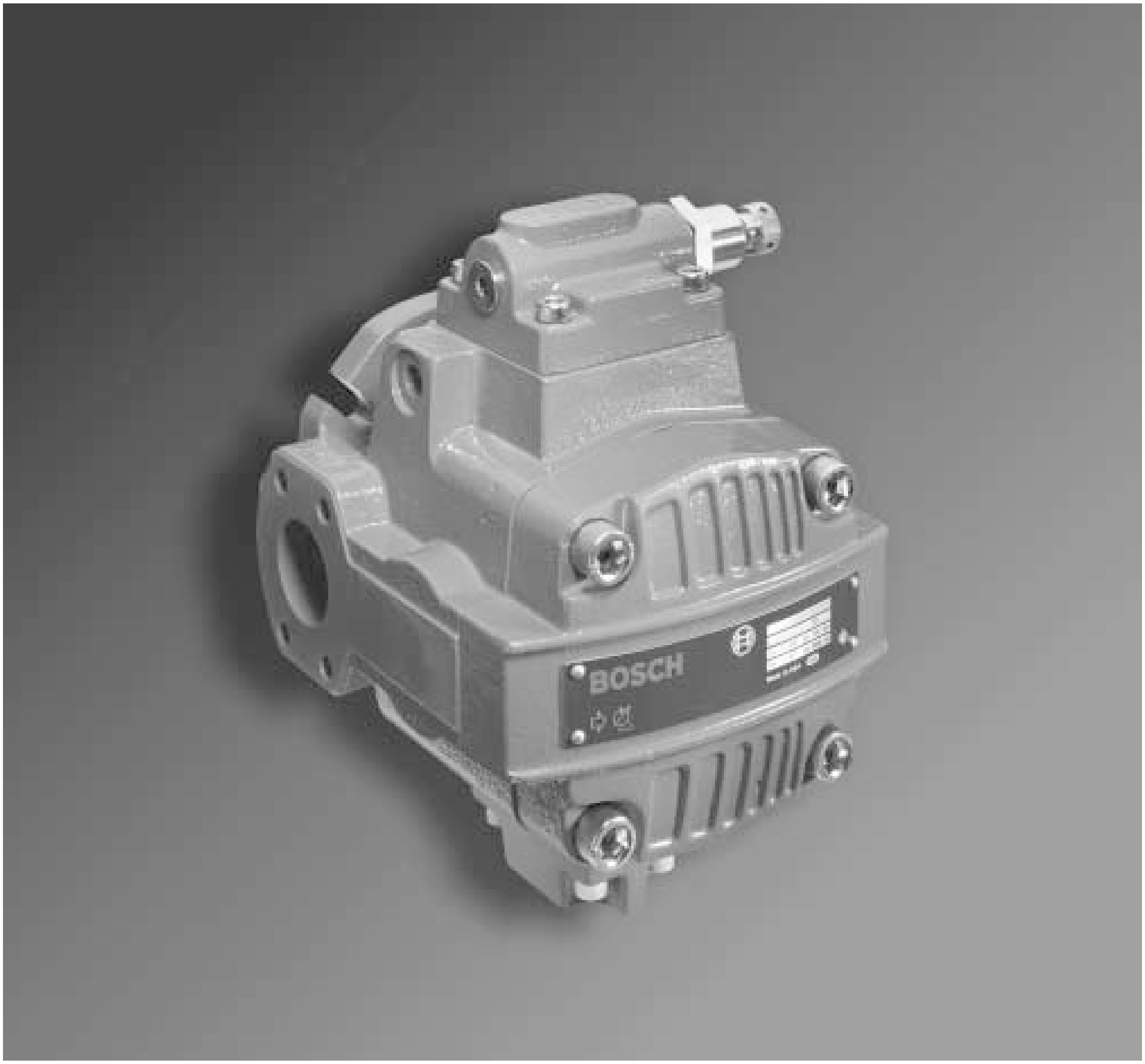
VPV Vane Pump

Whisper™ Pump
Service and Repair Guide



BOSCH

Automation

Welcome to the Service Guide for the VPV Pump !

Dear Customer:

First of all we would like to thank you for choosing the Bosch VPV Pump.

This brochure was designed as a guide covering all aspects of the repair procedures and to help accomplish maximum performance and a long life for the Bosch VPV 16cc–164cc (1 in^3 –10 in^3), 210 bar (3000 PSI) pump.

On the following pages there is an illustrated step by step guide for all repair procedures.

If there are any additional questions our technical support team will be glad to help. Please call:

Phone: (262) 554-7100 or
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If you have Internet access we would like to invite you to visit our Website:
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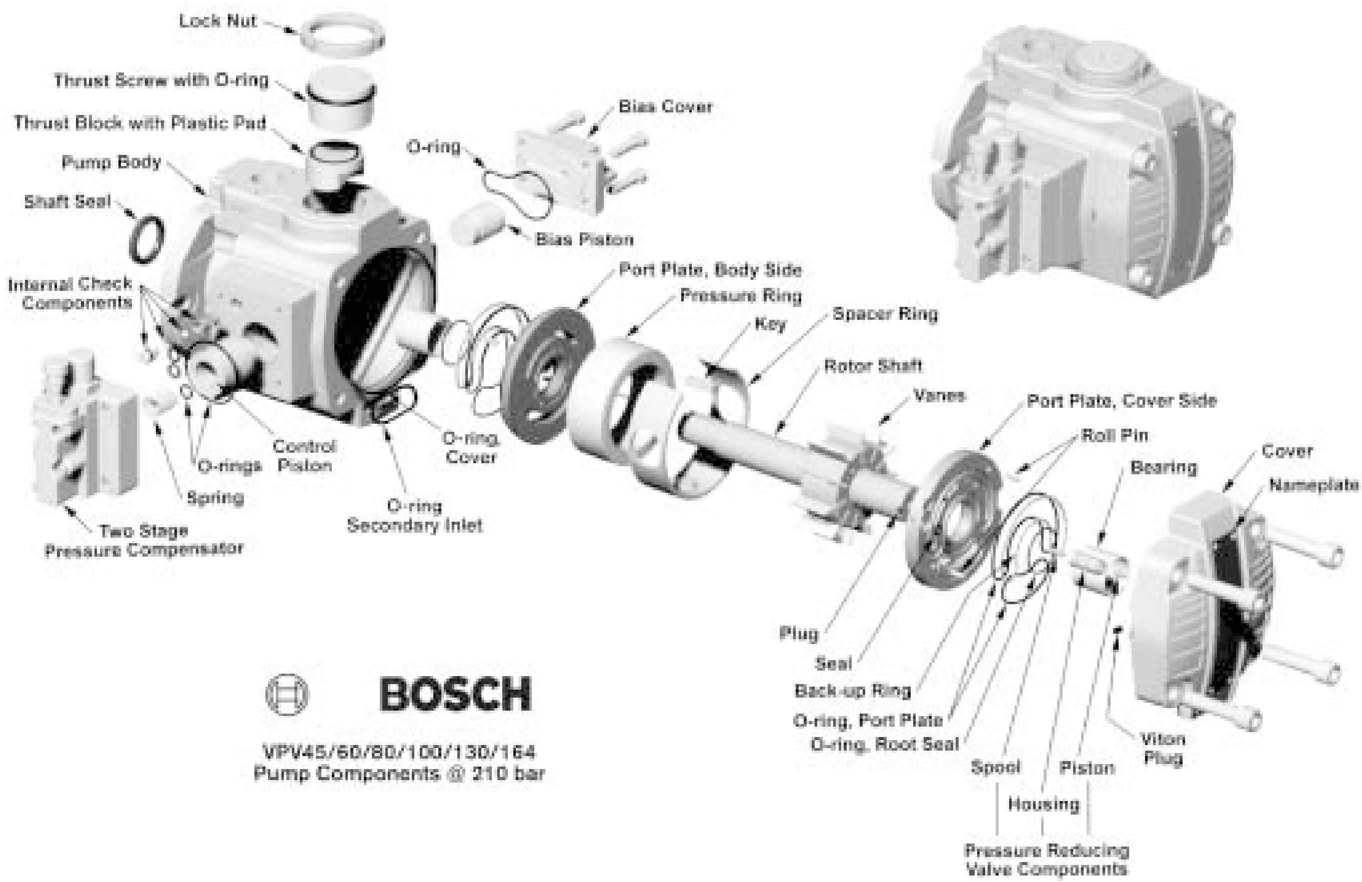

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1.1 Disassembly Procedures – VPV 16–164

1.1.1 Introduction

The disassembly shown on the following pages covers the Bosch VPV 16cc –164cc variable volume vane pumps. The complete disassembly procedures are similar for all pumps. Any differences between the pump models are described in additional notes.

1.1.2 Getting Started – Preparing the Tools

Table 1: Tools for Pump Disassembly

VPV	16	25/32	45/63/80	100/130/164
Cover Allen Wrench 4 Socket Head Cap Screws	8 mm	10 mm	14 mm	17 mm
Cover and Plates – Removal	2 Flat Blade Screwdrivers			
Vanes – Removal	Tweezers or a Pair of Long Needle Nose Pliers			
	11 Vanes	11 Vanes	11 Vanes	22 Vanes
Compensator + Bias Cover Allen Wrench 2 × 4 Socket Head Screws	6 mm	6 mm	8 mm	8 mm
Thrust Screw	VPV 16/25/32 – 8mm Allen Wrench VPV 45/63/80 – Non-slip Spanner Socket: 9 535 230 287 VPV 100/130/164 – Non-slip Spanner Socket: 9 535 230 286			
Thrust Screw Lock Nut	Adjustable Face Spanner Wrench – Note 1			
Bearing – Removal	Bosch Bearing Puller – Note 2			
Shaft Seal – Removal	Hammer and Round Head Punch			

Wooden Fixture (Fig. 1.1.2-a):

As an aid for repairing the VPV pump, we recommend building a wooden fixture. Please see the different inside diameters for each pump in Table 2.

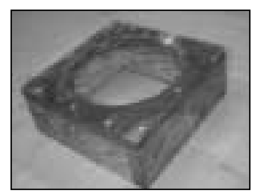


Fig. 1.1.2-a

Table 2: Recommended Geometry of Wooden Fixture

VPV	16	25/32	45/63/80	100/130/164
Diameter – inch (mm)	$3^{3}/_{8}$ (86)	$4^{1}/_{8}$ (105)	$5^{1}/_{8}$ (131)	$6^{1}/_{8}$ (156)
Minimum Height – inch (mm)	2 (51)	$2^{5}/_{8}$ (67)	3 (76)	$3^{7}/_{8}$ (98)

Note 1 (Fig. 1.1.2-b):

For older VPV 16–32 models, a crowfoot may be needed for the disassembling of the thrust screw locknut. This crowfoot is included in the Bosch VPV tool kit (Part-No. 9 511 230 557).

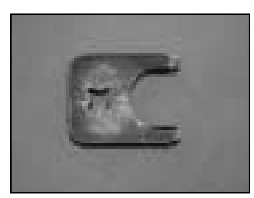


Fig. 1.1.2-b

Note 2 (Fig. 1.1.2-c):

It is recommended that the four different sizes of bearing puller tools be purchased as a complete kit to guarantee that the proper tool is on hand for any size VPV (Part-No. 9 511 230 691). Please see Section 5.2: Bearing Puller on Page 58.

Fig. 1.1.2-c

1.1 Disassembly Procedures – VPV 16–164

1.1.3 Instructions

1. Remove the straight key from the keyway of the shaft and place the pump shaft side down into the wooden fixture (Fig. 1.1.3-1). See Page 2 for details and illustration of wooden fixture.

Fig. 1.1.3-1

2. Remove the four socket head cap screws on the cover by using the appropriate size Allen wrench (Fig. 1.1.3-2a).

Fig. 1.1.3-2a

Note 3:

For disassembling the larger pumps, a great amount of torque will be needed to loosen the cover bolts. Therefore, we recommend loosening the bolts before removing the pump from the motor-unit. Use a socket or extend the length of your Allen wrench and make sure to clamp the pump safely (Fig. 1.1.3-2b).

Fig. 1.1.3-2b

3. Insert flat blade screwdriver into the slots provided on each side of the cover. Pry the cover assembly loose using equal force on each screwdriver (Fig. 1.1.3-3). After the cover is loose, carefully remove it by hand and set it aside in a clean area.

Fig. 1.1.3-3

1.1 Disassembly Procedures – VPV 16–164

4. In order to remove the port plate from the cover, insert flat blade screwdriver into the slots between the port plate and cover and pry the port plate loose (Fig. 1.1.3-4a). After the port plate is loose, carefully remove it by hand.

Fig. 1.1.3-4a

Note 4:

When disassembling a VPV 45–164, please pay attention not to loosen the ratio valve cartridge that is located in the cover (see Fig. 1.1.3-4b and c) and the ratio valve sealing assembly that is located on the back of the cover port plate. The ratio valve cartridge is an essential part of the pump and is not a wear item, so it is not part of the repair kit.

Fig. 1.1.3-4b

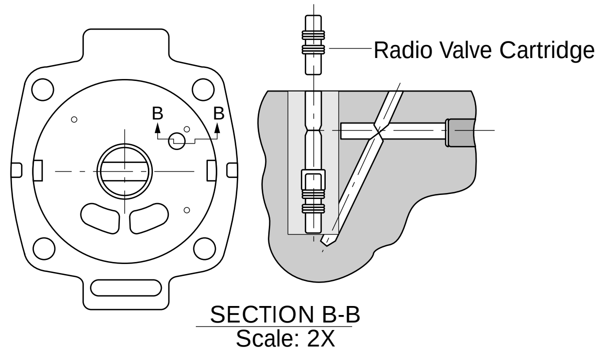


Fig. 1.1.3-4c

5. Remove the cover O-ring (Fig. 1.1.3-5).

Fig. 1.1.3-5

6. Remove the vanes from the rotor by using a small pair of tweezers or long needle nose pliers (Fig. 1.1.3-6). Caution should be exercised not to nick or score the vanes, pressure ring and rotor.

Fig. 1.1.3-6

1.1 Disassembly Procedures – VPV 16–164

7. Remove the rotor shaft (Fig. 1.1.3-7).

Fig. 1.1.3-7

8. Remove the four socket head screws on the compensator by using the appropriate Allen wrench (Fig. 1.1.3-8) and remove the compensator.

Fig. 1.1.3-8

9. Carefully remove the control piston and spring (Fig. 1.1.3-9a and b) being careful not to nick or scratch the piston or the piston bore.

Fig. 1.1.3-9a

Fig. 1.1.3-9b

10. Remove the four socket head cap screws on the bias cover by using the appropriate Allen wrench (Fig. 1.1.3-10) and remove the bias cover. The bias cover is over the bias piston or the smaller piston opposite the control piston. Carefully remove the bias piston ensuring that the bias piston and the piston bore are not scratched or nicked.

Fig. 1.1.3-10

1.1 Disassembly Procedures – VPV 16–164

11. For VPV 45–164 pumps, loosen the thrust screw lock ring by using a spanner wrench (Fig. 1.1.3-11). For VPV 16–32 pumps, loosen the locknut with an adjustable wrench (not pictured). Please see Note 1 on Page 2 when disassembling the VPV 16–32.

Fig. 1.1.3-11

12. Remove the thrust screw (Fig. 1.1.3-12a) by using the appropriate spanner socket or Allen wrench, from the Bosch VPV repair tool kit.

Fig. 1.1.3-12a

Note 5:

In addition to the thrust screw, the VPV 45–164 has a thrust block (Fig. 1.1.3-12b). Remove the thrust block from the body.

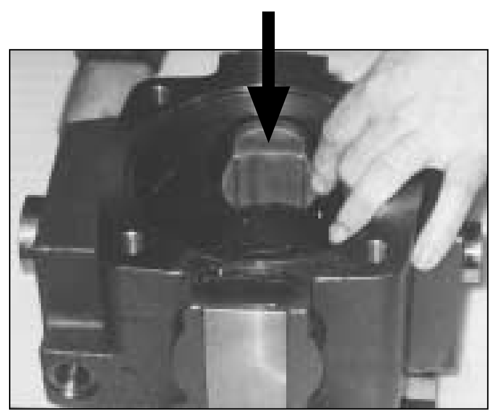


Fig. 1.1.3-12b: Thrust Block for VPV 45–164

13. Remove the pressure ring (Fig. 1.1.3-13).

Fig. 1.1.3-13

1.1 Disassembly Procedures – VPV 16–164

14. Remove the spacer ring (Fig. 1.1.3-14).

Fig. 1.1.3-14

15. Remove the port plate from the body by carefully grabbing the port plate at the thru-hole location (Fig. 1.1.3-15). After the plate has been lifted out, set it aside. Be careful not to scratch or nick the coating on the port plates. Leave the seals in the port plate.

Fig. 1.1.3-15

16. If the bearings are damaged and need to be replaced, remove the bearings in the body and the cover by using the Bosch VPV bearing puller (Fig. 1.1.3-16). Please see Section 5.2 – Bearing Puller for more details.

Fig. 1.1.3-16

17. To drive out the shaft seal take a round head punch and carefully tap it out from the cover side of pump (Fig. 1.1.3.-17). Remove the shaft seal.

Fig. 1.1.3-17

1.1 Disassembly Procedures – VPV 16–164

After the pump has been completely disassembled, all parts must be thoroughly cleaned with clean solvent. At this time inspect and determine which parts need to be replaced. In a major overhaul, it is recommended that both bearings and all seals be replaced regardless of their condition. Kits containing all seals are available for use in the repair of this pump.

When ordering repair parts it is necessary to provide either the alpha-code or the 10-digit part-number which will be 0 513 xxx xxx, describing the pump. This information can be found on the nameplate attached to the rear cover of the pump body. We always prefer the 10-digit part number, but the long hydraulic code is also sufficient.

1.2 Assembly Procedures – VPV 16–164

1.2.1 Introduction

To guarantee proper operation of the VPV pump, Bosch recommends replacing all important pump parts by using the Bosch repair kit and the Bosch VPV Seal kit.

1.2.2 Getting Started – Repair Kit, Seal Kit and Shaft Seals

Table 3 shows which Repair Kit corresponds to which VPV pump.

Table 3: VPV Repair Kit (3000 PSI)

VPV	SAE	METRIC	SAE “P1”	METRIC “P1”
16	9 511 230 606	9 511 230 607	9 511 230 608	9 511 230 609
25	9 511 230 598	9 511 230 599	9 511 230 623	9 511 230 622
32	9 511 230 598	9 511 230 599	9 511 230 623	9 511 230 622
45	9 511 230 639	9 511 230 644	9 511 230 642	9 511 230 646
63	9 511 230 639	9 511 230 644	9 511 230 642	9 511 230 646
80	9 511 230 641	9 511 230 645	9 511 230 643	9 511 230 647
100	9 511 230 650	9 511 230 654	9 511 230 652	9 511 230 656
130	9 511 230 650	9 511 230 654	9 511 230 652	9 511 230 656
164	9 511 230 651	9 511 230 655	9 511 230 653	9 511 230 657

As it is shown in Table 4 the Seal Kit is included as part of the Repair Kit. However, if only a Seal Kit is needed please refer to Table 5 on the next page.

Table 4: Contents VPV Repair Kit + VPV Seal Kit

VPV Repair Kit

Ref	Description	QTY
1	Roll Pins	4
2	Key	1
3	Vane Kit	1
4	Thrust Screw Assembly (VPV 16–32 only)	1
5	Thrust Block Assembly (VPV 45–164 only)	1
6	Spacer Ring	1
7	Rotor Shaft	1
8	Pressure Ring	1
9	Body Port Plate	1
10	Cover Port Plate	1
11	Bearing	2
12	Seal Kit	1

VPV Seal Kit

Ref	Description	QTY
13	Shaft Seal	1
14	O-ring Cover	1
15	Back-up Ring Port Plates	2
16	O-ring Kit Compensator (see *)	1
17	O-ring Secondary Inlet (VPV 45–164 only)	1
18	O-rings Port Plates (see **)	1
19	O-rings Root Seal	2
20	O-ring Bias Cover	1
21	Ratio Valve Sealing Assembly (VPV 45–164 only)	1

* see Page 29 for Single Stage Compensator
see Page 22 for Two-Stage Compensator

** see Page 13

The reference numbers for the parts in Table 4 are shown in Fig. 1.2.2 on the next page. The VPV seal kit part numbers are listed in Table 5.

