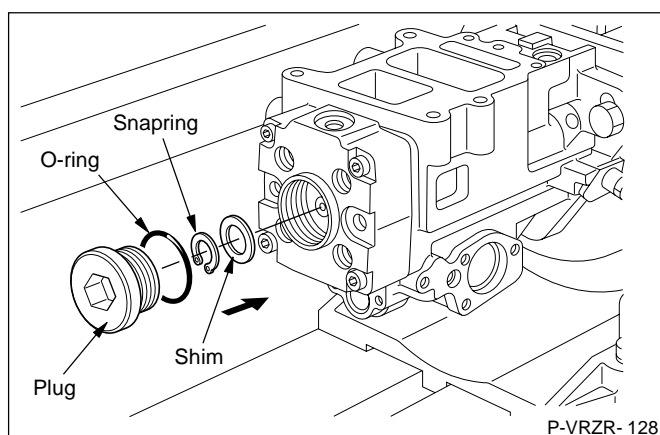
- (8) Tighten the torx bolts until the distributor head assembly is securely tightened to the pump housing.



- (9) Install the other two torx bolts and then tighten all four torx bolts to the specified torque.

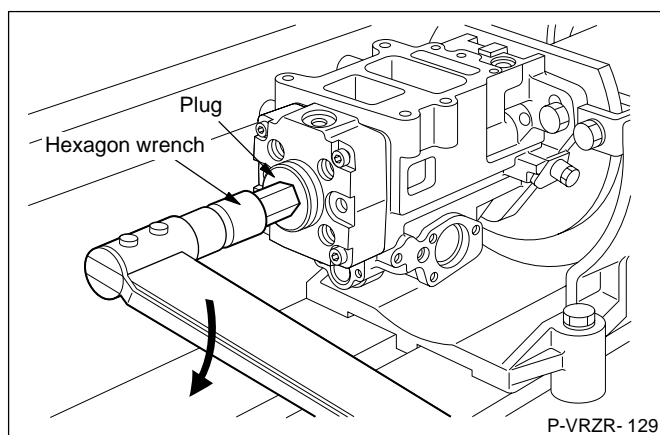
**Specified torque: 10.0 ~ 14.0 N·m
{1.0 ~ 1.4 kgf·m}**

Tool name	Part no	Remarks
Holder	157915-9820	
Bit	157915-9600	T30



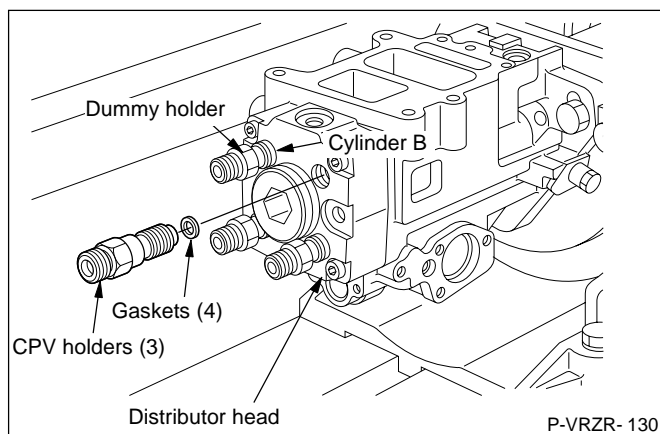
- (10) Assemble the shim and snapping to the rotor shaft.

- (11) Install the plug to the distributor head together with a new O-ring.



- (12) Tighten the plug using a hexagon wrench (SW14mm).

**Specified torque: 20.0 ~ 29.0 N·m
{2.0 ~ 3.0 kgf·m}**



(3) CPV holder reassembly

- (1) Assemble the gaskets and CPV holders to the distributor head's cylinders A, C and D.

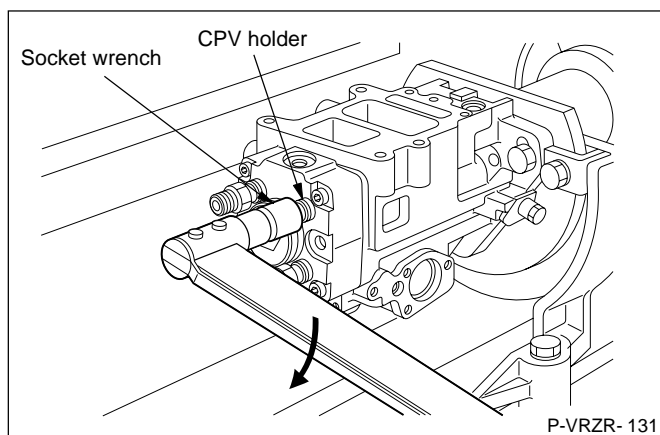
Advice

The CPV holders must be reassembled to the distributor head in their original positions A, C and D marked on the head.

- (2) Assemble the dummy holder and gasket to the distributor head's cylinder B.

Tool name	Part no	Remarks
Holder	157845-9500	Part of pipe assembly 157845-9520.