1.2 Assembly Procedures – VPV 16–164

For applications using water-glycol, please use the shaft seals listed in Table 6:
For all other applications, please use the shaft seals listed in Table 7:

Table 5: VPV Seal Kit

VPV	SAE + METRIC
16	9 511 230 605
25/32	9 511 230 597
45/63/80	9 511 230 658
100/130/164	9 511 230 659

Table 6: Shaft seals for water-glycol applications

VPV	Shaft Seal
16	9 535 230 232
25/32	9 535 230 231
45/63/80	9 535 230 230
100/130/164	9 535 230 258

Table 7: Shaft seals for general applications

VPV	Shaft Seal
16	9 535 230 154
25/32	9 535 230 069
45/63/80	9 535 230 183
100/130/164	9 535 230 246

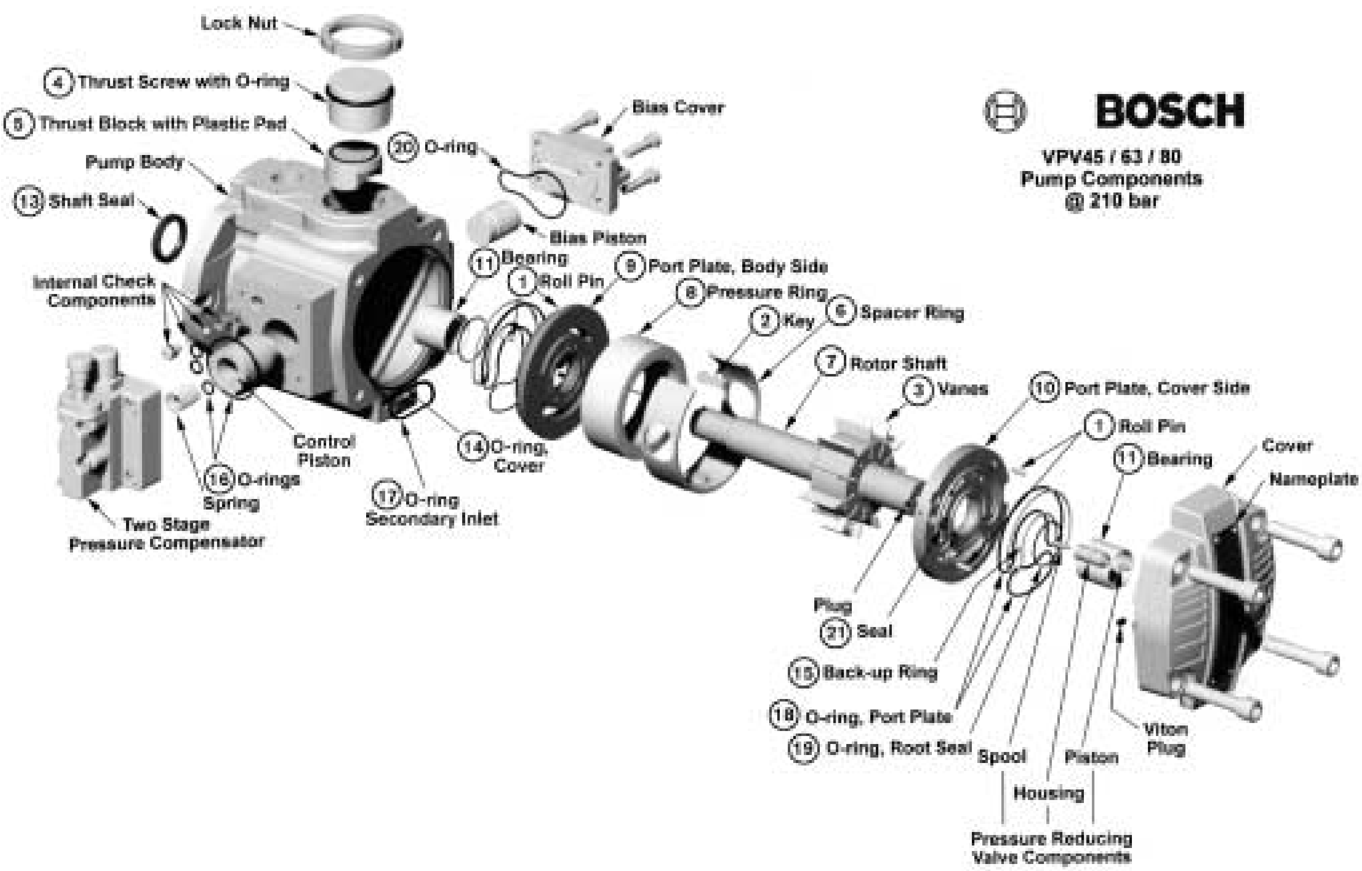


Figure 1.2.2 Pump Components with numbered Repair and Seal Kit Parts

Table 8: Overview Torque Rates

VPV	16		25/32		45/63/80		100/130/164	
Cover – in-lbs (Nm)	700	(82)	1200	(140)	1800	(210)	4970	(580)
Bias Cover – in-lbs (Nm)	350	(41)	350	(41)	680	(80)	680	(80)
Compensator – in-lbs (Nm)	350	(41)	350	(41)	680	(80)	680	(80)
Thrust Screw Nut – in-lbs (Nm)	960	(112)	960	(112)	* See Below			

* On VPV 45–164 pumps, tighten the thrust screw locking ring with a spanner wrench as tight as possible.

1.2 Assembly Procedures – VPV 16–164

Preparing the tools

Table 9: Tools for the Assembly of VPV Pumps

VPV	16	25/32	45/63/80	100/130/164
Cover- Allen Wrench	8 mm	10 mm	14 mm	17 mm
Installation Pins into Port Plates	Hammer			
Compensator & Bias Cover Allen Wrench	6 mm	6 mm	8 mm	8 mm
Thrust Screw	Spanner Socket (Tool Kit 9 511 230 557) and 8 mm Allen Wrench			
Thrust Screw Lock Ring	Adjustable Face Spanner Wrench **Note 1**, **Page 2**			
Bearing and Shaft Seal Installation	Press, Loctite 7070 Cleaner & Loctite 569 Hydraulic Sealant			
Lubrication	Clean Hydraulic Oil			

1.2.3 Instructions

1. Replace the shaft seal prepare the exploded view Fig. 1.2.2 ➪⑬.
   Before installing the shaft seal, clean the seal bore (Fig. 1.2.3-1a) and seal O.D. with Loctite 7070 cleaner and place some hydraulic sealant (Loctite 569) on the O.D. surface of the shaft seal as it is shown in Fig. 1.2.3-1b. Finally, press the shaft seal into the pump body to the depths recommended in Table 10, with the installation depth being measured from the pump housing surface. Insure that the shaft seal is installed properly in the pump body or leakage will occur.

Fig. 1.2.3-1a

Fig. 1.2.3-1b

Table 10: Shaft Seal Depths

VPV	Depth (mm)	Tolerance (mm)
16	2.0	±0.5
25/32	4.3	±0.5
45/63/80	10.0	±0.5
100/130/164	10.0	±0.5

1.2 Assembly Procedures – VPV 16–164

2. Replace the bearings for the body and cover ➪⑪. The body and cover bearings are identical.

   Place the bearings into the bearing bores and thoroughly lubricate the bearing I.D.'s with clean hydraulic fluid.

   Please pay attention to the correct orientation of the bearing prior to installing the bearings in the pump body and cover as it is shown in Fig. 1.2.3-2a, b and c.

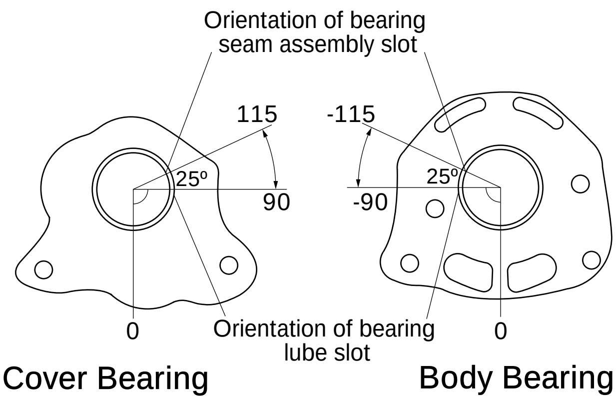


Fig. 1.2.3-2a: Orientation of the bearing

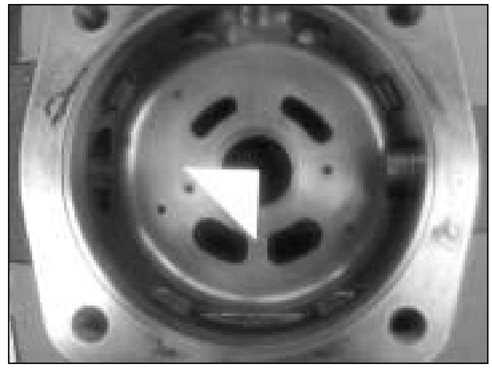


Fig. 1.2.3-2b: Body Bearing

It is recommended that a guide tool be used to properly install the bearings in the bores. After the bearing is installed, make sure the bearing is flush to 0.020" (0.5 mm) below the machined surface. Using a new rotor shaft, check the fit of the shaft to the installed bearings and assure that the shaft enters the bearing without drag. Replace the bearing if any drag is noticed.

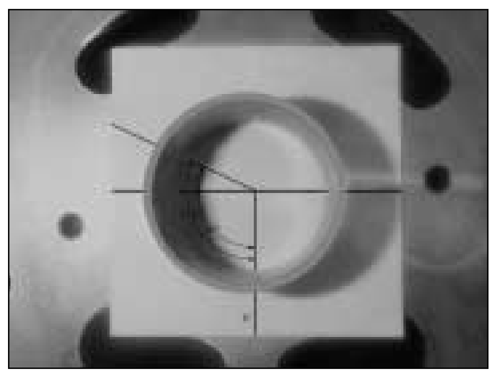


Fig. 1.2.3-2c: Body Bearing

3. Replace the port plates ➪⑨ and ➪⑩ and make sure to drive the two roll pins ➪① into the holes on the back of each port plate (Fig. 1.2.3-3). Let the pins protrude .3".

Fig. 1.2.3-3

1.2 Assembly Procedures – VPV 16–164

4. Replace the seals and back-up rings on the backside of both port plates (Port plate with seals see Fig.1.2.3-4a)

   Install seals on each port plate.

Fig. 1.2.3-4a

Cover Port Plate (see Fig. 1.2.2)

REF	Description	QTY	
		VPV 16/25/32	VPV 45/63/80/100/130/164
15	Back-up seal (white) in large race track	1	1
15	Back-up seal (white) in small counterbore	0	1
18	O-ring in large race track	1	1
18	O-ring in small race track	1	1
19	O-ring in counterbore	1	1
21	O-ring in small counterbore	0	1

Body Port Plate (see Fig. 1.2.2)

REF	Description	QTY	
		VPV 16/25/32	VPV 45/63/80/100/130/164
15	Back-up seal (white) in large race track	1	1
18	O-ring in large race track	1	1
18	O-ring in small race track	1	1
19	O-ring in countebore	1	1

If necessary, use a light grease or petroleum jelly to help retain the seals during placement of the port plates into the body (Fig. 1.2.3-4b). Avoid applying too much grease on the seals during assembly since this condition can cause the O-rings to dislodge when the port plates are installed in the pump.

Fig. 1.2.3-4b

1.2 Assembly Procedures – VPV 16–164

5. Place the port plate into the pump body (Fig. 1.2.3-5a). Note that the pins fit in the provided holes. Completely lubricate the port plate's wear surface with clean hydraulic fluid.

Fig. 1.2.3-5a

Note 6:

Be certain to ensure that the correct port plates are installed in the body and the cover. If unsure, compare the arrows on the port plates with the arrow on the pump. The arrow on the pump can be found below the open segment for the control piston on the pump body. Both arrows must point in the same direction (Fig. 1.2.3-5b). All VPV pumps operate in a clockwise only direction of rotation as viewed from the shaft end of the pump.

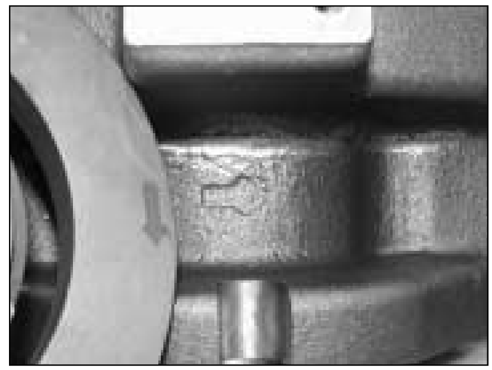


Fig. 1.2.3-5b

6. Install the spacer ring ➪⑥ in the pump body (Fig 1.2.3-6).

Note 7:

On the VPV 45–164, the open segment on the spacer ring aligns with the thrust block bore. On the VPV 16–32 there is no break in the spacer ring. Align the break with the thrust screw. The remaining set of holes will align with the bias and control pistons.

Fig. 1.2.3-6

7. Assemble the bias piston into the body through the clearance hole in the spacer ring (Fig. 1.2.3-7). Lubricate the piston with clean hydraulic fluid.

Fig. 1.2.3-7

1.2 Assembly Procedures – VPV 16–164

8. Assemble the control piston and spring through the clearance hole in the spacer ring (Fig. 1.2.3-8a and b). Lubricate the piston before installing.

Fig. 1.2.3-8a

Fig. 1.2.3-8b

9. Thoroughly lubricate the pressure ring with clean hydraulic fluid. Place the pressure ring ➪⑧ in the pump body (Fig. 1.2.3-9).

Fig. 1.2.3-9

10. For VPV 45–164 pumps, prior to installing the thrust screw assembly, lightly coat the bearing surface on the thrust block assembly ➪⑤ with clean hydraulic fluid.

    Note 8a: VPV 16-32

    Install the thrust screw in the body by using an Allen head wrench.

Fig. 1.2.3-10a: VPV 45–164

    Note 8b: VPV 45-164

    Install the thrust screw with O-ring ➪④ by using a spanner wrench and socket (see Fig 1.2.3-10a). Install the thrust block with plastic pad ➪⑤ (Fig1.2.3-10b) in the body. The contoured end has to align with the pressure ring.

    For preliminary adjustment of the thrust screw, tighten it all the way and then turn it out a $^3/_4$" turn CCW. Take care not to over-tighten the thrust screw or damage to the pump can occur. For the final thrust screw adjustment, see Page 32.

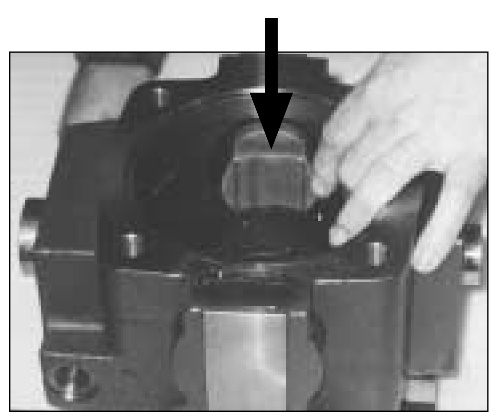


Fig. 1.2.3-10b: Thrust Block for VPV 45–164

1.2 Assembly Procedures – VPV 16–164

11. For the VPV 45–164, install the thrust screw lock ring by using the adjustable face spanner wrench (Fig. 1.2.3-11). For the VPV 16–32 use and Allen head wrench to tighten the thrust screw. See torque rates in Table 11.

Table 11: Torque Rates – Thrust Screw

VPV	16/25/32		45/63/80/100/130/164
Thrust Screw – in-lbs (Nm)	960	(112)	Tighten with Spanner Wrench

Fig. 1.2.3-11

12. Prior to replacing the rotor shaft lubricate it with clean hydraulic fluid. Replace the rotor shaft ➪⑦ (Fig. 1.2.3-12). Care must be taken not to damage the shaft seal while inserting the shaft. Verify that the key is not in the shaft.

Fig. 1.2.3-12

13. Lubricate the vanes with clean hydraulic fluid and place the vanes ➪③ in the rotor vane slots (Fig. 1.2.3-13b). The rounded tips of the vane contact the I. D. of the pressure ring. Make sure that the direction of the vane tips matches the direction of pump rotation (see Fig. 1.2.3-13a). The pump rotation is shown on the pump body and the port plates. Make sure that the vanes slide freely in the rotor vane slots.

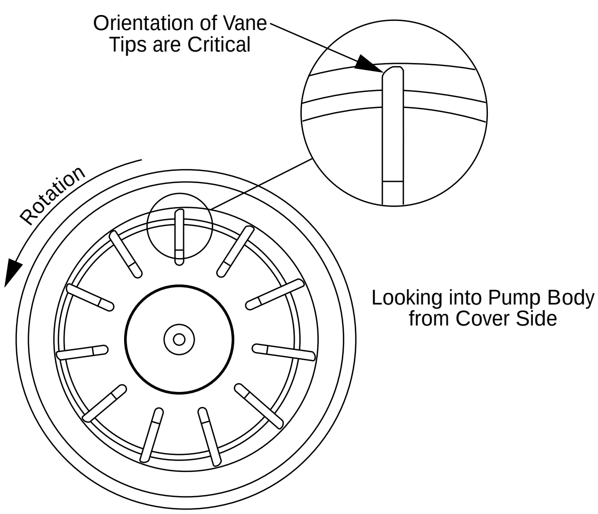


Fig. 1.2.3-13a

Fig. 1.2.3-13b

14. Prior to mounting the compensator to the pump body, install all O-rings ➪⑯ on the mating surface of the compensators first stage (see Fig. 1.2.3-14a).
A light grease or petroleum jelly may be used to retain the O-rings during placement. Keep the mating interface of the compensator and the pump housing free of grease.

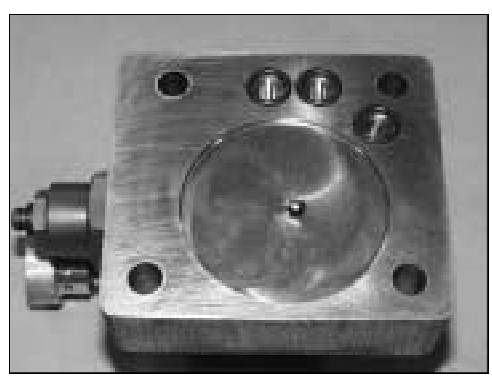


Fig. 1.2.3-14a

1.2 Assembly Procedures – VPV 16–164

The O-rings are included both as part of the pump and the compensator repair kit.

Note 9:

When lubricating O-rings and the seals of the compensator, please use a minimum amount of grease or petroleum jelly.

Mount the compensator to the pump and torque the four socket head cap screws by using the appropriate Allen wrench (Fig. 1.2.3-14b).

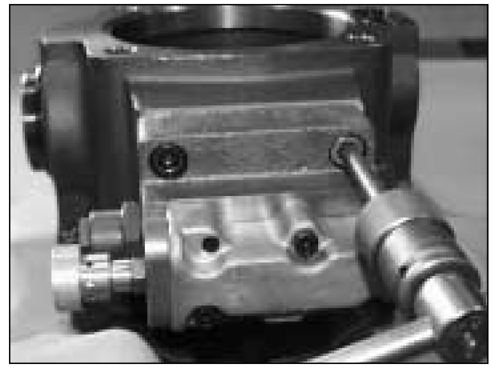


Fig. 1.2.3-14b

Table 12: Torque Rates – Compensator

VPV	16	25/32	45/63/80	100/130/164
Compensator – in-lbs (Nm)	350 (41)	350 (41)	680 (80)	680 (80)

15. Install the O-ring on the mating surface of the bias cap/ volume control ➪⑳. A light grease or its equivalent may be used to retain the O-ring in its groove. Torque the four socket head cap screws by using the appropriate Allen wrench (Fig. 1.2.3-15).

Note 10:

When lubricating O-rings and seals of the bias cover please use a minimum amount of grease or petroleum jelly.

Fig. 1.2.3-15

Table 13: Torque Rates – Bias Cover

VPV	16	25/32	45/63/80	100/130/164
Bias Cover – in-lbs (Nm)	350 (41)	350 (41)	680 (80)	680 (80)

1.2 Assembly Procedures – VPV 16–164

16. Insert O-ring on body pilot bore ➪⑭ (Fig. 1.2.3-16a). A light grease or petroleum jelly may be used to hold the O-ring in place while installing the cover.

Fig. 1.2.3-16a

Note 11:

For the VPV 45–164 insert a second O-ring ➪⑰ into the secondary inlet (Fig. 1.2.3-16b).

Fig. 1.2.3-16b

17. Assemble the port plate ➪⑩ on to the cover. Assure that the orientation of the port plate is correct on the VPV 45-164 pumps, such that the secondary inlet passages in the cover line up with the small O-ring in the back of the cover port plate (Fig. 1.2.3-4a, Page 13).

18. Install the cover by inserting the four hex head cap screws with the appropriate Allen wrench or socket (Fig. 1.2.3-17).

    Torque rates see Table 14. Keep the mating surfaces of the pump body and cover free of oil/dirt/grease before assembling the cover.

Fig. 1.2.3-17

Table 14: Torque Rates – Cover

VPV	16	25/32	45/63/80	100/130/164
Cover – in-lbs (Nm)	700 (82)	1200 (140)	1800 (210)	4970 (580)

2.1 Disassembly Procedures – Two-Stage Compensator

Shown in Fig. 2.1 are the Bosch two-stage compensators rated at 3000 PSI for the VPV 16–32 (left side) and the VPV 45–164 (right side).

Following are the complete disassembly procedures. Any differences between the different compensator models are described in additional notes.

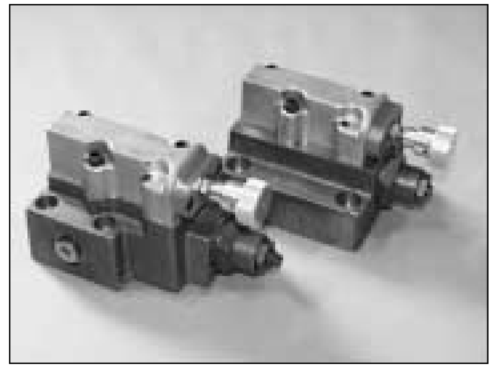


Fig. 2.1: Two-Stage Compensator
Left: for VPV 16–32, Right: for VPV 45–164

1. Remove the two socket head cap screws attaching the pressure adjustment cap to the body of the second stage by using the appropriate wrench (Fig. 2.1-1). Remove the pressure adjustment cap and the adjusting screw as one assembly.

Fig. 2.1-1

2. Remove the spring and the seat from the second stage body (Fig. 2.1-2)

Fig. 2.1-2

3. In order to remove the guided poppet take a large flat blade screwdriver and unscrew the guided poppet in the second stage of the compensator (Fig. 2.1-3a).

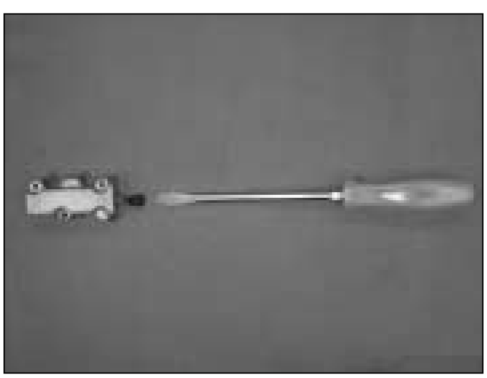


Fig. 2.1-3a

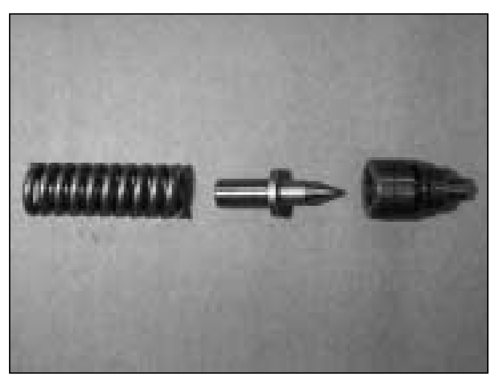


Fig. 2.1-3b

2.1 Disassembly Procedures – Two-Stage Compensator

4. Remove the plug from the second stage body by using the appropriate Allen wrench (Fig. 2.1-4).

Fig. 2.1-4

5. Remove the three socket head cap screws that attach the second stage body to the first-stage body by using the appropriate Allen wrench (Fig. 2.1-5).

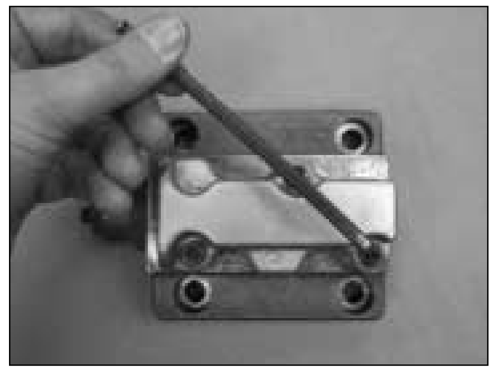


Fig. 2.1-5

6. Remove the plug from the first stage compensator by using the appropriate Allen wrench (Fig. 2.1-6a).

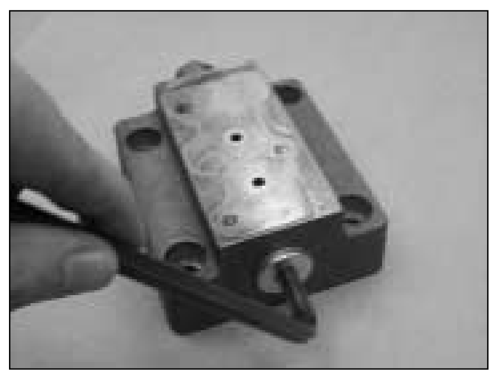


Fig. 2.1-6a

Note 1:

The two-stage compensator for the VPV 16–32 has a shock clipper which is located on the side of the first stage compensator. Remove the plug by using the appropriate Allen wrench (Fig. 2.1-6b).

Fig. 2.1-6b

2.1 Disassembly Procedures – Two-Stage Compensator

7. Remove the first stage adjustment screw adapter by using an adjustable wrench (Fig. 2.1-7a). Remove the differential spring, spring seat and stop tube (see Fig. 2.1-7b). Please note that the stop tube has been removed from the most current compensator design and replaced with an external washer and snap ring.

Fig. 2.1-7a

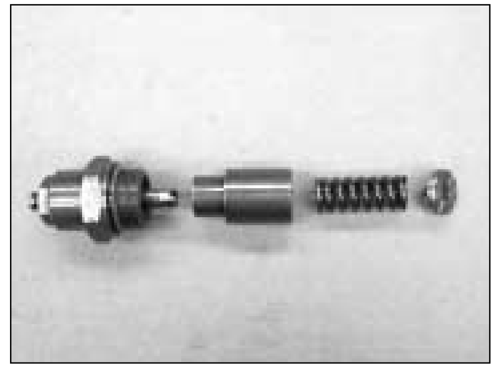


Fig. 2.1-7b

8. Loosen the locknut on the adjustment housing and disassemble the adjustment stem with a screwdriver (Fig. 2.1-8).

Fig. 2.1-8

9. Remove the compensator spool (Fig. 2.1-9). Caution should be exercised not to nick or mar the spool's surface.

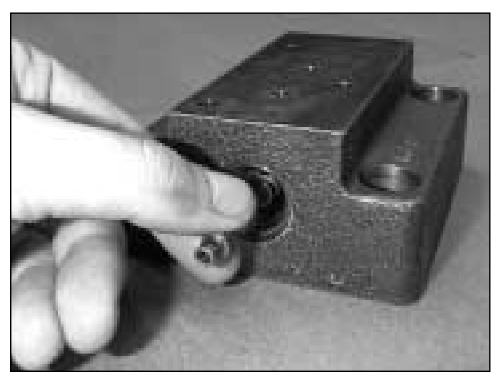


Fig. 2.1-9

2.2 Assembly Procedure – Two-Stage Compensator

2.2.1 Getting Started

To guarantee proper operation of the two-stage compensator Bosch recommends replacing all compensator seals included in the Bosch compensator seal kit.
Please use the following compensator seal kits:

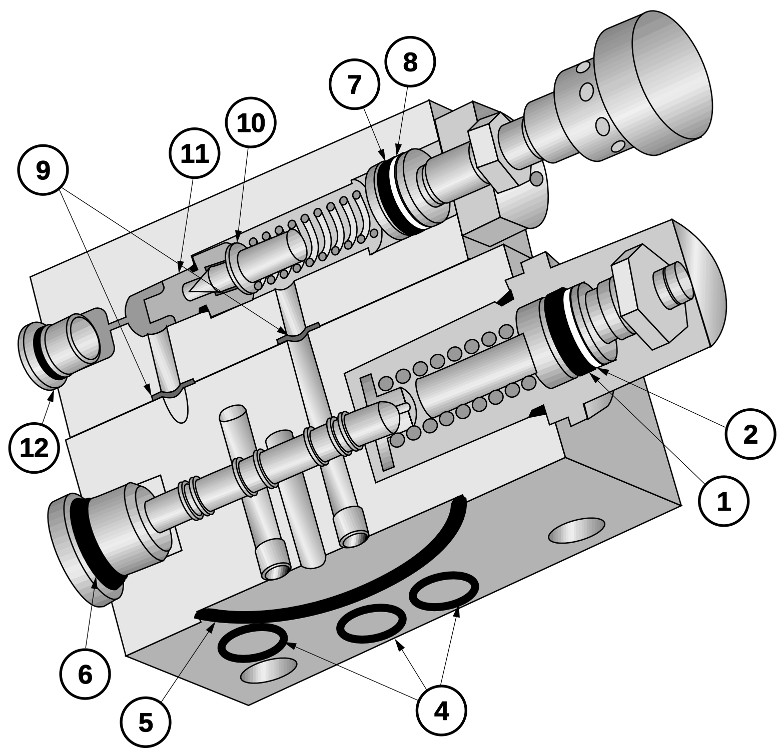
Table 15: Compensator Seal Kit for Two-Stage Compensator 3000 PSI

VPV	SAE	METRIC
16/25/32	9 511 230 627	9 511 230 628
45/63/80/100/130/164	9 511 230 660	9 511 230 661

Table 16: Complete Assembly for Two-Stage Compensator 3000 PSI

VPV	SAE	METRIC
16/25/32	9 511 230 601	9 511 230 602
45/63/80/100/130/164	9 511 230 610	9 511 230 611

Fig. 2.2.1-1 Two-Stage Compensator for VPV 45–164



The VPV 16–32 has an additional plug with an O-ring for the shock clipper on the side of the first stage compensator.

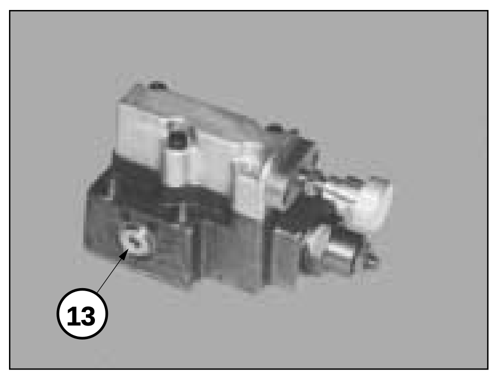


Fig. 2.2.1-2 Plug for Shock Clipper

Table 17: Compensator Seal Kit for Two-Stage Compensator (see Fig. 2.2.1.1 & Fig. 2.2.1.2)

REF	Description	QTY VPV 16/25/32	QTY VPV 45/63/80/100/130/164
1	O-ring	1	1
2	Back-up ring	1	1
3	O-ring	1	1
4	O-ring	2	3
5	O-ring	1	1
6	Plug w. O-ring	1	1
7	O-ring	1	1

REF	Description	QTY VPV 16/25/32	QTY VPV 45/63/80/100/130/164
8	Back-up ring	1	1
9	O-ring	2	2
10	Poppet	1	1
11	Poppet Seat w/O-ring	1	1
12	Plug w. O-ring	1	1
13	Shock Clipper Plug w/O-ring	1	0

2.2 Assembly Procedure – Two-Stage Compensator

2.2.2 Instructions

1. Thoroughly lubricate the compensator spool with clean hydraulic fluid. Make sure there are no burrs on the compensator spool and insure that the spool has no residual magnetism. Spools that are magnetic will attract metallic particles and damage the compensator body or spool. Insert the compensator spool into the smaller opening of first stage body by holding the squared end and inserting the round end first (Fig. 2.2.2-1).

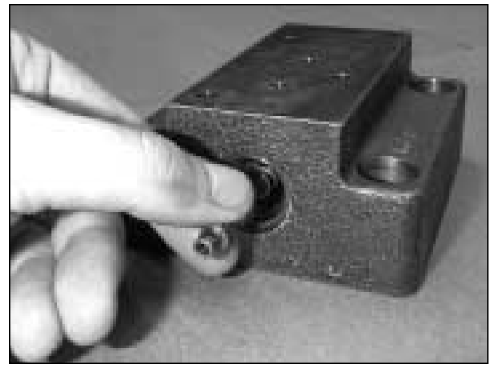


Fig. 2.2.2-1

2. Replace the O-ring ➪① and the back-up ring ➪② on the adjustment stem (Fig. 2.2.2-2a) and the O-ring ➪③ on the adjustment housing (Fig. 2.2.2-2b). Assemble the adjustment stem into the adjustment housing with a flat blade screwdriver.

Fig. 2.2.2-2a

Fig. 2.2.2-2b

3. Place the spring seat on the spring and insert it into the stop tube. Then insert the stop tube into the adjustment housing (Fig. 2.2.2-3). For later compensator designs without a stop tube, insert the spring and spring seat into the adjustment housing.

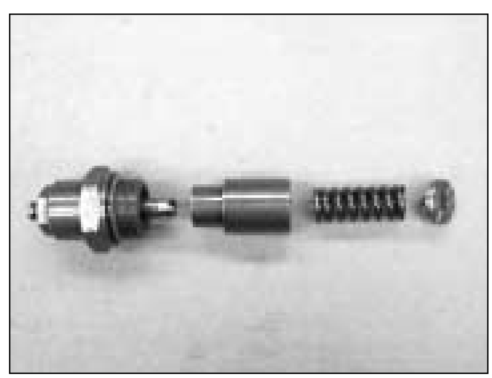


Fig. 2.2.2-3

2.2 Assembly Procedure – Two-Stage Compensator

4. Install the first stage differential spring adjustment screw adapter as one assembly into first stage body (Fig. 2.2.2-4).

   Torque to 708-888 in-lbs (80-100 Nm).

Fig. 2.2.2-4

5. Replace the back plug with the O-ring ➪⑥ and insert it into first stage compensator body. (Fig. 2.2.2-5a)

   Torque to 442-531 in-lbs (50-60 Nm).

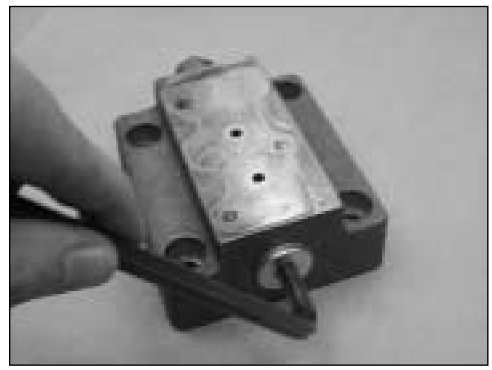


Fig. 2.2.2-5a

Note 2 (for VPV 16-32 Compensator):

For the two-stage compensator for the VPV 16–32 replace the plug with the O-ring ➪⑬ for the shock clipper on the first-stage compensator and torque to 144-180 in-lbs (17-21 Nm) (Fig. 2.2.2-5b)

Fig. 2.2.2-5b

6. Replace the plug with the O-ring ➪⑫ on the backside of second stage compensator (Fig. 2.2.2-6).

   Torque to 150-186 in-lbs (17-21 Nm).

Fig. 2.2.2-6

2.2 Assembly Procedure – Two-Stage Compensator

7. Replace the poppet seat with the O-ring ➪⑪ and insert it into the second stage body using a large screwdriver (Fig. 2.2.2-7). Avoid damaging any of the O-ring sealing surfaces.

   Torque to 168 in-lbs (19 Nm)

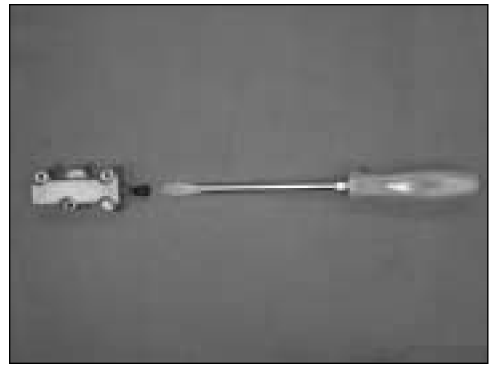


Fig. 2.2.2-7

8. Replace the guided poppet ➪⑩.
   You may place the compensator upright to insert first the guided poppet (Fig. 2.2.2-8a) and then the spring (Fig. 2.2.2-8b) into the second stage body. Please make sure that the poppet and poppet seat are not damaged or nicked or the compensator will not function properly.

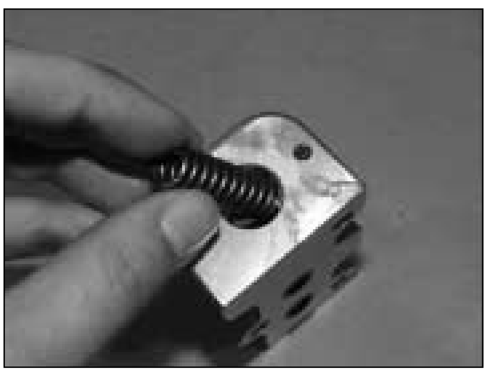


Fig. 2.2.2- 8a

Fig. 2.2.2-8b

9. Replace the O-ring ➪⑦ and back-up ring ➪⑧ of the pressure adjustment lock-nut. Mount the pressure adjustment assembly to the second stage compensator (Fig. 2.2.2-9b).

Fig. 2.2.2-9a

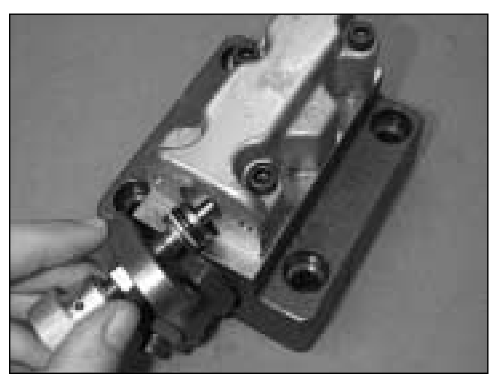


Fig. 2.2.2-9b

2.2 Assembly Procedure – Two-Stage Compensator

10. Torque the two socket head screws to 44-62 in-lbs (5-7 Nm) (Fig. 2.2.2-10).

Fig. 2.2.2-10

11. Prior to mounting the second stage to the first stage body, insure that all O-rings (2 pcs.) ➪⑨ are in place on the mating surface of the second stage body (Fig. 2.2.2-11a). A light grease or petroleum jelly may be used to retain the O-rings during placement. Mount the first stage to the second stage body (Fig. 2.2.2-11b).

    Torque to 129-171 in-lbs (15-20 Nm).