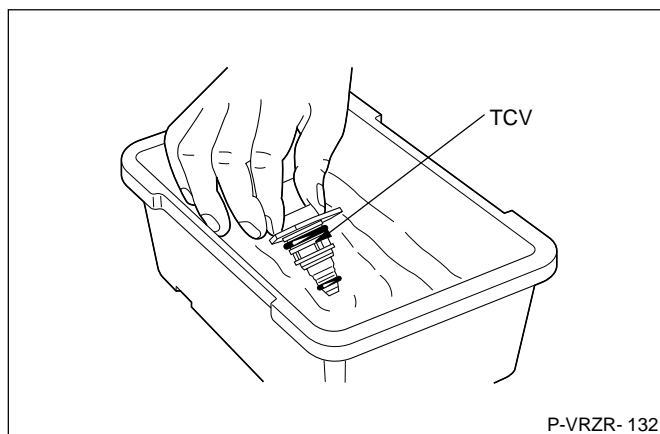
6 REASSEMBLY



(3) Tighten the CPV holders using a socket wrench.

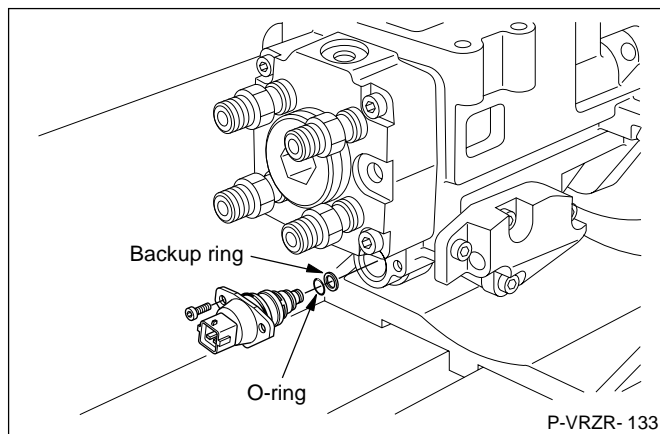
**Specified torque: 44.0 ~ 54.0 N·m
{4.5 ~ 5.5 kgf·m}**

Tool name	Part no	Remarks
Socket wrench	157914-3600	



(4) TCV (timing control valve) installation

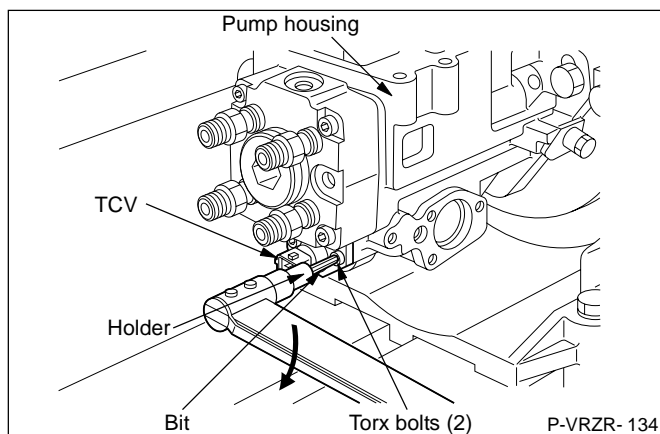
(1) Clean the TCV in clean light oil.



(2) Assemble the backup ring, the O-ring and the TCV in the pump housing.

Advice

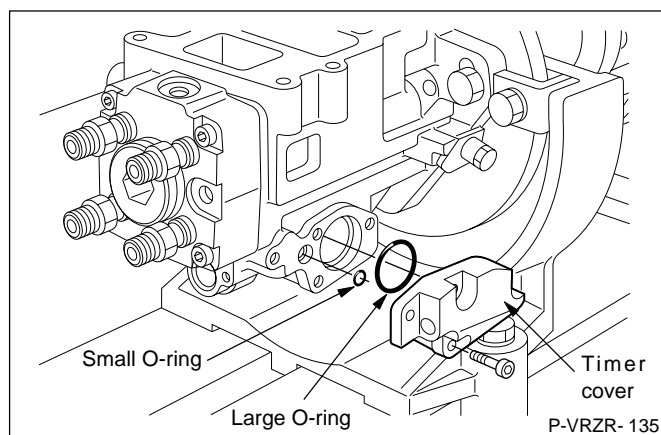
Two backup rings are removed at disassembly. One is reassembled at reassembly.



(3) Push the TCV into the pump housing using your finger and fix it using the torx bolts.