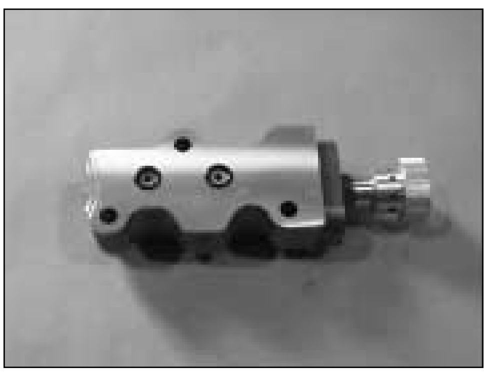


Fig. 2.2.2-11a

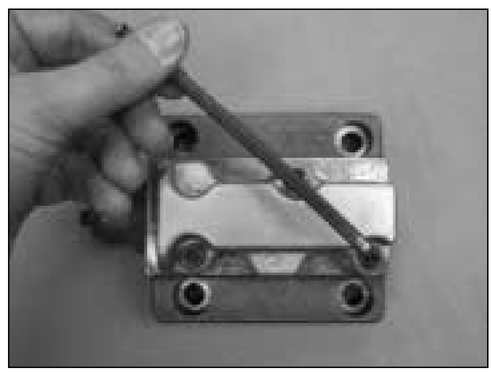


Fig. 2.2.2-11b

12. Replace the O-rings on the backside of the compensator. (Fig. 2.2.2-12)

Table 18:

VPV 16/25/32	VPV 45/63/80/ 100/130/164	REF
1 large O-ring	1 large O-ring	➪⑤
2 small O-rings	3 small O-rings	➪④

Fig. 2.2.2-12

2.3 Disassembly Procedure – Single Stage Compensator

Shown is the Bosch single stage compensator (Fig 2.3). Following are the complete disassembly procedures. The single stage control is normally only available for the VPV 16–32.

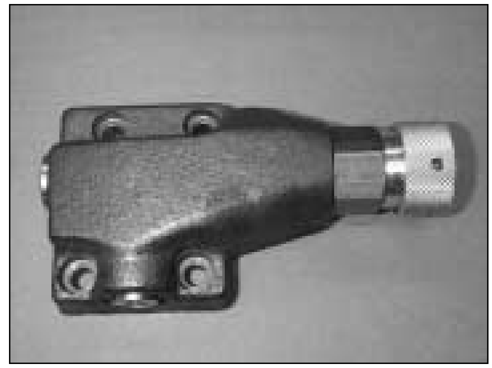


Fig. 2.3

1. Remove the roll pin on the backside of single stage compensator. Use a hammer and a small punch to drive the pin out. Then remove it with pliers (Fig. 2.3-1).

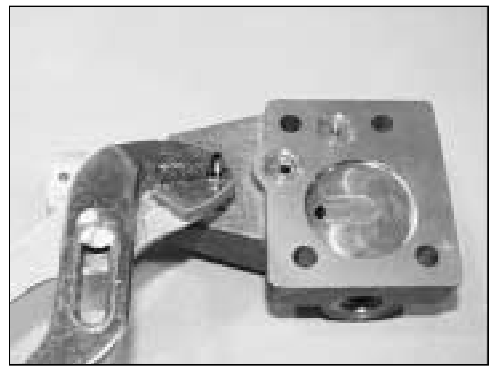


Fig. 2.3-1

2. Remove the adjustment knob, including the spring and spring seat as one assembly (Fig. 2.3-2).

Fig. 2.3-2

2.3 Disassembly Procedure – Single Stage Compensator

3. Remove the hex head plug on the side of single stage compensator by using the appropriate Allen wrench (Fig. 2.3-3).

Fig. 2.3-3

4. Remove the hex head plug opposite to the adjustment knob by using the appropriate Allen wrench (Fig. 2.3-4).

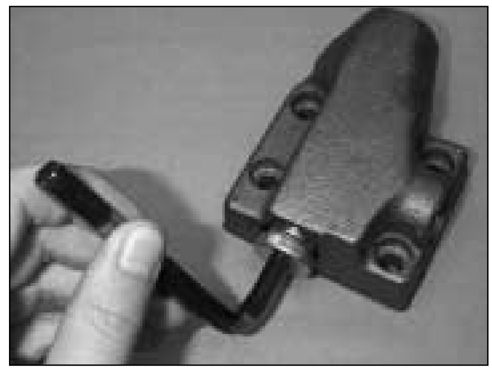


Fig. 2.3-4

5. Insert an Allen wrench to remove the compensator spool (Fig. 2.3-5).

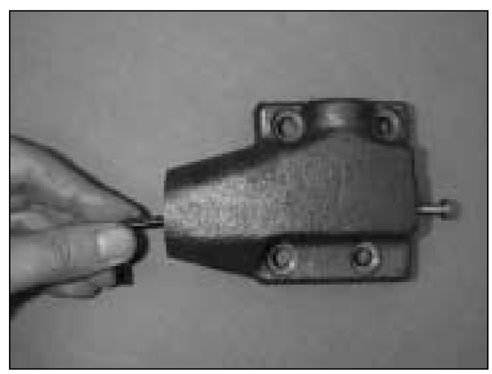


Fig. 2.3-5

2.4 Assembly Procedures – Single Stage Compensator

2.4.1 Getting Started

To guarantee proper operation of the single stage compensator Bosch recommends replacing all compensator seals included in the Bosch compensator seal kit.
Please note that for the single stage compensator two different designs exist (Fig. 2.4.1-a). The old design needs a “teardrop O-ring” on the backside of the compensator.
Please determine the design of the compensator being repaired to ensure the correct O-rings are used.

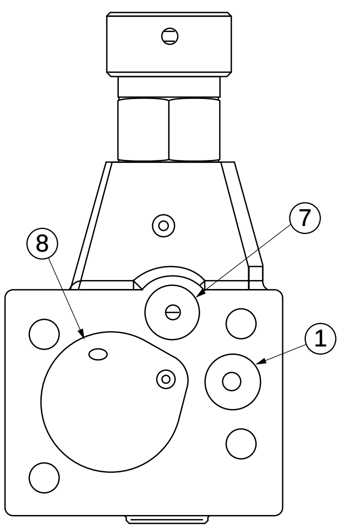
Table 19: Compensator Seal Kit for Single Stage Compensator 3000 PSI

VPV	SAE	METRIC
16/25/32	9 511 230 625	9 511 230 626

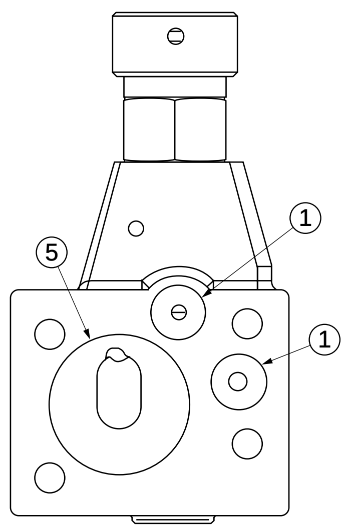
Table 20: Complete Assembly for Single Stage Compensator 3000 PSI

VPV	SAE	METRIC
16/25/32	9 511 230 595	9 511 230 596

With Teardrop Design



W/O Teardrop Design



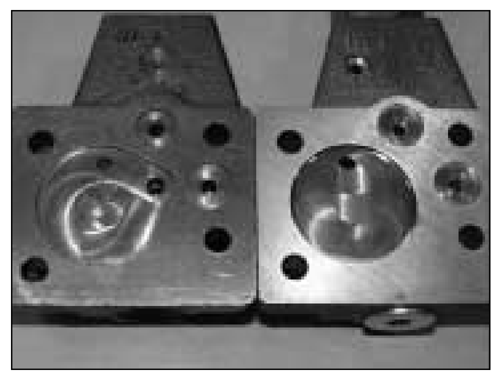


Fig. 2.4.1-a: Different Designs Single Stage
Left: Teardrop O-ring (old design)
Right: With counterbore (new design)

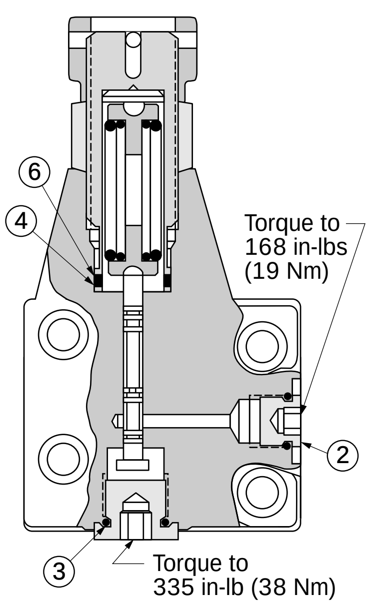


Table 21: Compensator Seal Kit for Single Stage Compensator VPV 16–32

REF	Description	QTY		
		Total	W/O Teardrop	With Teardrop
1	O-ring (Backside of Comp.)	2	2	1
2	O-ring with Shock Clipper Plug	1	1	1
3	O-ring (Plug)	1	1	1
4	O-ring (Adjustment Stem)	1	1	1
5	O-ring (Backside of Comp.)	1	1	0
6	Back up ring (Adjustment Stem)	1	1	1
7	O-ring (Backside of “Teardrop” Comp.)	1	0	1
8	O-ring (Backside of “Teardrop” Comp.)	1	0	1

2.4 Assembly Procedures – Single Stage Compensator

2.4.2 Instructions

1. Thoroughly lubricate the compensator spool with clean hydraulic fluid. Insert the compensator spool into the single stage body by holding the rounded end and inserting the small round end first (Fig. 2.4.2-1).

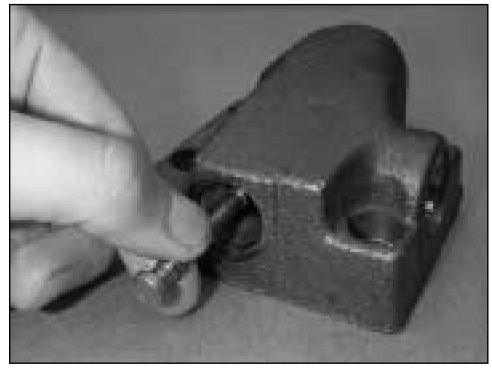


Fig. 2.4.2-1

2. Replace the O-ring ➪④ and back-up ring ➪⑥ on the adjustment knob. Put the spring seat on the spring and insert both into the adjustment knob (Fig. 2.4.2-2a & 2b).

Fig. 2.4.2-2a

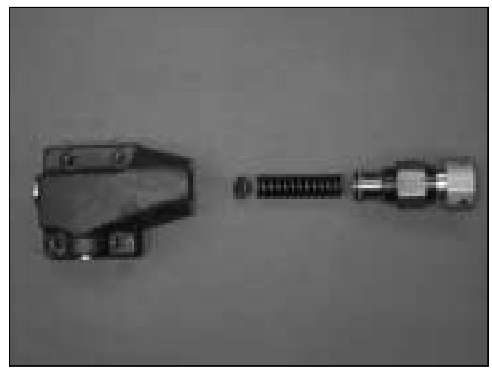


Fig. 2.4.2-2b

3. Insert adjustment knob (Fig. 2.4.2-3)

Fig. 2.4.2-3

4. Replace the O-ring ➪③ on the hex head plug and insert it into the compensator on the opposite side of the adjustment knob (Fig. 2.4.2-4).

   Torque to 283-369 in-lbs (33-43 Nm).

Fig. 2.4.2-4

2.4 Assembly Procedures – Single Stage Compensator

5. Replace the shock clipper plug including the O-ring ➪② on the side of single stage compensator and insert it by using the appropriate Allen wrench (Fig. 2.4.2-5).

   Torque to 150-186 in-lbs (17-21 Nm).

Fig. 2.4.2-5

6. Insert roll pin on the backside of single stage compensator (Fig. 2.4.2-6).

Fig. 2.4.2-6

7. Replace the O-rings on the backside of the compensator (Fig. 2.4.2-7). (See Table 22)

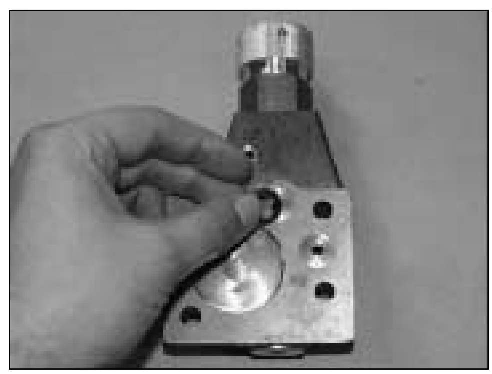


Fig. 2.4.2-7

Table 22:

W/O Teardrop	REF	Teardrop	REF
1 × O-ring (-127/75)	➪⑤	1 × O-ring (-128/75)	➪⑧
2 × O-ring (-111/75)	➪①	1 × O-ring (-111/75) 1 × O-ring (-110/75)	➪① ➪⑦

3.1 Proper Setting of the Thrust Screw

1. Make sure the pump is in “deadhead” condition before attempting adjustment of the thrust screw. The “deadhead”, or compensated condition, can be reached by blocking the outlet port by shutting off downstream valves which means that the output flow is blocked. The output flow must be completely shut off. Any valve leakage will affect the proper setting of the pump.
2. Loosen the pressure adjustment locknut on the compensator.
3. Back off the pressure adjustment to its absolute minimum (until it stops) by turning counterclockwise. On a two-stage control, this adjustment is on the second stage (the top assembly).
4. If your pump has a torque limiter control, back out the torque limiter adjustment all the way.
5. Using a flat blade screwdriver back out the first stage adjustment to its absolute minimum (until it stops).
6. Determine the size and pressure rating of the pump by observing the I.D. tag on the pump cover. If you have a combination pump the I.D. tag is on the adaptor of pump #1. The hydraulic code will state the size in cc/rev in the following manner: 0513R18C3***VPV63***SM21HYBO1. The pressure in this example is 210 bar or 3000 PSI: 0513R18C3VPV63SM***21***HYBO1, 21= 210 bar/3000 PSI, ***14*** = 140 bar /2000 PSI. Additional code information can be found in the catalog, document #9 535 233 724, or the Pump I.D. Guides, SAE #9 535 233 782, Metric #9 535 233 785. See the minimum thrust screw settings and differential pressures as shown below.

Table 23: 1800 rpm Two-Stage Compensator

Size	Thrust Screw	Differential Setting (1st stage)
VPV 16 2000 PSI	170-190 PSI	100-110 PSI
VPV 16 3000 PSI	170-190 PSI	100-110 PSI
VPV 25/32 2000 PSI	160-180 PSI	100-110 PSI
VPV 25/32 3000 PSI	190-205 PSI	100-110 PSI
VPV 45/63/80 2000 PSI	190-210 PSI	100-110 PSI
VPV 45/63/80 3000 PSI	230-250 PSI	100-110 PSI
VPV 100/130/164 2000 PSI	180-200 PSI	100-110 PSI
VPV 100/130/164 3000 PSI	210-230 PSI	100-110 PSI

Note:

On the VPV 16–32 the shock clipper port must be blocked when calibrating the pump. The first stage setting is always additive to the thrust screw setting.

Thrust Screw Setting + Differential Spring (first stage) = Total Minimum Setting

Example for the VPV 164 (1800 rpm, 3000 PSI):

1st adjustment – Thrust screw adjustment	210-230 PSI
2nd adjustment – Differential Spring (first stage)	100-110 PSI
Total adjustment setting	310-340 PSI

3.1 Proper Setting of the Thrust Screw

Table 24: 1500 rpm Two-Stage Compensator

Size	Thrust Screw	Differential Setting (1st stage)
VPV 16 2000 PSI (140 bar)	165-185 PSI	100-110 PSI
VPV 16 3000 PSI (210 bar)	165-185 PSI	100-110 PSI
VPV 25/32 2000 PSI	155-175 PSI	100-110 PSI
VPV 25/32 3000 PSI	170-185 PSI	100-110 PSI
VPV 45/63/80 2000 PSI	185-205 PSI	100-110 PSI
VPV 45/63/80 3000 PSI	210-225 PSI	100-110 PSI
VPV 100/130/164 2000 PSI	145-165 PSI	100-110 PSI
VPV 100/130/164 3000 PSI	190-210 PSI	100-110 PSI

Example for the VPV 164 (1500 rpm, 3000 PSI):

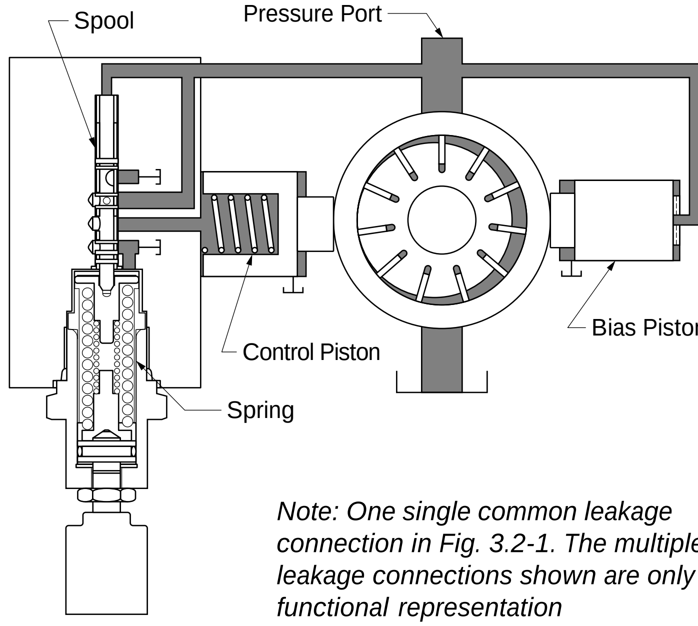
1st adjustment – Thrust screw adjustment	190-210 PSI
2nd adjustment – Differential Spring (first stage)	100-110 PSI
Total adjustment setting	290-320 PSI

7. If you are working with a VPV 16, 25 or 32 make sure the shock clipper port is blocked (located on the side of stage 1, the lower section of the two-stage control) before adjusting the thrust screw. For VPV 45–164 there is no external shock clipper port, therefore proceed to the next step.
8. If the pump has a stroke limiter, also known as a max. flow limiter or volume control, make sure it is backed out all the way. This is done by turning the bolt at the position on the pump housing opposite the pump control.
9. To adjust the thrust screw loosen the thrust screw locking nut. For VPV 16–32 a 5/16" Allen wrench is required. For the VPV 45–164 a spanner wrench is required. The spanner is available in the VPV Tool Kit, Bosch part number 9 511 230 557.

- While observing a pressure gage turn the thrust screw clockwise to increase pressure, or counter-clockwise to decrease pressure, to the appropriate thrust screw pressure in the proper table above. Be careful, the thrust screw should not be turned more than ¼ turn in either direction.
- Once the proper minimum thrust screw pressure is reached by adjusting the thrust screw, then adjust the differential pressure on the first stage compensator with a flat blade screwdriver. Adjust the first stage differential screw 110 PSI over the thrust screw setting.
- It is useful to “jog” the pump from deadhead to full flow several times and then re-check the thrust screw setting to assure repeatability.

10. Turn the second stage compensator knob in to the desired pressure and lock the setting with the jam nut.
11. Replace the lock nut on the thrust screw and tighten securely.

3.2 Adjustment Procedures – Single Stage Compensator



Note: One single common leakage connection in Fig. 3.2-1. The multiple leakage connections shown are only for functional representation

Fig. 3.2-1

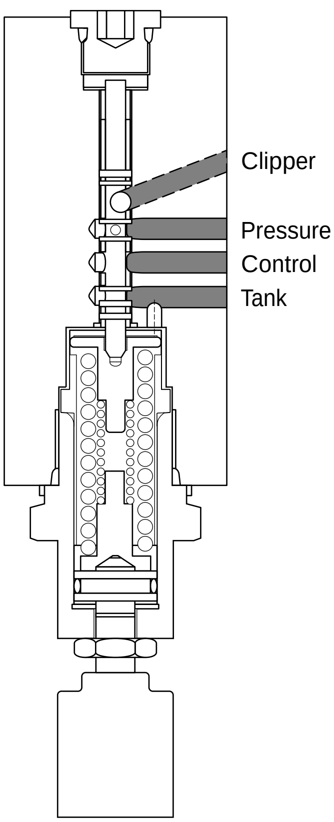


Fig. 3.2-2: Actual Representation of Fluid Paths.

The single stage compensator consists of a spool, spring and adjusting screw, which are assembled in a body and bolted to the pump body. To control the pressure at the control piston, the spool is designed to meter fluid in and out of the control piston chamber. A hole is drilled about three-fourths the length of the spool and intersects with a hole drilled at a right angle to the spool axis. The purpose of these holes is to allow fluid to flow from the pressure port of the pump to the end of the spool. No matter what position the spool is in, system pressure is applied to the end of the spool, creating a force, which opposes the spring force. As the system pressure increases, the force on the end of the spool also increases and the balance of forces determines the spool position. The spring cavity of the compensator is drained to tank to prevent any pressure buildup from leakage, which would add to the spring force and change the compensator setting.

The compensator spool (Fig. 3.2-3) is really an infinite positioning servo valve held offset by the compensator adjusting spring and activated by system pressure. To simplify the explanation, the spool travel will be broken down into two finite spool positions, which are shown in Table 25.

Table 25:

Spool Position	Pump Condition	System condition
1	Full Flow	System Pressure < Compensator Setting
2	Deadhead	System Pressure > Compensator Setting

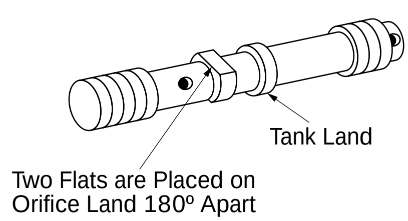


Fig. 3.2-3: Compensator Spool

3.2 Adjustment Procedures – Single Stage Compensator

When there is no resistance to pump flow, the spring will force the spool into the spring offset or "bottomed out" position (Fig. 3.2-4) shown. In this position, fluid from the pressure port can flow through the compensator to the control piston and allow system pressure to be applied to the control piston. A land on the spool (tank land) prevents the fluid in the control piston chamber from flowing to tank. Because the control piston has twice the area of the bias piston and the same pressure is applied to both pistons, the greater force exerted by the control piston will force the ring into the on-stroke or flow position. The length of the bias piston, which bottoms out against the bias cover and prevents the ring from over-stroking and hitting the rotor, establishes the maximum flow rate.

As the resistance to pump flow increases, the pressure will be sensed on the end of the spool and when the force exerted is great enough to partially compress the spring, the spool will move. The ring will remain in the on-stroke or flow position because the tank line is still blocked and fluid can flow to the control piston through an orifice created by two flats ground on the adjacent land (orifice land).

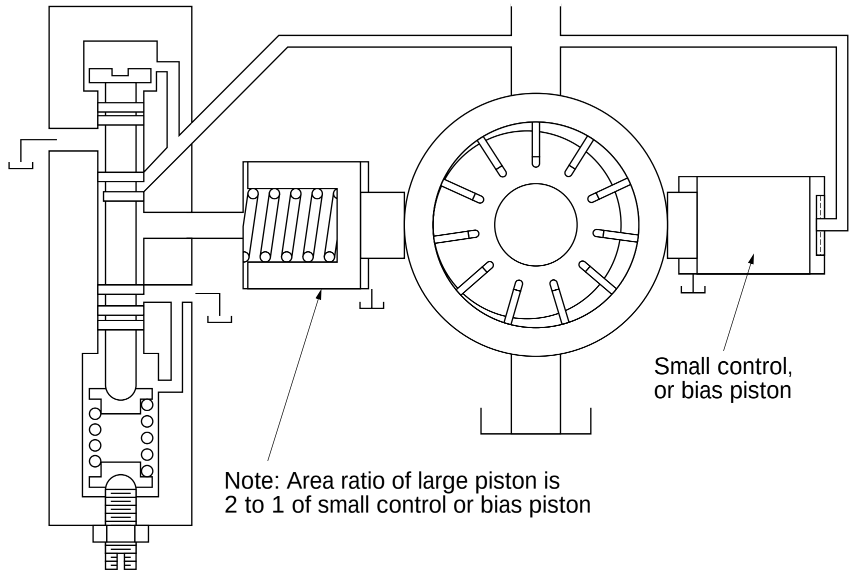
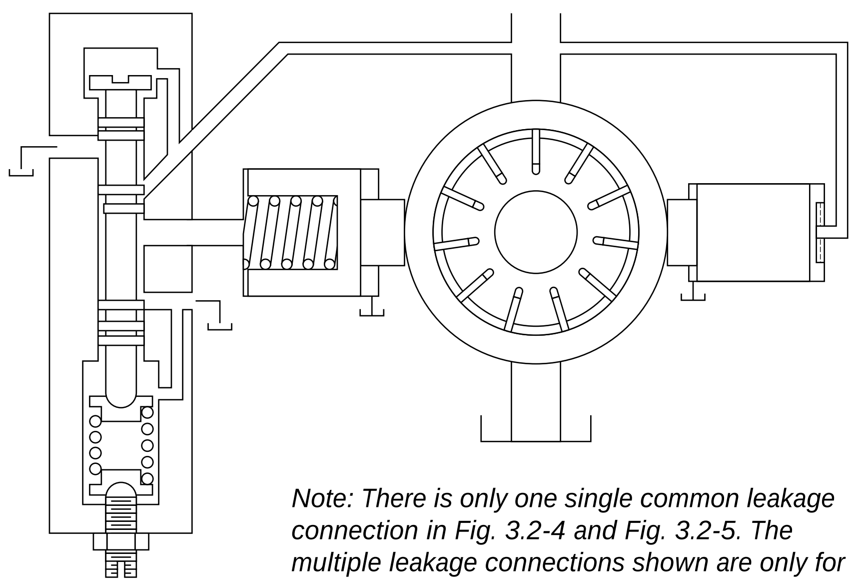


Fig. 3.2-4

When the system pressure reaches the compensator setting (spring precompression), the spool will move into position #2 (Fig. 3.2-5) which meters fluid out of the control piston chamber as well as into it.

The further the spool moves, the greater will be the amount of fluid bled off from the control piston chamber across the variable orifice created by the tank land. Since the flow of fluid to the control piston is limited by the orifice created by the flats on the pressure land, the pressure in the control chamber has dropped to approximately half of the outlet pressure, the bias piston force will exceed the control piston force and move the ring-off-stroke, reducing flow. As the ring shifts, the flow rate out of the pump is being reduced and the compensator is positioning the ring to find the exact flow rate necessary to maintain the pressure setting on the compensator. If the pump flow becomes blocked, the ring will continue to be destroked until the deadhead or no-flow position is reached. Remember that system pressure is always applied to the bias piston, which is trying to push the ring off-stroke. A balance of forces of the control piston versus bias piston determines the ring position.

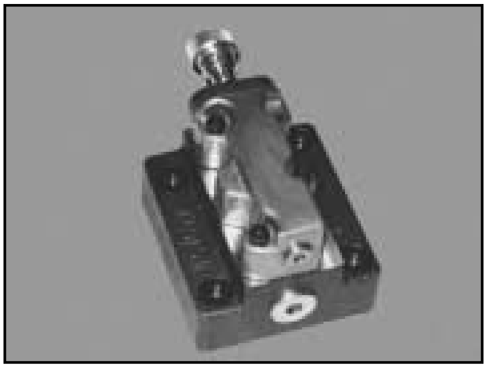
To set-up a single stage compensator, follow the instructions given in section 3.1 on how to set a thrust screw. Once the thrust screw pressure is set, adjust and lock the compensator knob at the maximum compensating pressure of your system.



Note: There is only one single common leakage connection in Fig. 3.2-4 and Fig. 3.2-5. The multiple leakage connections shown are only for functional representation

Fig. 3.2-5: Position 2- Deadhead

3.3 Adjustment Procedures – Two-Stage Compensator



The two-stage control works exactly the same as the single stage control. However, instead of loading the spool with a spring, it is hydraulically loaded. To do this, a small relief valve referred to as the second stage is connected to the spring chamber.

Two additional flats are ground on the land at the end of the spool, which will allow fluid to flow into the spring chamber.

If there is a pressure spike in the system above the compensator setting, the spool will momentarily move to the over travel position in an effort to de-stroke the pump. Only position #2 (Fig. 3.2-5) is a true compensating condition. Do not become confused with the term “deadhead”, it means the same thing as compensating.

When the spring in the second stage is compressed, it will hold the poppet on its seat and block the flow to tank. With the flow blocked, the pressure at the bottom of the spool will be the same as the pressure at the top. Remember that pressure is equal throughout a static fluid. Since the area at the ends of the spool are equal, the hydraulic forces created are equal but opposite in direction and cancel each other out. To unbalance the forces, a light bias spring is added which pushes the spool into the bottomed-out position shown. With the spool in this position, system pressure is applied to the control piston and will push the ring on-stoke as it did in the single stage control.

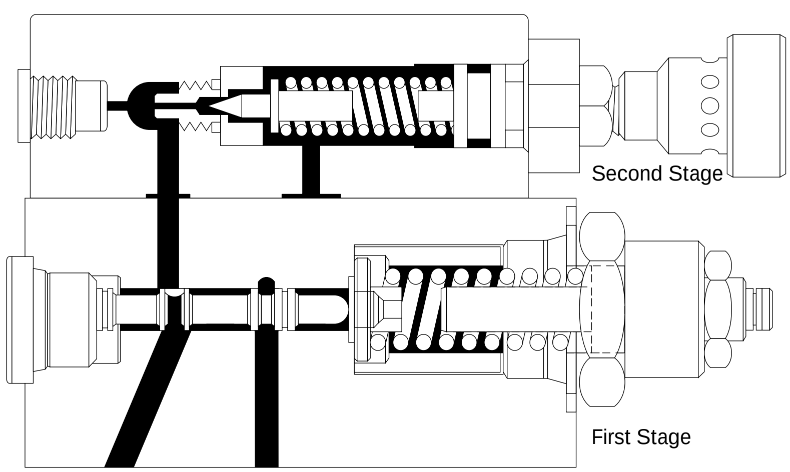


Fig. 3.3-1

3.3 Adjustment Procedures – Two-Stage Compensator

As system pressure increases, the pressure at the ends of the spool is always equal until it reaches the second stage setting. At that point the relief valve (second stage) will open and limit the pressure in the bias spring chamber by allowing fluid from the chamber to flow to tank. This will limit the amount of hydraulic force applied to the bottom end of the first stage spool. Fluid that is under pressure always takes the path of least resistance and, when the second stage opens, the entire pump flow is going to try to flow through the compensator to tank. To get to the tank, the fluid must flow through the very small flats ground on the end of the spool. As the entire pump flow tries to flow through the flats, they offer resistance to the flow, the pressure upstream of the flats is increased. This pressure is sensed at the top of the spool and, as the pressure increases, the hydraulic force pushing down on the spool increases. When this force becomes greater than the hydraulic force at the bottom, plus the bias spring force, the spool will be pushed towards the bias spring and vent the pressure behind the control piston to tank. The pump will then compensate as it did with the single stage control.

To set-up a two-stage compensator, follow the instructions given in Section 3.1 on how to set a thrust screw and differential setting. Once this is done, adjust and lock the compensator knob at the maximum compensating pressure of your system.

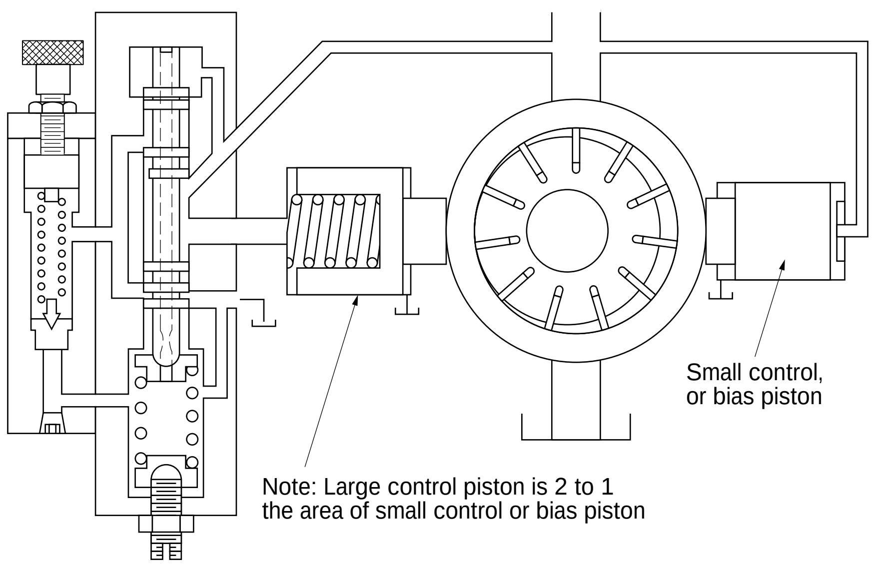
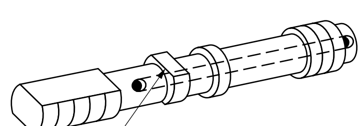


Fig. 3.3-2: Full Flow Position

Note: There is only one single common leakage connection common throughout in Fig. 3.3-2. The multiple leakage connections shown are only for functional representation.

Fig. 3.3-3: Two-Stage Compensator Spool



3.4 Multi-Pressure Compensator

Multi-pressure pump control can markedly reduce horsepower demand and heat generation during periods of idle time or time in the machine operating cycle when maximum pressure is not required. The modular design of the standard two-stage compensator lends itself to variable preset multi-pressure control arrangements with integral or remotely located valving. Whenever remote relief valves and switching valves are used, care must be taken not to introduce too much contained fluid between the pump and the remote valving.

Severe reduction of the pump reaction time constants or erratic control may occur with lines of large size (larger than 1/4" O.D.T.) or of lengths exceeding 20 feet. Special circuits might be needed in certain cases to alleviate problems, including the use of orifices at each end of the remote line.

3.4.1 Solenoid Two-Pressure Control

Fig. 3.4.1-1 shows the construction of the solenoid two-pressure compensator. The upper second stage is the high pressure control and serves to limit the maximum desired circuit pressure. The lower second stage contains either a normally open or normally closed two-way valve which is energized to select which of the two second stages will have control of the pump.

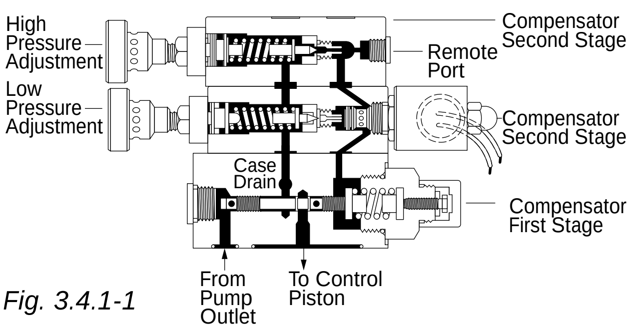


Fig. 3.4.1-1

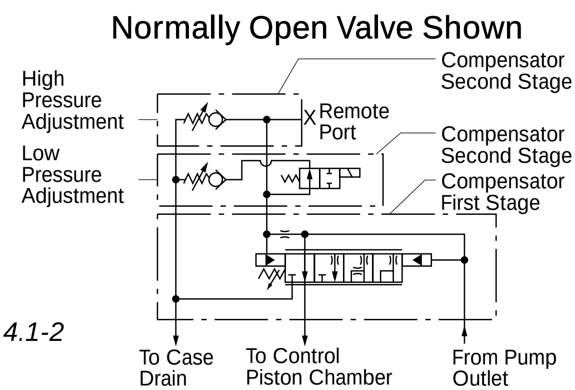


Fig. 3.4.1-2

3.4 Multi-Pressure Compensator

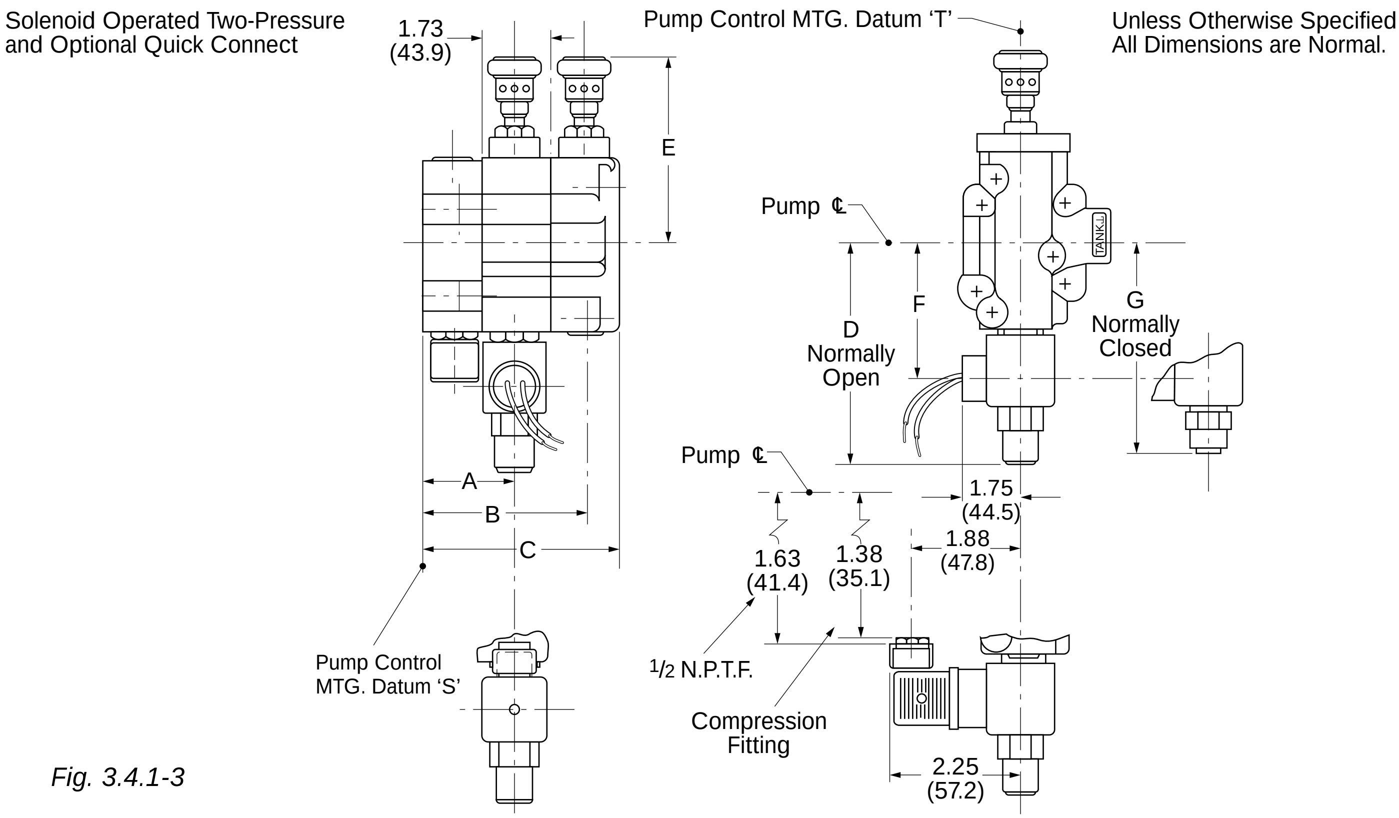


Fig. 3.4.1-3

To adjust a solenoid operated two-pressure control, determine if the solenoid is normally open (N.O. means low pressure) or normally closed (N.C. means high pressure). The hydraulic code on the pump nametag will identify which type of solenoid is on the compensator, assuming that the pump and compensator have not been modified from the factory.

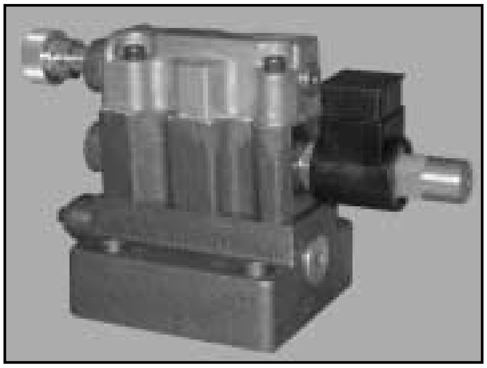
An example hydraulic code of a two-pressure control is: 0513R18C3VPV63SM21XAZB03. In this example, the X identifies the pump as a two-pressure compensator with a **normally open** solenoid. If the hydraulic code has a Y in this place, the solenoid is **normally closed**.

The solenoid must be closed to begin compensator adjustment. If the solenoid is normally closed, leave the solenoid de-energized. If the solenoid is normally open, energize the solenoid to close. Use the following steps to adjust the compensator:

1. Back out both the low pressure and high pressure adjusting knobs all the way.
2. Back out the first stage adjusting screw all the way.
3. Follow the procedure to set the thrust screw setting as detailed in Section 3.1, Proper Setting of the Thrust Screw.
4. Follow the procedure to set the first stage setting as detailed in Section 3.1, Proper Setting of the Thrust Screw.
5. With the solenoid closed, adjust the high pressure adjusting knob to set the maximum compensating pressure of the pump. Tighten the locknut on the adjusting screw to fix this pressure.
6. The solenoid must be opened to adjust the low pressure setting. After opening the solenoid (energize if N.C. or de-energize if N.O.), adjust the low pressure adjusting knob to set the second (i.e. low) pressure on the pump. Tighten the locknut on the adjusting screw to fix this pressure.