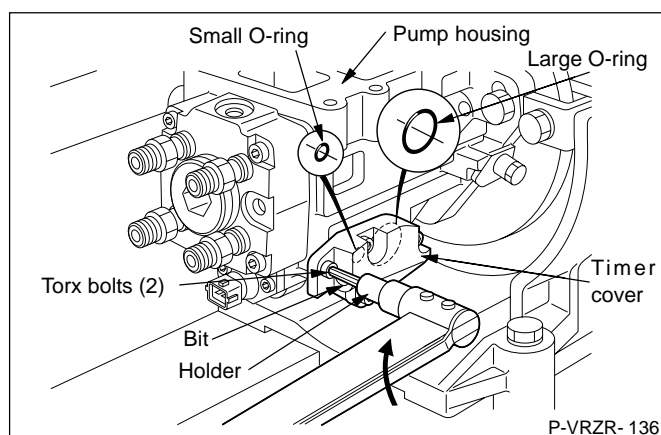
**Specified torque: 7 ~ 10.0 N·m
{0.7 ~ 1.0 kgf·m}**

Tool name	Part no	Remarks
Holder	157915-9820	
Bit	157915-9600	T30



(5) Timer cover and TPS (timer piston sensor) reassembly

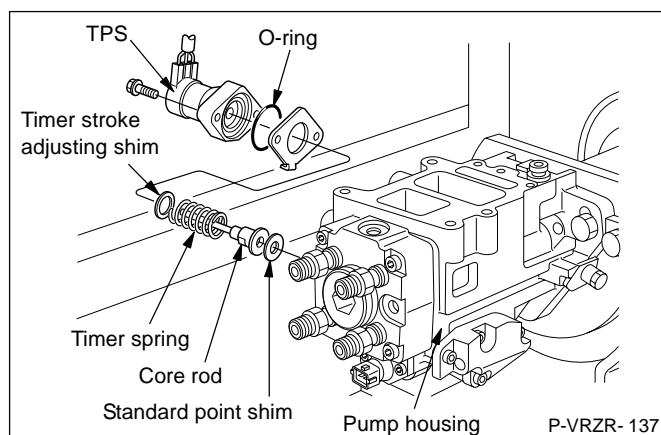
- (1) Assemble the timer cover and the small and large O-rings (new) to the high pressure side. (See below for the assembly procedure.)



- (2) Push the small O-ring securely into the pump housing using your finger.
- (3) Push the large O-ring securely into the timer cover using your finger and install the timer cover using the torx bolts.

**Specified torque: 7.0 ~ 10.0 N·m
{0.7 ~ 1.0 kgf·m}**

Tool name	Part no	Remarks
Holder	157915-9820	
Bit	157915-9600	T30



- (4) Assemble the TPS standard point shim, the core rod, the timer spring and the timer stroke adjusting shim in the pump housing.

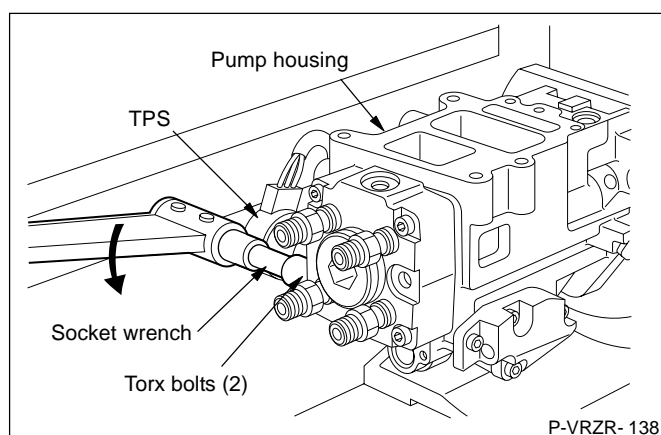
Advice

Do not mistake the assembly positions of the TPS standard point shim and the timer stroke adjusting shim.

- (5) Assemble the TPS to the pump housing.

Advice

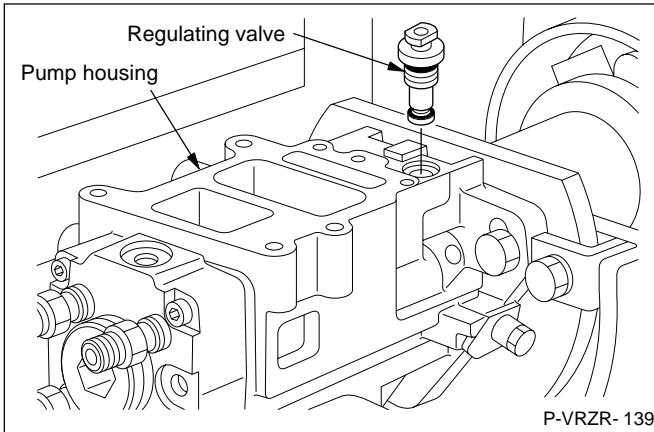
Ensure the O-rings are not damaged.



- (6) Secure the TPS to the pump housing using the torx bolts and a socket wrench (M6).