3.4 Multi-Pressure Compensator

3.4.2 Solenoid Vented



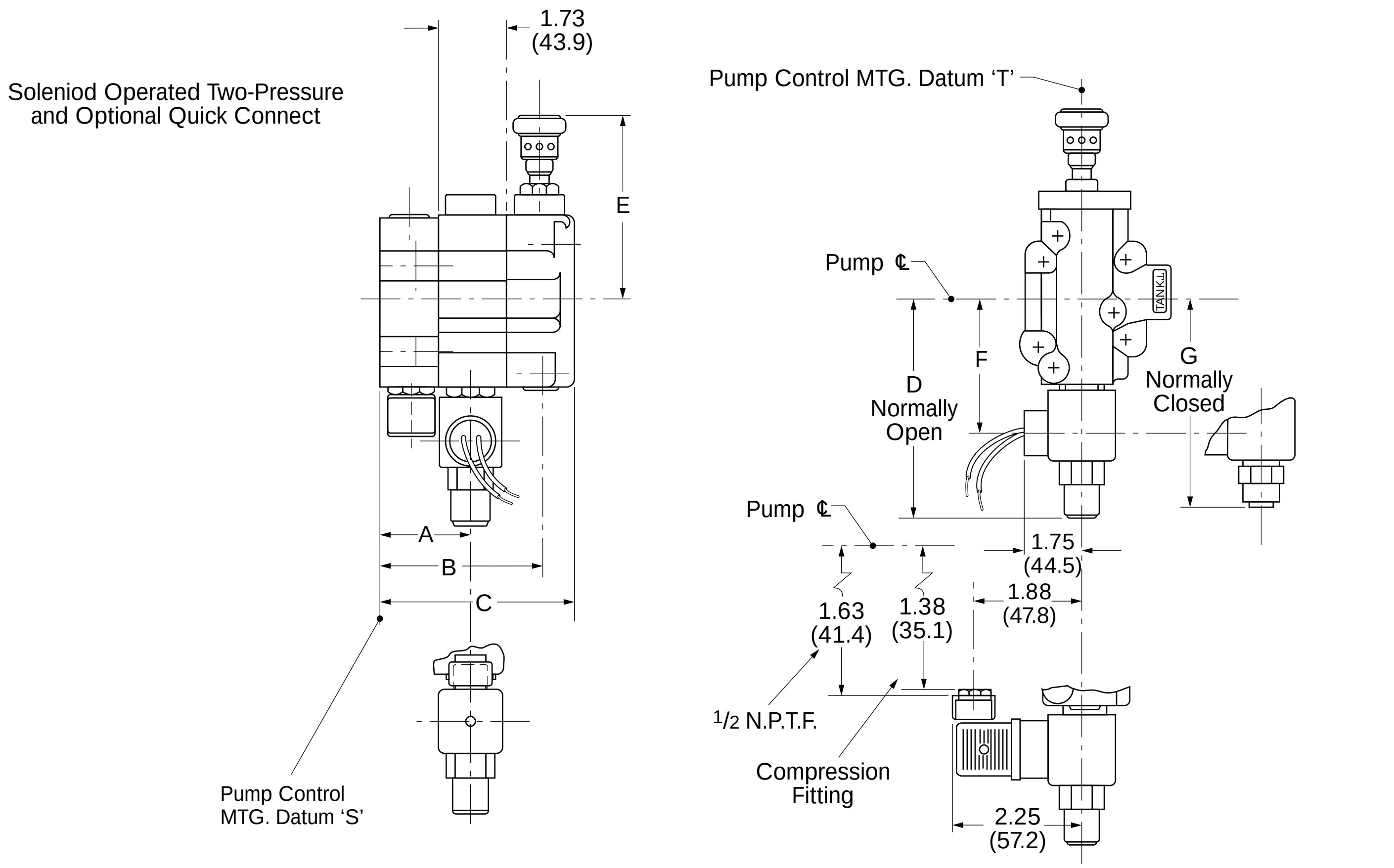


Fig. 3.4.2-1

3.4 Multi-Pressure Compensator

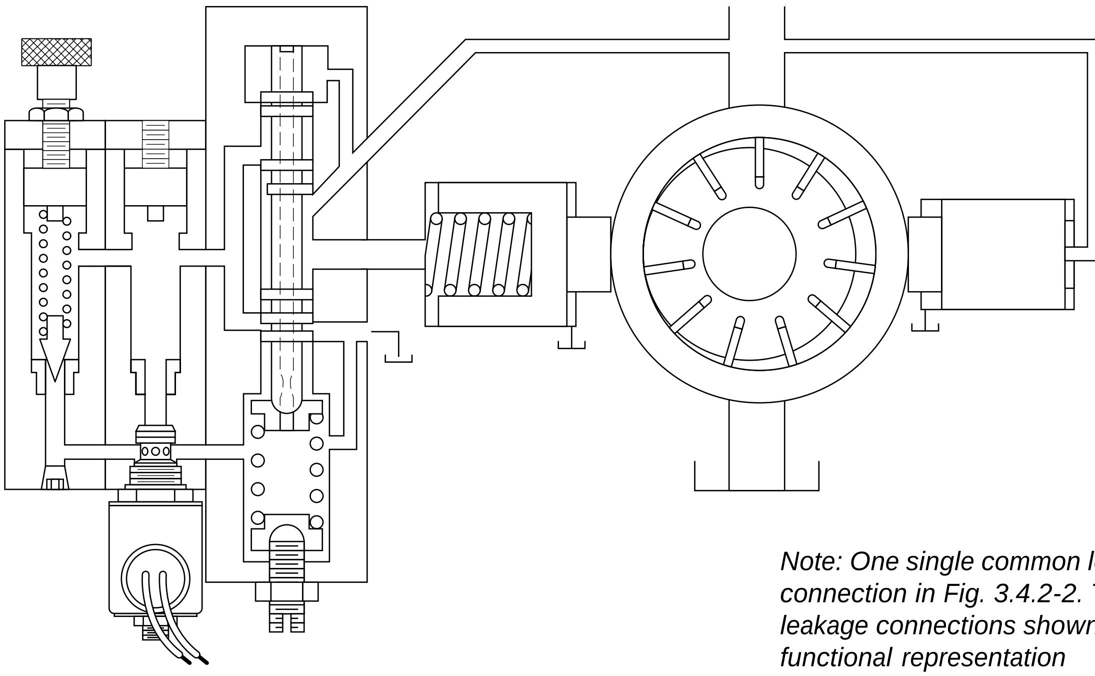


Fig. 3.4.2-2

Note: One single common leakage connection in Fig. 3.4.2-2. The multiple leakage connections shown are only for functional representation

Figure 3.4.2-2 shows a hydraulic representation of a solenoid vented compensator. Once again, the solenoid must be closed to begin compensator adjustment.

Using the hydraulic code on the pump, determine if the solenoid is normally open or closed. An example hydraulic code of a solenoid vent is: 0513R18C3VPV63SM21ZAZB03. In this example, the Z identifies the pump as a solenoid vented compensator with a normally open solenoid. If the hydraulic code has a W in this place, the solenoid is normally closed.

If the solenoid is normally closed, leave the solenoid de-energized. If the solenoid is normally open, energize the solenoid to close. Use the following steps to adjust the compensator:

1. Back out the high pressure adjusting knob all the way.
2. Back out the first stage adjusting screw all the way.
3. Follow the procedure to set the thrust screw setting as detailed in Section 3.1, Proper Setting of the Thrust Screw.
4. Follow the procedure to set the first stage setting as detailed in Section 3.1, Proper Setting of the Thrust Screw.
5. With the solenoid closed, adjust the high pressure adjusting knob to set the maximum compensating pressure of the pump. Tighten the locknut on the adjusting screw to fix this pressure.
6. To check the solenoid vent pressure, the solenoid must be opened. After opening the solenoid (energize if N.C. or de-energize if N.O.), the system pressure should decrease to the first stage setting.

3.5 Load Sense

The purpose of the load sensing flow control is to maintain constant flow regardless of changes in load or pump shaft rotational speed. This is accomplished by using an external metering valve and continually sensing pressure drop across this valve with a pilot line. The pump becomes a “control element” with this option, very similar to a very accurate pressure compensated flow control. However, because manipulation of the hydraulic power source is extremely efficient and the pump only uses precisely enough pressure to accomplish the task, the load sensing flow compensator (LSFC) is very energy conserving. Accuracy of the LSFC is +2-5% of set flow rate over the full range of load pressure. A changeable orifice is installed as standard and built into the compensator body.

The two-stage pressure compensator module is the basic foundation for the LSFC. The control seeks to maintain a constant pressure drop across a remote orifice. Any increase in flow due to decreasing load or increase in pump shaft rpm will cause an increase in the differential pressure. The VPV load sense □P is factory set at 100 PSI (7 bar) for VPV 16–80 pumps and 200 PSI (14 bar) for VPV 100–164 pumps. The opposite control action occurs smoothly should the □P fall below this differential setting, dynamically changing ring position to adjust for any differential pressure changes. Constant velocity of the load under widely varying pressure conditions results.

Should the load stall or otherwise be restricted from movement or use of fluid, the pressure compensator as secondary control will take over and maintain maximum deadhead pressure until the problem is corrected. Should the remote valve be totally closed, the pump will go to minimum deadhead.

The sensing pilot line P1, which is downstream, connects to the compensator as shown. A #4 SAE connector for P1 has a 0.040" orifice in it to dampen out any tendency to oscillate for sense lines of ¼" tubing up to 8 feet long. Additional 0.030" orificing in each line might be necessary for longer lines. Sense lines should be hard tubing of approximately equal length and ¼" diameter tapped into the main line, at least 10 pipe diameters upstream and downstream of the remote orifice. If located too close to the remote orifice, turbulent flow might create erratic action. Thorough air bleeding of the sense lines is absolutely essential to proper operation.

The quality of the remote valve is very important to the accuracy and stability of the LSFC. Successful valves are:

1. Standard flow control valves.
2. Electrohydraulic proportional flow controls of many types.

Table 26: Complete Assembly for Load Sense Compensator 3000 PSI

VPV	SAE	METRIC
16/25/32	9 511 230 603	9 511 230 604
45/63/80/100/130/164	9 511 230 612	9 511 230 613

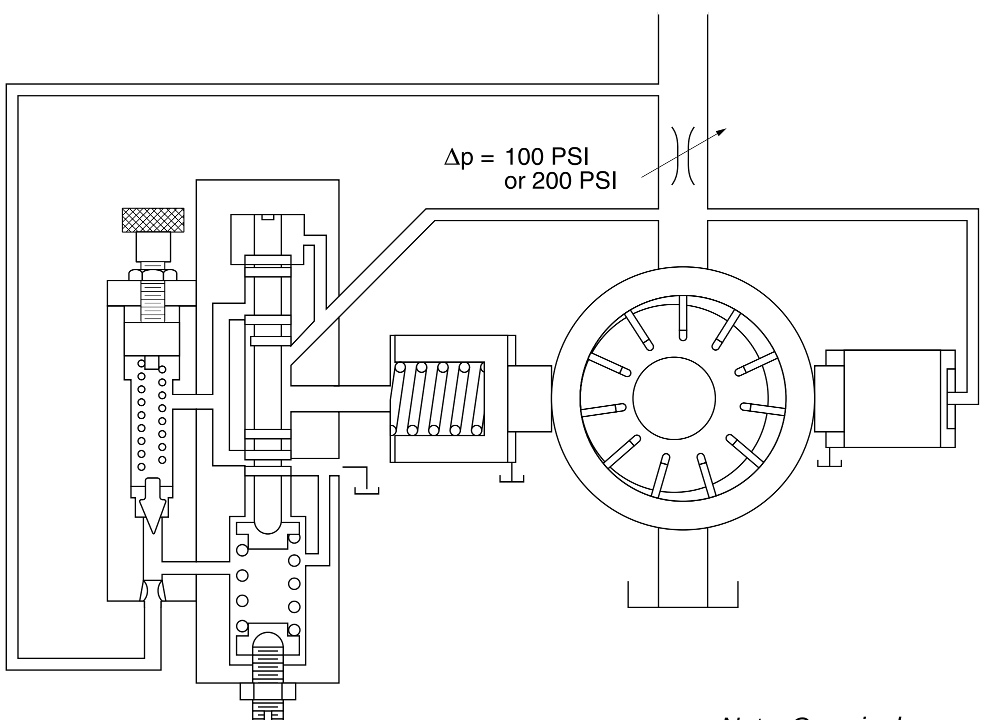
3.5 Load Sense

All orifices must be non-pressure compensated and sharp edged for temperature stability. If only low accuracy is needed, the ΔP of a four-way valve or other two-way is generally useable. Remember that at least 100 PSI (200 PSI for VPV 100–164) ΔP must be developed at the minimum flow rate or the LSFC will not work well.

Figure 3.5-3, on following page, is the schematic for the LSFC plus a flow versus pressure characteristic curve. The curve shows that two areas (shaded) must be avoided! (30-60 CIPM is the normal control flow required). First, flow rates below 10% of maximum output at rated rpm and second pressures below minimum deadhead (generally 400 PSI on 3000 PSI rated pumps). Flat flow lines extend from minimum deadhead to approximately 100 PSI below the setting of the pressure compensator, at any flow rate within the limits of maximum to 10% of maximum capability.

The LSFC is intended for and should be applied on meter-in circuits only. Meter-out circuits could pose serious safety problems or design difficulties because of the P1 sense line location downstream of the orifice. This puts P1 at atmospheric or at tank line pressure, which can vary drastically. Please do not apply LSFC-equipped pumps on meter-out circuits until the factory advises otherwise.

The procedure to set-up a load sense control is essentially the same as the procedure to set-up a two-stage control. The differential setting (first stage adjustment) must be set to a minimum of 100 PSI (200 PSI for VPV 100–164 pumps) above the thrust screw setting. This ΔP can be increased to 200 PSI (14 bar) for better operation, but this higher differential setting does increase the minimum compensating pressure at which the pump can operate at. Therefore, the higher differential setting should only be used if low pressure compensating is not a concern for your system.



Note: One single common leakage connection in Fig. 3.5-1. The multiple leakage connections shown are only for functional representation

Fig. 3.5-1

3.5 Load Sense

Load Sensing Flow Compensator Control

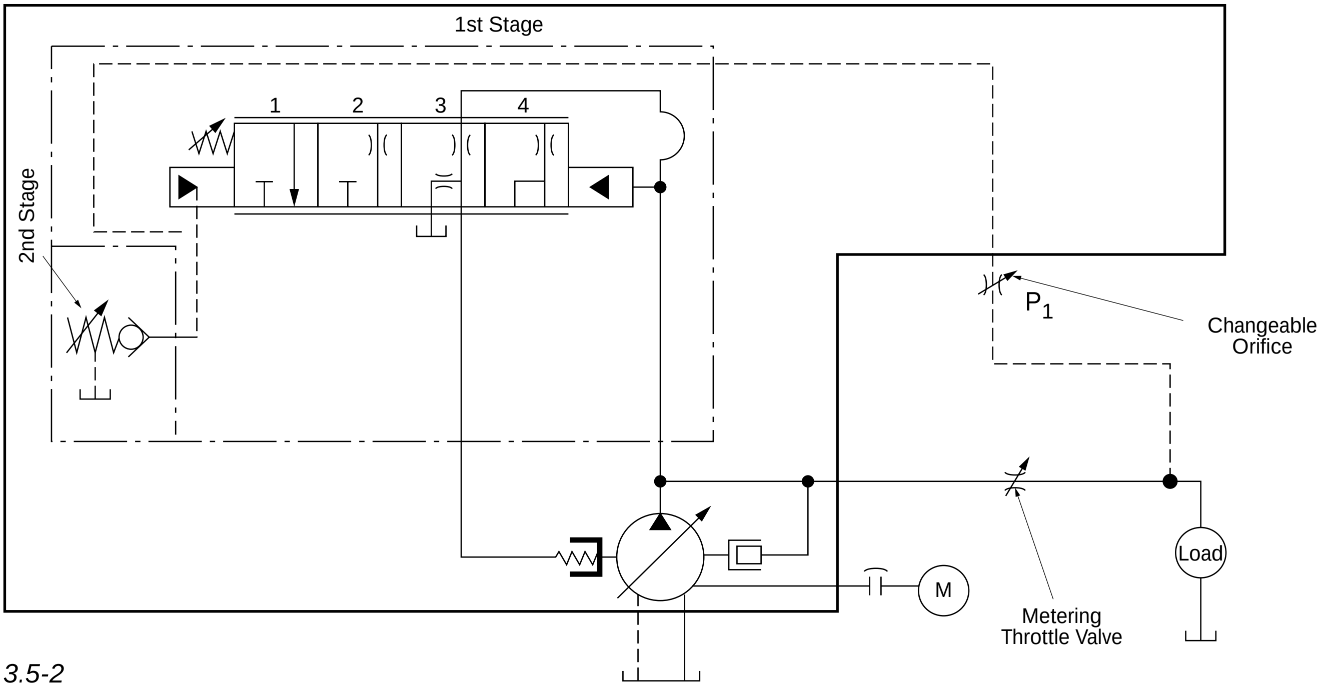


Fig. 3.5-2

Table 27:

LSFC Condition	Valve Position	Condition	System Condition
Rated □P	3	On stroke to set flow	Constant flow close deadhead
Above Rated □P	4	Minimum deadhead	External orifice shut off
Below Rated □P	2 to 1	Full deadhead	External orifice open beyond pump displacement
Zero □P	3 to 4 Comp. Override	Deadhead	Load resistance above compensator setting

LSFC Flow vs. Pressure Characteristic Curves

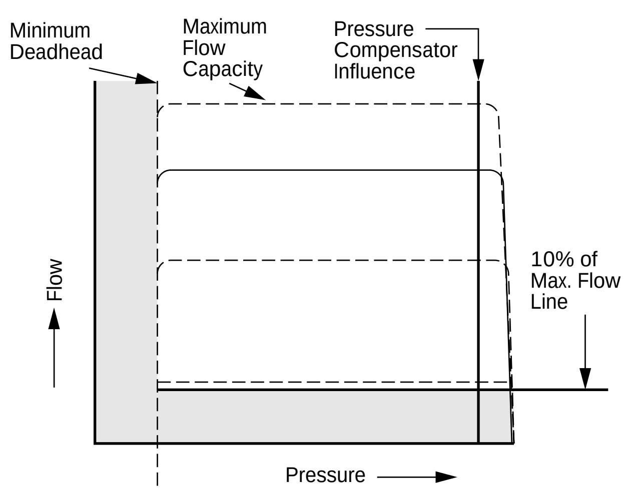


Fig. 3.5-3

3.6 Torque Limiter

The torque limiter control option is only available on VPV 45–164 pump sizes.

Table 28: Complete Assembly for Torque Limiter Compensator 3000 PSI

VPV	SAE
45	9 511 230 713
63	9 511 230 714
80	9 511 230 715
100	9 511 230 708
130	9 511 230 700
164	9 511 230 716

At this time point in time, torque limiting compensators are only available with SAE connections. Torque limiting controls featuring BSPP connections may be offered in the future. If your application requires BSPP connections, please contact the factory for availability. Bosch also plans to develop torque limiter control options with built-in load sensing, solenoid vent and solenoid multi-pressure options. Once again, please check with the Bosch factory for the availability of these options.

Table 29: Maximum Full Flow Pressure

VPV	PSI (Bar)	
45	2250	(155)
63	2250	(155)
80	1750	(121)
100	2250	(155)
130	2250	(155)
164	1500	(103)

The torque limiter control has two customer settable adjustments.

The second stage pressure adjustment (knurled knob parallel to inlet/outlet ports) is used to set the maximum deadhead pressure of the pump. A family of pressure cut-off curves, Fig. 3.6-1, are achievable using this adjustment. Clockwise adjustment increases the maximum deadhead pressure, while counter-clockwise adjustment decreases the maximum deadhead pressure.

The torque limiter adjustment (knurled knob perpendicular to the inlet/outlet ports) is used to set the torque cut-off curves. A family of torque cut-off curves, Fig. 3.6-2 and Fig. 3.6-3, are achievable using this adjustment. Clockwise adjustment increases the torque cut-off point, while counter-clockwise adjustment decreases the torque cut-off point.

Fig. 3.6-1 shows that it is possible to use a torque limiter control as a standard two-stage pressure compensator up to the maximum full-flow pressures as shown in Table 29.

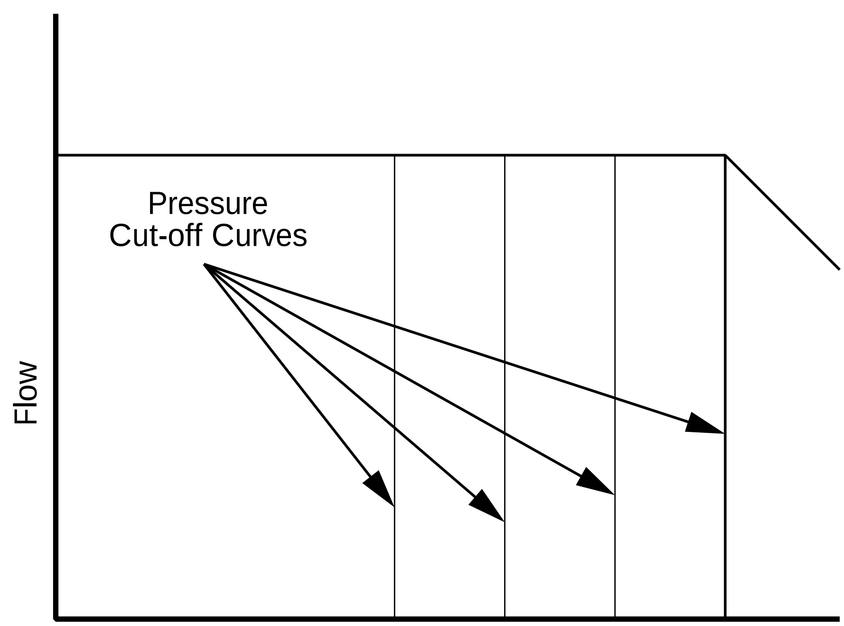


Fig. 3.6-1

3.6 Torque Limiter

Fig. 3.6-2 shows that the second stage pressure adjustment (pressure cut-off curve) will over-ride the torque limiter adjustment (torque cut-off curve) when the two intersect. This feature limits the maximum pressure of the pump.

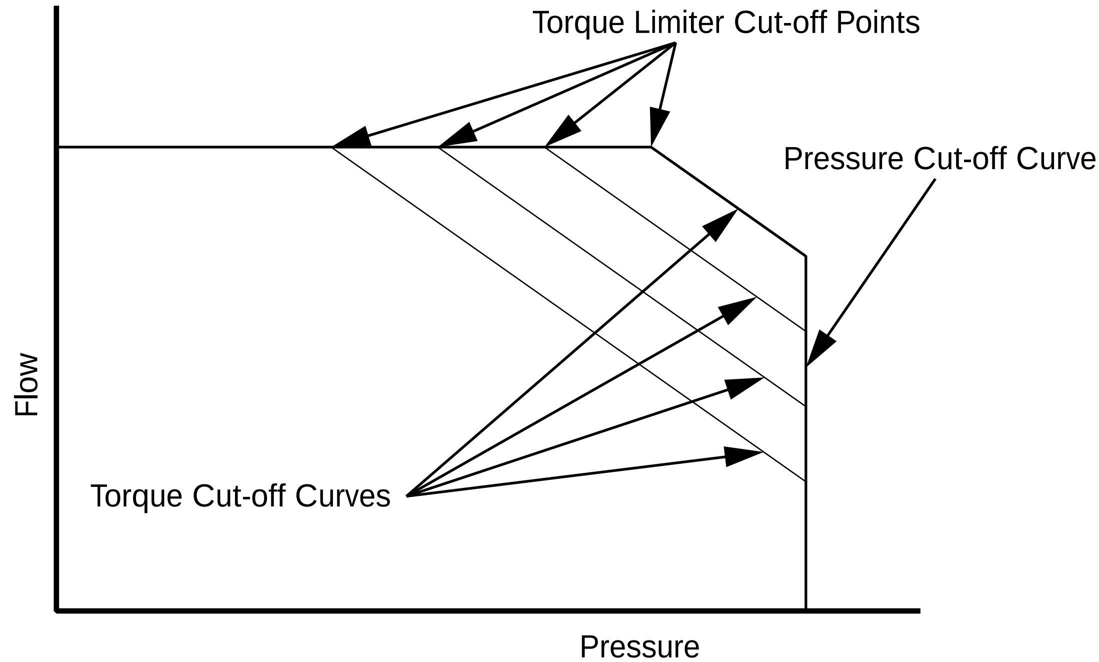


Fig. 3.6-2

Fig. 3.6-3 shows that it is possible to set the torque limiter cut-off point to a level where the pressure cut-off curve is not reached. In this case, the maximum deadhead pressure is limited by the torque limiter cut-off adjustment. It can also be seen that the torque limiter cut-off point can be set to a level where maximum output flow of the pump can not be achieved.

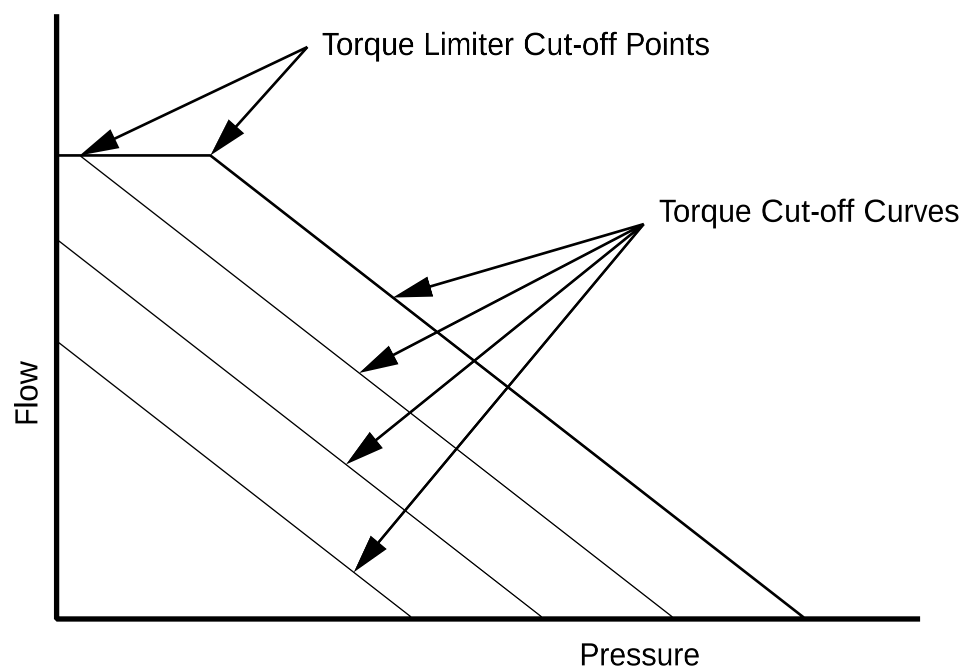


Fig. 3.6-3

3.6 Torque Limiter

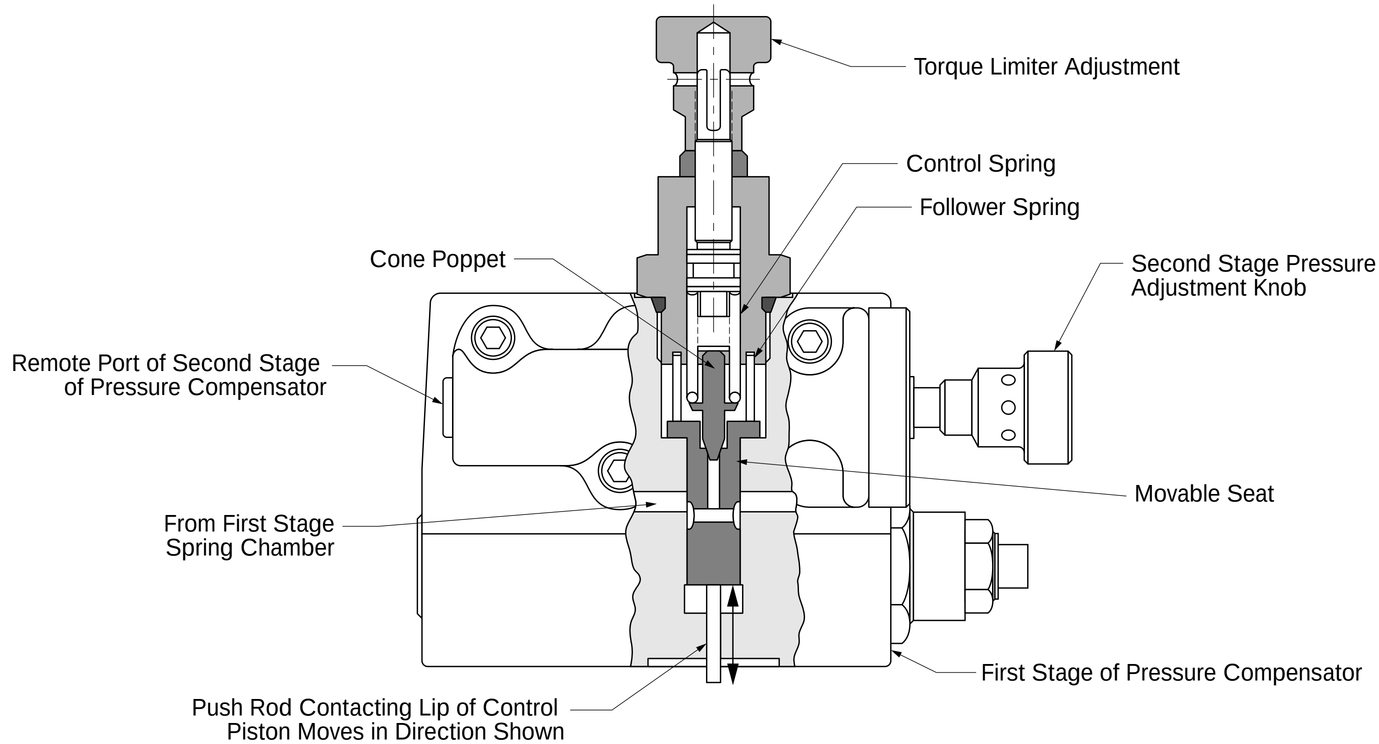


Fig. 3.6-4

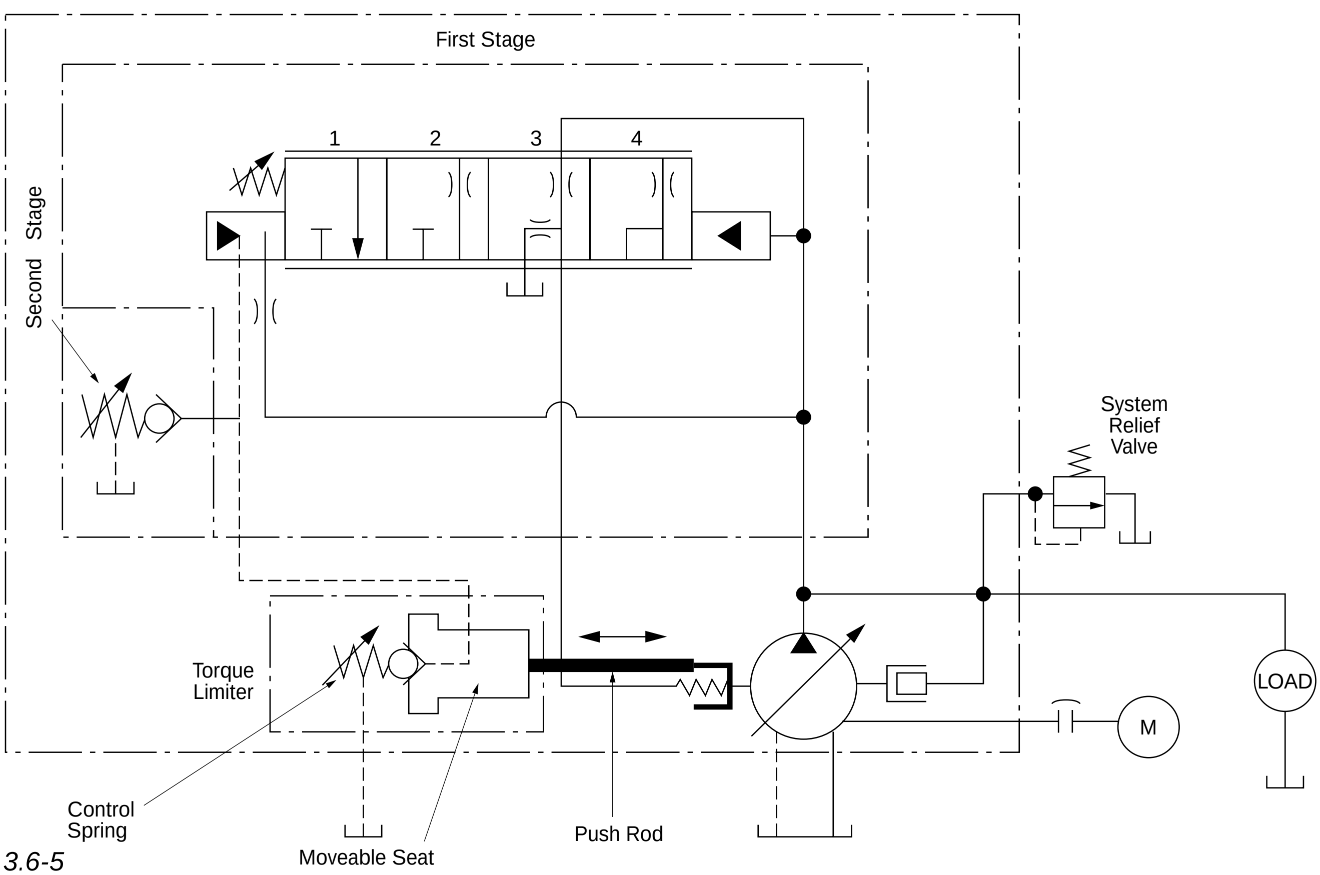


Fig. 3.6-5

3.6 Torque Limiter

Table 30:

Torque Limiter	Spool Position	Pump Condition	System Position
Poppet Seated	1	Free Flow	No Resistance
Poppet Opening	2	Full Flow	Resistance Starting
Poppet Metering	2 to 3	Reduced Stroke	Resistance Increasing
Poppet Metering	3	Deadhead	Blocked
Poppet Open	4	Spool Over Travel	Shock Pressure Above Deadhead

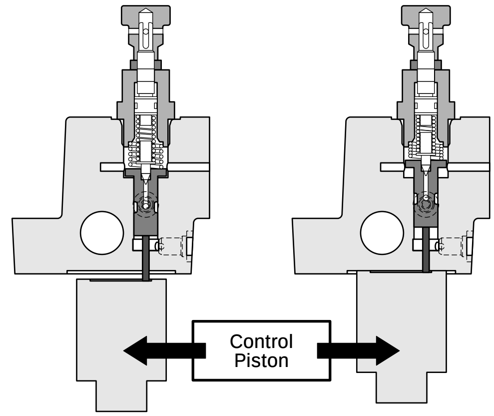


Fig. 3.6-6

Setting the Maximum Deadhead Pressure (Second Stage Setting)

Caution: VPV torque limiter adjustment stems that have the adjustment knob removed pose special concerns when the pump is re-started. Some internal control components can be damaged if the torque limiter is not adjusted properly. Please consult the factory if this condition exists.

1. If you received a pump straight from the factory, please skip to step 7. Otherwise, proceed with the following steps.
2. Before starting the pump, complete the following operations.
   - Back-out (counter-clockwise) the second stage of the compensator all the way.
   - Turn the torque limiter adjustment knob fully out (counter-clockwise).
3. Start the pump running into an open circuit under minimal load and at normal operating temperature.
4. If the pump does not prime, turn the thrust screw clockwise in small increments until the pump primes.
5. Close a load valve in the circuit such that the pump has no output flow (i.e. deadhead condition).
6. Follow the instructions given in Section 3.1 on how to set the proper thrust screw setting and first stage differential setting.
7. Torque limiter pumps straight from the factory should already have the proper thrust screw and first stage settings. With the pump operating in deadhead, turn the torque limiter adjustment knob fully in (i.e. clockwise). This will set the torque limiter function out of the way such that second stage pressure adjustment can be made.
8. Adjust the second stage pressure adjustment to the desired maximum deadhead pressure and lock in place with the jam nut. Proceed to setting the torque limiter adjustment.

Setting the Torque Limiter

1. With the pump still in deadhead, adjust the torque limiter knob out (counter-clockwise) as follows:

   VPV45, VPV80, and VPV164 — 1½ full turns CCW
   VPV63, VPV100, and VPV130 — 2 full turns CCW
2. Turning the torque limiter adjustment out by this amount will assure a low torque setting when the circuit is opened.
3. Take the pump out of deadhead by opening the circuit.
4. Load the hydraulic circuit and check to see if the desired flow/pressure/torque requirements of your system are achieved.
5. To adjust the torque limiter settings, turn the torque limiter adjustment knob in for higher torque and out for less torque in small increments.
6. Continue this process until the desired conditions are achieved.
7. Lock the jam nut under the torque limiter knob.

Application Notes:

1. When the torque limiter adjustment is fully backed out or near its lowest setting, the pump may not reach full flow.
2. Putting a flow and pressure load on the pump with the torque limiter adjusted fully in may cause the pump motor to stall or be damaged if the motor is undersized for full flow and high pressure.
3. It is possible for the torque limiter to control the maximum deadhead pressure of the pump. This condition can occur if the torque limiter curve reaches zero output flow before the second stage maximum deadhead pressure is achieved.

3.7 Maximum Flow Limiter

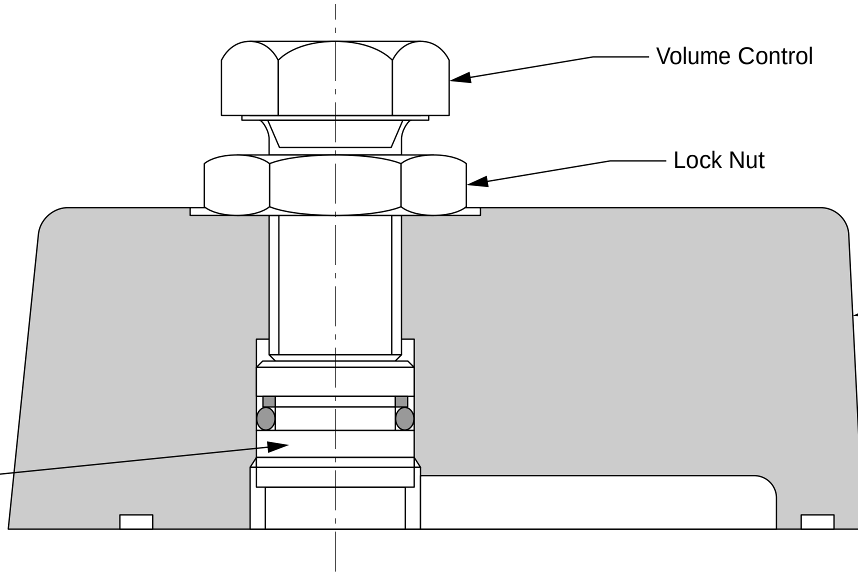


Table 31:

Pump Model VPV	Nominal Stroke in.	mm	Decrease in Flow per Turn (CW)	Minimum Flow Attainable
16	0.075	1.9	53%	< 0%
25	0.080	2.0	50%	0%
32	0.099	2.5	40%	20%
45	0.077	1.9	80%	< 0%
63	0.106	2.7	56%	8%
80	0.132	3.4	44%	26%
100	0.117	3.0	50%	17%
130	0.150	3.8	40%	34%
164	0.186	4.7	32%	47%

- During initial start-up, volume should be at least 50% of the maximum flow.
- Only make adjustments to volume control with pump running at full flow and low pressure while observing output flow.