**Specified torque: 7.0 ~ 10.0 N·m
{0.7 ~ 1.0 kgf·m}**

6 REASSEMBLY

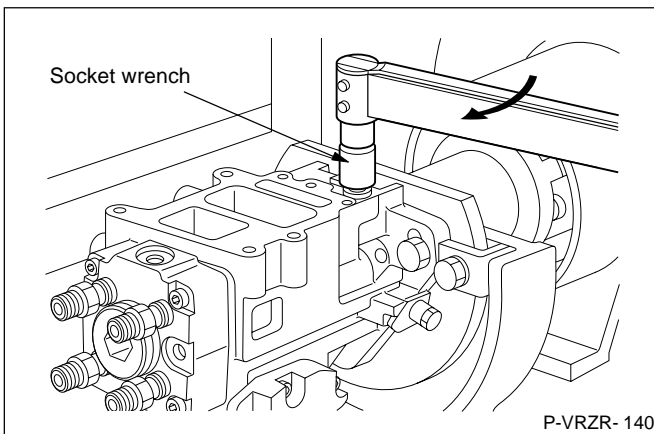


(6) Regulating valve installation

- (1) Shake the regulating valve and confirm that the piston is moving (listen for a clicking sound).
- (2) Install the regulating valve in the pump housing.

Advice

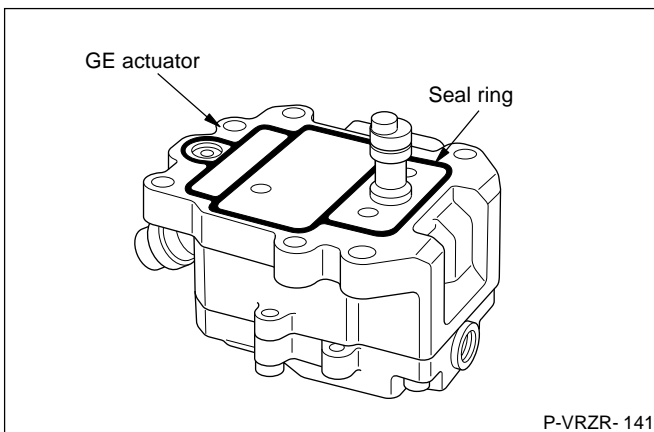
Confirm that the regulating valve piston moves smoothly.



- (3) Tighten the regulating valve using the socket wrench.

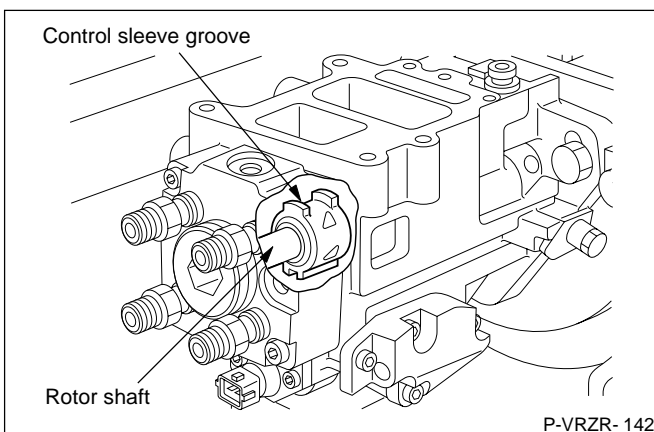
**Specified torque: 10.0 ~ 13.0 N·m
{1.0 ~ 1.3 kgf·m}**

Tool name	Part no	Remarks
Socket wrench	157913-7000	



(7) GE actuator installation

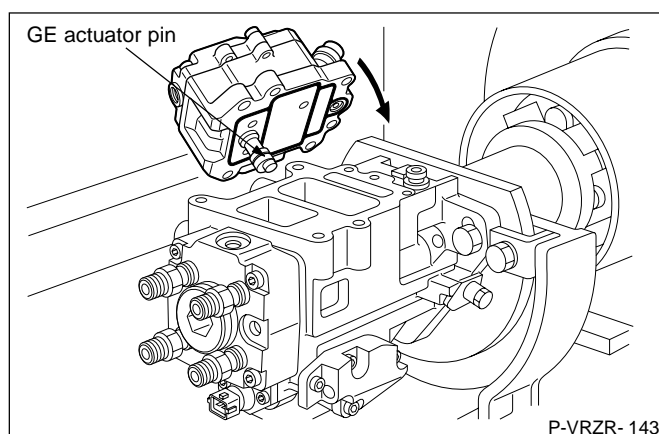
- (1) Assemble the seal ring (new) to the GE actuator.



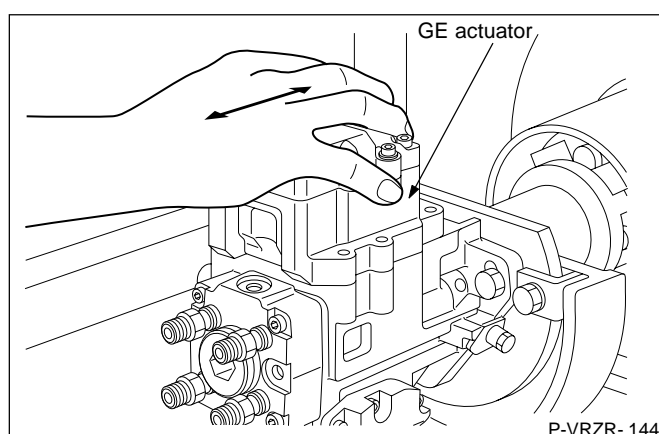
- (2) Position the control sleeve groove toward the GE actuator and fix it in an intermediate position.

Note:

This facilitates GE actuator installation.



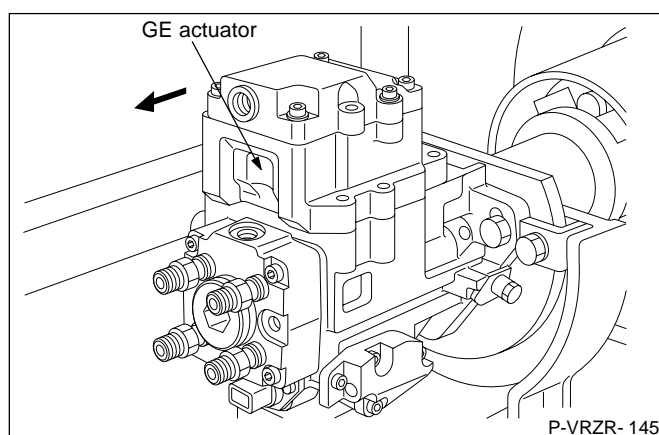
- (3) Assemble the GE actuator pin in the control sleeve groove.



- (4) Move the GE actuator in an axial direction as shown by the arrow in the figure at left and confirm that the actuator moves smoothly.

Advice

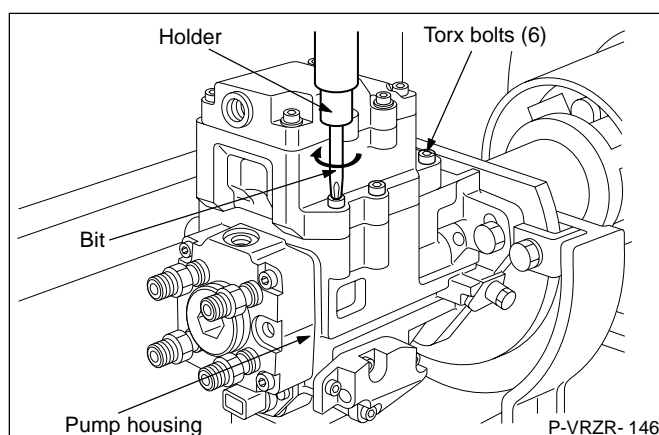
- Do not force the GE actuator. Forcing it may damage the seal ring.
- The GE actuator will not move if its pin is not inserted into the control sleeve groove. If it will not move, remove the GE actuator and again insert the pin into the groove.



- (5) Move the GE actuator fully toward the full side (ie, the head side).

Advice

If the GE actuator is positioned toward the drive shaft side, it may not be possible to measure the pre-stroke.



- (6) Secure the GE actuator to the pump housing using the torx bolts.

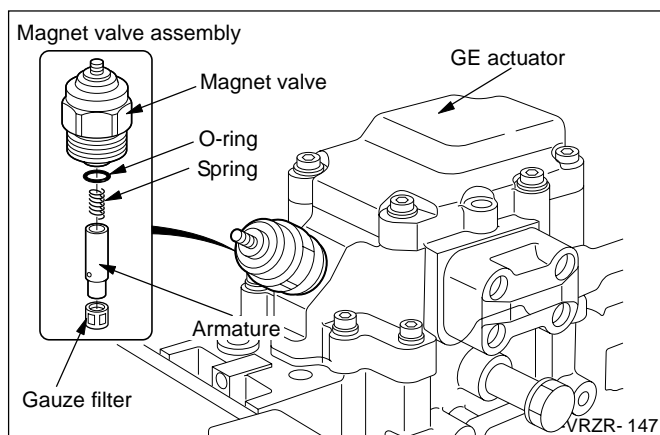
Advice

Tighten diagonally opposed torx bolts gradually and uniformly to the specified torque.

Specified torque: 7.0 ~ 10.0 N·m
{0.7 ~ 1.0 kgf·m}

Tool name	Part no	Remarks
Holder	157915-9820	
Bit	157915-9600	T30

6 REASSEMBLY

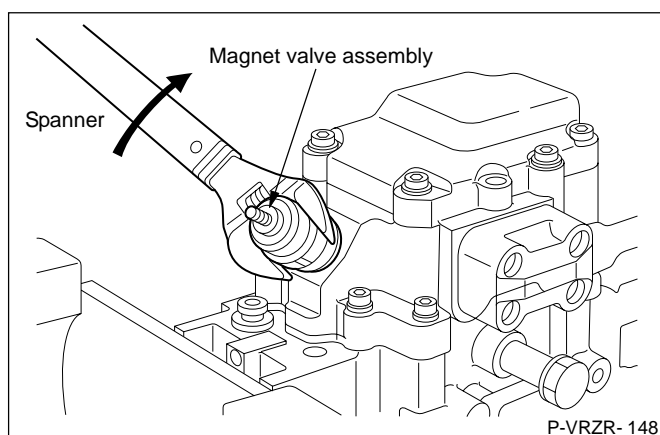


(8) Magnet valve assembly installation

- (1) Install the magnet valve assembly to the GE actuator.

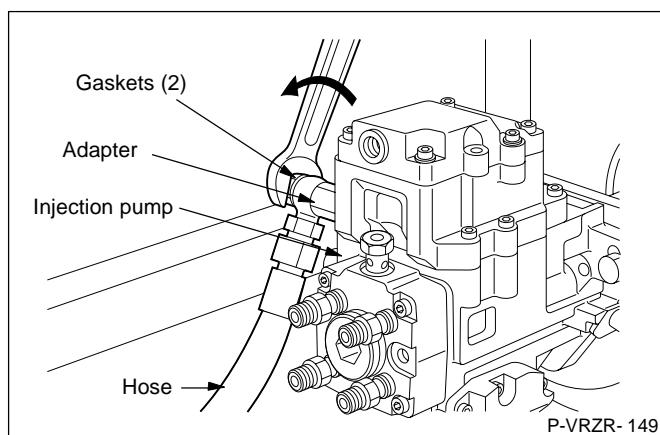
Advice

Ensure the filter is installed securely.



- (2) Tighten the magnet valve assembly using a torque spanner.

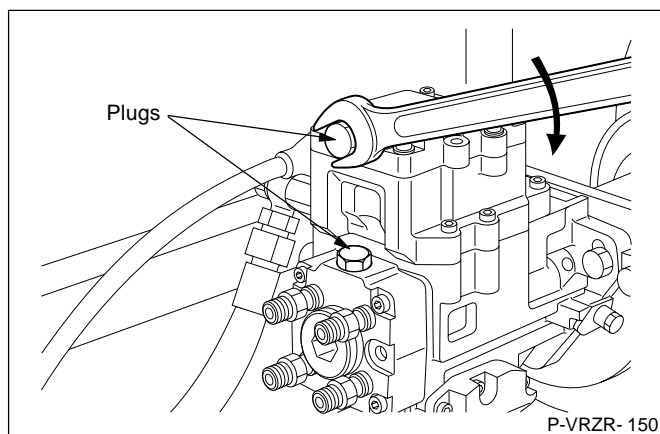
Specified torque: 20.0 ~ 25.0 N·m
{2.0 ~ 2.5 kgf·m}



(9) Pre-stroke adjustment

- (1) Connect the fuel hose to the injection pump using the adapter.

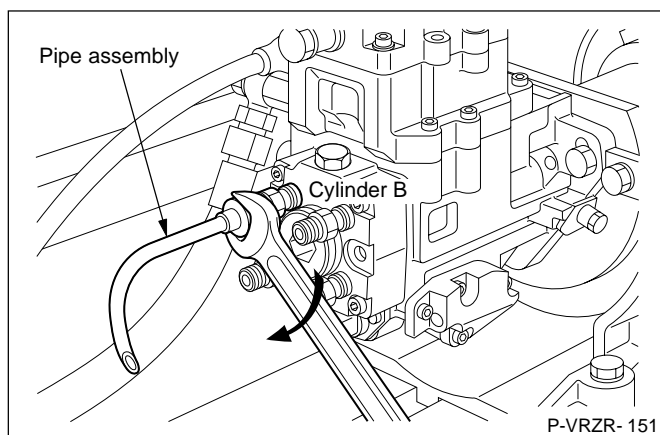
Tool name	Part no	Remarks
Adapter	157977-8000	
Gasket	026512-1640	



- (2) Install plugs to where the distributor head and GE actuator overflow valves were removed.

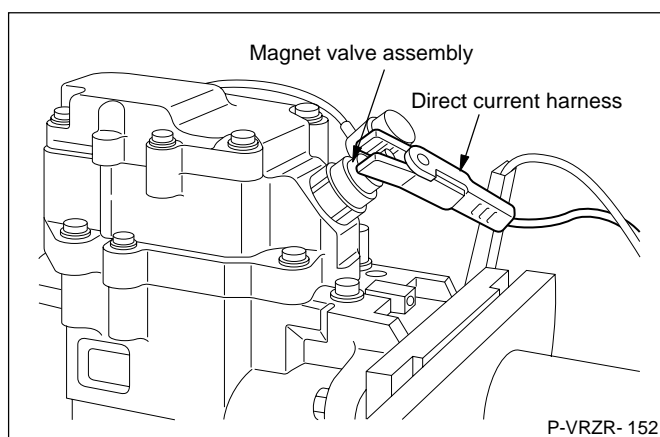
Advice

Install any suitable plugs to maintain pump chamber air tightness.



- (3) Remove cylinder B's delivery valve holder and assemble the pipe assembly to cylinder B.

Tool name	Part no	Remarks
Pipe assembly	157845-9520	

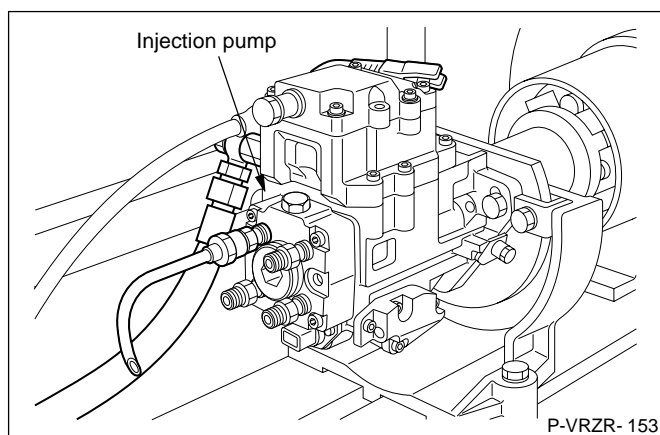


- (4) Connect the direct current harness to the magnet valve.

Advice

Magnet valve supply voltage

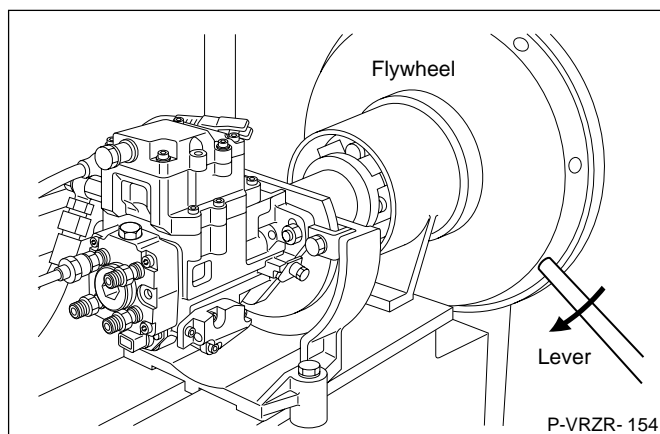
- 12V specification: 12V



- (5) Turn the pump test bench drive switch ON.
(6) Supply test oil to the injection pump at the specified pressure (20.0 kPa {0.2 kgf/cm²}).

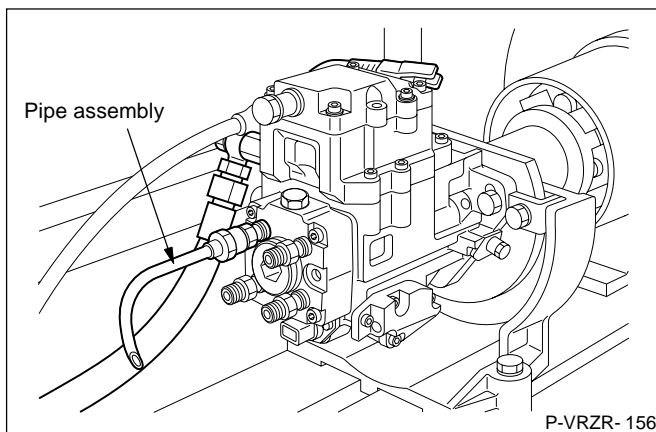
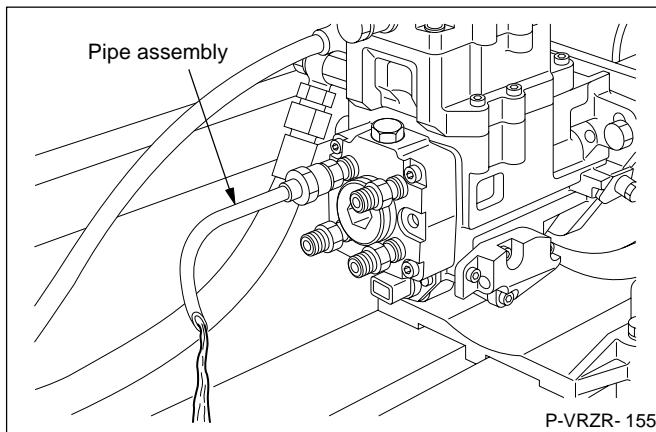
Advice

Leave the drive switch ON. Do not turn the drive switch OFF until pre-stroke adjustment has been completed.



- (7) Turn the pump test bench flywheel about one turn in the specified direction of rotation using the lever and use the angle measurement display to confirm that it turns smoothly.

6 REASSEMBLY



- (8) Turn the pump test bench flywheel using the lever and set the pump test bench angle measurement at the '0' position (ie, the beginning of cam lift position).

Advice

- Confirm that test oil flows from the pipe assembly's overflow.
- Align the flywheel with the position set during Procedure [2] "Setting the '0' point for pre-stroke adjustment" on page 55.

- (9) Turn the pump test bench flywheel slowly in the specified direction of rotation using the lever and read the angle measurement indication (ie, the pre-stroke) when test oil stops flowing from the pipe assembly overflow.

Note:

Test oil has stopped flowing when only 2 ~ 3 drops / second flow from the overflow.

⚠ CAUTION

Remove the lever after operating the flywheel.

Operating the test bench without removing the lever can cause serious injury and damage the test bench.

Advice

Leave the drive switch ON. If the drive switch is turned OFF, angle measurement will stop. Stop test oil flow to the injection pump by turning the test oil cock OFF.

- (10) If the pre-stroke is not as specified, replace the forked plate and readjust. (Refer to the next page for forked plate specifications. Refer to page 57 for the replacement procedure.)

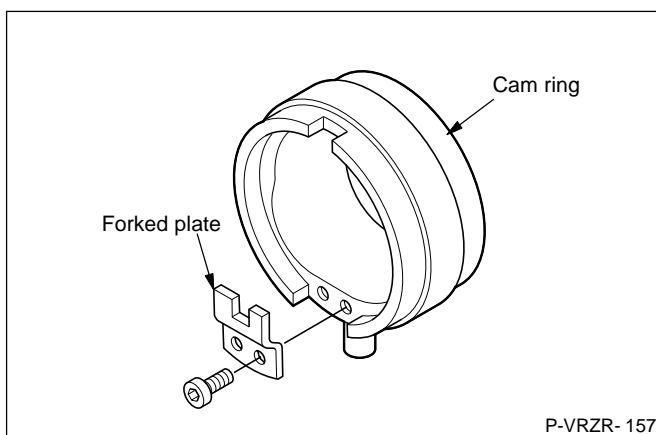
Specified value: $2.5 \pm 0.5^\circ$

Advice

For clockwise rotation, if the value is larger than specified, select plates starting from A. If smaller, select plates working back from M.

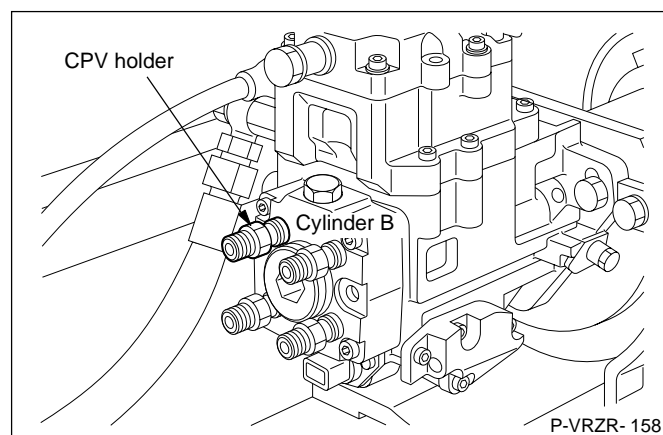
Note:

Forked plate pre-strokes correspond to angles of rotation.

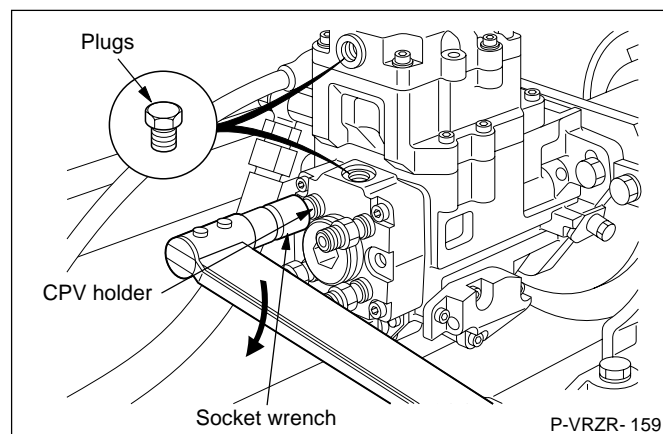


Forked plates for 4 cylinders

RBAJ part no	Bosch part no	Stamping	Pre-stroke variation (°)
149615-0001	9 443 612 824	A	-3.03
149615-0101	9 443 612 825	B	-2.50
149615-0201	9 443 612 826	C	-1.97
149615-0301	9 443 612 827	D	-1.43
149615-0401	9 443 612 828	E	-1.07
149615-0501	9 443 612 829	F	-0.54
149615-0601	9 443 612 830	G	0
149615-0701	9 443 612 831	H	0.54
149615-0801	9 443 612 832	I	1.07
149615-0901	9 443 612 833	J	1.43
149615-1001	9 443 612 834	K	1.97
149615-1101	9 443 612 835	L	2.50
149615-1201	9 443 612 836	M	3.03



- (11) Remove the pipe assembly from cylinder B and replace it with the CPV holder. Replace the gasket at the same time.



- (12) Tighten the CPV holder using a socket wrench.

**Specified torque: 44.0 ~ 54.0 N·m
{4.5 ~ 5.5 kgf·m}**

Tool name	Part no	Remarks
Socket wrench	157914-3600	

- (13) Remove the plugs.