4.1 Fluids, Filters & System Preparation

Thorough system preparation is of the utmost importance if satisfactory component life is to be achieved. Sufficient care in system preparation and fluid selection, as well a filtration, can mean the difference between successful operation and shutdown.

Prior to installing the pump, the entire system, reservoir, cylinders, valving and all piping must be drained, flushed and filled with new or refiltered fluid.

Once drained, the reservoir's inside surfaces must be cleaned of all chips, scale, rust, etc.

All return and/or pressure line filter elements must be inspected and replaced if necessary. We do not recommend the use of suction strainers as they tend to be a leading cause of cavitation. If suction strainers are used, we recommend oversizing them.

Fluid Recommendations

Bosch recommends the use of premium quality hydraulic fluids, such as Mobil DTE 25, DTE 26 or equivalent, with zinc anti-wear additives. The viscosity grade selected for your system should be based on the information in Table 32.

Table 32:

VPV	Fluid type	Oil (anti-wear)	Oil (non-anti-wear)	Phosphate Ester	Polyol Ester	Water-Glycol	FDA	Environmentally acceptable
	ISO classification	HM	HL	HFDR	HFDU	HFC	–	HETG, HEPG, HEES. HEPR
	note 1	note 2	note 2 & 3	note 4	note 4	note 4	note 5	
16/25/32	max. press, psi	3000	3000	3000	3000	1500	1500	note 6
	min. viscosity, SUS	100	100	100	100	100	100	
	seal material	Viton	Viton	Viton	Viton	Buna	Viton	
45/63/80	max. press, psi	3000	3000	3000	3000	1500	1500	note 6
	min. viscosity, SUS	150	150	150	150	150	150	
	seal material	Viton	Viton	Viton	Viton	Buna	Viton	
100/130/164	max. press, psi	3000	2000	note 6	note 6	1500	1000	note 6
	min. viscosity, SUS	150	150			150	150	
	seal material	Viton	Viton	Viton	Viton	Buna	Viton	

Notes

1: Equivalent viscosity in cST: 100 SUS ~ (21 cSt) and 150 SUS ~ (32 cSt)

2: Please refer to our publication S106, # 9 535 233 456, Petroleum Hydraulic Fluid Recommendations, for detailed viscosity limits and approved oils.

3: Anti-wear oils are recommended, but not required, when operating at noted pressures.

4: Please refer to our publication S107, # 9 535 233 457, Fire Resistant Fluids, for detailed information pertaining to the use of FR fluids.

5: Maximum operating pressures are contingent upon the fluid which is being used, as there is a wide range of fluid types that are FDA approved. Pressures listed are based on typical fluids. Please consult factory.

6: Please consult factory with viscosity information on these fluids.

4.1 Fluids, Filters & System Preparation

Fluid Temperature:

Pump reservoir (bulk) fluid temperature should not exceed 140° F (60° C). Always select fluid for optimum viscosity at operating temperature. Maximum start-up viscosity should not exceed 4000 SUS (864 cSt).

Filtration:

For increased component life, fluid contamination level should not exceed 18/15 (up to 2000 PSI), or 17/14 (from 2000 to 3000 PSI), per ISO/DIS 4406 "Solid Particulate Contamination Code." We do not recommend the use of inlet strainers as they tend to be a leading cause of cavitation.

When converting your system from petroleum base fluids to water-glycol, water-in-oil emulsion, or synthetic fluids contact the factory and/or your fluid supplier for system preparation instructions. Refer to Bosch publication S-107, "Fire Resistant Fluids."

We recommend that the users of fire resistant fluids obtain a copy of the NFPA publication entitled "Recommended Practice–Hydraulic Fluid Power–Use of Fire Resistant Fluids in Industrial Systems."

4.2 Pump Installation Procedures

1. Remove all plastic protective cap plugs from the components before installation.
2. Prior to installation, Bosch recommends pouring a small amount of clean hydraulic circuit fluid into the pump inlet port. Then rotate the pump shaft by hand in the direction indicated by the arrow cast into the pump body. All Bosch pumps rotate from thrust block to compensator. (i.e. clockwise as viewed from the shaft end of the pump). This insures lubrication at initial start-up.
3. Mount the pump and drive motor to a rigid base not more than three feet above the fluid level. Align the pump shaft to within 0.006" (0.152 mm) of Full Indicator Movement (F.I.M.) of the motor shaft, as shown in illustration 1 and 2.

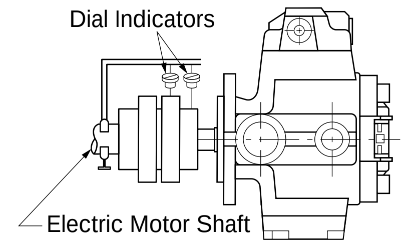


Illustration 1:

Two precision dial indicators must be used in order to insure proper alignment in the vertical, horizontal and parallel planes.

The coupling halves can be either engaged or disengaged. If disengaged, the outside diameter of the pump coupling must be smooth and machined true in respect to the coupling bore.

Proper alignment is achieved when neither indicator varies more than 0.006" (0.152 mm) during one complete revolution of the shaft.

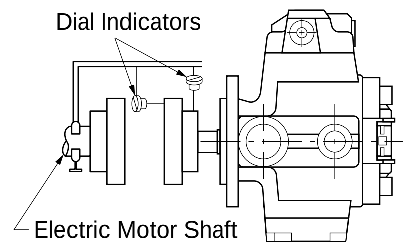


Illustration 2:

One indicator rides on the inside face of the pump coupling. Measuring parallel offset alignment, as in illustration 1, proper alignment is achieved when neither indicator varies more than 0.006" (0.152 mm) during one complete revolution of the shaft.

Caution:

The coupling selected should provide a clearance fit on the pump and motor shafts. Never use couplings with interference or sweat fits. Do not press jaw-coupling hub together tightly. Allow air gap between hub and insert to prevent end thrust into pump rotor, which will damage pump. No external forces (other than rotational) should be applied to the shaft.

4. Carefully connect the inlet, outlet and case drain plumbing to the pump. Do not force hard piping to align them with the pump ports. This may pull the pump out of alignment with the motor.

   The inlet line must be plumbed full size to within 3" of the bottom of the reservoir. Never reduce or restrict the inlet.

   Case flow on all VPV pumps exists through the port located on the pump body. VPV 16–32 models also have an external shock clipper drain port located on the compensator that, if you wish to enable the clipper feature, must be plumbed. VPV 45–164 models have internal shock clipper drains and no additional plumbing is necessary.

   The case drain line must also be plumbed to within three inches of the bottom reservoir. The case drain and main system return lines must be separated from the pump inlet line by a baffle. This enables all return flow to travel the length of the reservoir before entering the pump again, allowing for heat dissipation and de-aeration.
5. The case drain lines from multiple pumps in a combination should independently be plumbed back into the reservoir to prevent problems. Bosch recommends not to install check valves in case drain lines if possible. If necessary, Bosch strongly recommends “swing style” check valves which have low mass and will limit case drain spikes.
6. Fill the reservoir with fluid (please refer to the fluid recommendations).

4.3 System Start-Up Procedures

1. Rotate the shaft by hand in the direction given by the arrow on the body, to insure freedom of rotation.
2. To prime the pump on initial start-up it is imperative to clear all air from the pumping chambers. To do this, open center valving should be immediately down-stream of the pump outlet port, which allows all flow (fluid and air) to pass directly to tank upon start-up. If open center valving is not included in your circuitry, position your valving so as to move cylinders and/or motors in a no-load condition (75 to 150 PSI, 5 to 10 bar) until the pump has primed. This "no-load condition" value is not a pump compensating value, but is strictly the result of system resistance.

   Another way to clear air from the pumping chamber and allow the pump to prime is to incorporate an automatic air bleed valve on the pump discharge port, or as close to the discharge port as possible. This valve will automatically open to allow air to exit back to tank upon start-up. Once all air contained in the pump has been purged, the valve automatically closes.
3. If your pump incorporates the optional screw volume control, Bosch recommends not reducing the pump's output flow by more than 50% on start-up (pump-flow is reduced by turning the adjustment screw clockwise).
4. Jog the motor (no more than 10 revolutions, if possible) and observe the direction of rotation. If the pump shaft is not rotating in the correct direction as the cast in arrow on the pump indicates, reverse direction of rotation of the motor.

   If rotation is correct, continue jogging the electric motor until the pump has primed. You will notice a definite pump tone change as well as pressure gage movement when the pump begins to prime. Once the pump has primed, pressure adjustments can be made.
5. Pressure adjustments must be made against a blocked or dead-headed system (cylinders and/or motors stalled or valving shut off). Increase the pressure by turning the pressure adjustment clockwise. Decrease the pressure by turning the pressure adjustment counter-clockwise. The pump pressure setting should be as low as possible, yet high enough to insure satisfactory machine performance.
6. Bosch recommends installing a low resistance check valve to prevent pump reversal on system shutdown.

4.4 Trouble Shooting

Trouble	Potential Cause	Remedy
EXCESSIVE PUMP NOISE	1. Coupling misalignment.	Align the pump and motor shaft to within 0.006" (0.152 mm) total indicator reading. The tighter the alignment, the quieter the pump will be.
	2. The continuous system pressure is significantly above or below the rated pressure of the pump.	Decrease system pressure to the pump rated pressure or adjust the pump thrust screw to match system requirements.
	3. Fluid in the reservoir is low and the pump is sucking air.	Fill the reservoir so that the fluid level is well above the end of the suction line during all of the working cycle.
	4. Restricted inlet.	If a suction strainer is used, check it for obstructions or dirt. We do not recommend the use of strainers as they tend to be a leading cause of cavitation which manifests as excessive noise. Check also for shop rags left in the reservoir.
	5. Air leak in the suction line.	Tighten all fittings. If leaks still occur, smear grease over the joints to locate the leak.
	6. Suction line has too many elbows or is too long.	The suction line should be as short and straight as possible to reduce the resistance to flow.
	7. Air in the fluid.	The return line should terminate below the fluid level to prevent splashing.
	8. Suction line is too small.	Suction line should always be equal in size to the suction port. Never reduce it!
	9. Vane does not move freely.	Contamination in the fluid or a burr in the vane slot can cause a vane to bind up. Proper filtration and/or deburring of the vane slots is required
	10. Vane is installed incorrectly.	In vane pumps the vanes must be mounted with the rounded edge toward the ring. In VPV series B01 and later, the leading edge of the vanes must be orientated in the direction of the rotation. The leading edge is identified as the low side of the vane taper.
	11. A vane is missing.	Make sure all vane slots have a vane in them.
	12. Port plates are installed Incorrectly.	Plates must be installed so that the arrows point in the same direction as the rotational arrows on the pump body. VPV series B01 and later require the use of port plates with ratio valves for VPV 45-164.
	13. Wrong direction of pump rotation.	Observe arrow on pump case. Direction of rotation must correspond. VPV Whisper Pumps™ are offered in RH rotation only.
	14. Low oil level.	Fill reservoir so that surface of oil is well above end of suction line during all of work cycle.
	15. Wrong type of oil.	Use a premium, clean hydraulic oil having the viscosity in accordance with the Bosch recommendations (see Page 50 and Publication S-106).
	16. Reservoirs not vented.	Vent reservoir through air filter to allow breathing action for fluctuating oil level.
	17. Slip line (case drain) does not terminate below oil level.	Extend slip line piping so that it terminates below the oil surface when oil is at its lowest level during any one machine cycle.
	18. Worn pressure ring.	Replace. This condition is caused by hot, thin, dirty oil or no oil at all.
	19. Two pumps to a common manifold.	A check valve must be placed in the discharge line of both pumps to prevent back flow and surging. This check valve must also be present if an accumulator is in the discharge line.

4.4 Trouble Shooting

Trouble	Potential Cause	Remedy
PUMP WILL NOT PRIME	1. Shaft rotation in the wrong direction.	When installing a pump, always jog the electric motor to check for proper shaft rotation. Rotation should only be clockwise (right hand).
	2. Air leak in the suction line.	Make sure all fittings are tight.
	3. Pump is air bound.	Use an air bleed valve to void the pump and suction line of air.
	4. Fluid level in the reservoir is too low.	Fill the reservoir so that the fluid level is well above the end of the suction line.
	5. Stroke limiter is turned in too far.	Flow should not be reduced more than 50% of maximum at start-up.
	6. Suction port dust plug left In place.	Remove plug.
PUMP IS UNSTABLE	1. Contamination in the compensator.	Thoroughly clean the control orifices and check filtration.
	2. Pressure ring is not moving properly.	Control piston should be checked for freedom of movement.
SYSTEM IS TOO HOT	1. Case drain line is installed too close to the pump inlet line.	The case drain and pump inlet should be separated by a baffle in the reservoir.
	2. Reservoir is undersized. Rule of thumb is a minimum of 3 times pump output flow.	Add a cooler.
	3. Pump operated at higher pressures than required.	Reduce pump pressure to the minimum required for installation.
	4. Pump discharging through relief valve.	Remove the relief valve. Relief valves are not required with Bosch pumps having a spring or hydraulic pressure compensator governor (Relief valves create additional heat energy).
	5. Excessive system leakage through cylinders or valves.	Check progressively through the system for excessive leakage.
	6. High ambient or radiant temperature.	Relocate power unit or baffle against radiant heat.
	7. Low oil in reservoir.	Bring level of oil up to recommended point.
	8. Excessive friction.	Make sure fluid is of the proper viscosity.
	9. Reservoir too small.	Increase size or install auxiliary cooling equipment.
	10. Restricted or undersize valves on hydraulic lines.	Clean valves and piping. Use adequate pipe sizes.
LEAKAGE AT OIL SEAL	1. Abrasives on pump shaft.	Protect shaft from abrasive dust and foreign material.
	2. Scratched or damaged shaft seal.	Replace oil seal assembly.
	3. Coupling misalignment.	Re-align the pump and motor shafts. Align to within 0.006" (0.152 mm) of the total indicator reading.
	4. Pressure in pump case.	Inspect case drain line for restriction. Should be full pipe size direct to reservoir. In the VPV 45–164 the case drain has a check valve as standard equipment. Check for possible failure.
	5. Oil too hot.	See trouble section headed “System is too hot”.

4.4 Trouble Shooting

Trouble	Potential Cause	Remedy
BEARING FAILURE	1. Chips or other foreign matter in bearings.	Make sure only clean oil is used. It is essential for efficient operation and long life of the bearings.
	2. Coupling misalignment.	Re-align pump and motor shafts. Align to within 0.006" (0.152 mm) total indicator reading.
	3. System excessively hot.	See trouble section "System too Hot".
	4. Electric motor shaft end play or driving or hammering coupling on or off the pump shaft.	Bosch pumps are not designed to handle end thrusts against the drive shaft. Eliminate all end play on electric motors. Couplings should be a slip fit onto the pump shaft.
	5. Incorrect fluid.	See fluid recommendations.
PUMP NOT DELIVERING OIL	1. Adjusting screw for pressure adjustment too loose.	Tighten adjustment screw three to five turns after spring tension is felt.
	2. Wrong direction of pump rotation.	Observe arrow on pump case or nameplate. Direction of rotation must correspond.
	3. Oil level low in reservoir.	Maintain oil level in reservoir well above bottom of suction line at all times.
	4. Air leak in suction line.	Tighten joints and apply good pipe compound. Compatible with the hydraulic fluid.
	5. Oil viscosity too heavy for proper priming.	Thinner oil should be used, per recommendations for given temperatures and service.
	6. Maximum volume control turned in too far.	Turn counterclockwise on volume control adjusting screw to increase delivery.
	7. Bleed-off in other portion of circuit.	Check for open center valves or other controls connected with a tank port.
	8. Pump is not tuned correctly.	Recalibrate pump (see calibration procedures)
	9. Pump cover too loose.	Tighten bolts on pump cover.
PUMP NOT MAINTAINING PRESSURE	1. Pump not delivering oil.	See trouble section: Pump not delivering oil.
	2. Pressure adjustment screw not set high enough.	Set adjusting screw to obtain desired operating pressure.
	3. Compensator in bad condition.	Replace compensator
	4. Vane/vanes stuck in rotor slots.	Inspect for wedged chips or sticky oil.
	5. Oil by-passing to reservoir.	Watch for open-center valves or other valves open to reservoir. Make sure that relief valve settings are properly set high enough above the operating pressure in the system.
	6. Thrust screw not set properly.	Re-set thrust screw.

5.1 Dimensions of Double Pumps

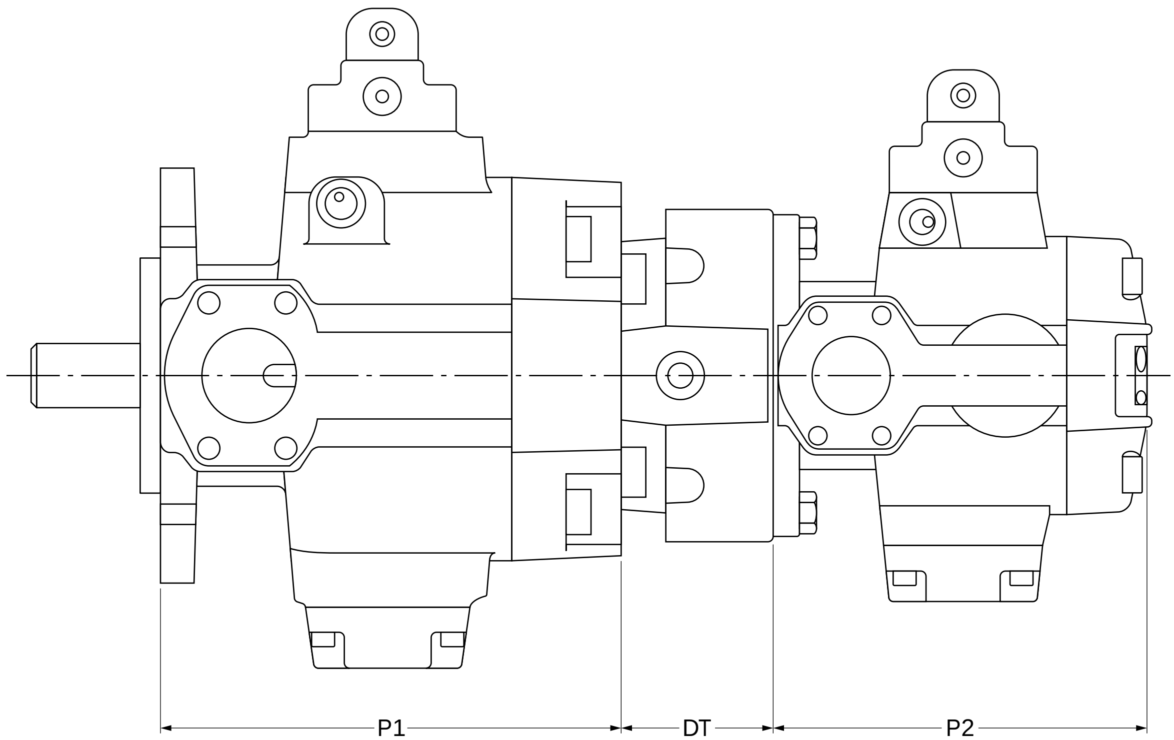


Table 33: Possible Size Combinations

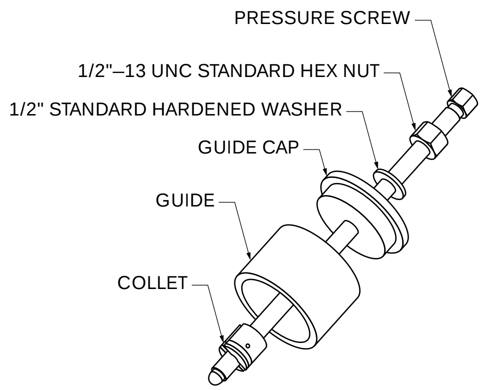
V [cm³/(U/rev/t)]	P1 (in)	DT (in)	P2 (in)
16 + 16	6.10"	1.95"	6.05"
25/32 + 16	6.94"	1.95"	6.05"
25/32 + 25/32	6.94"	2.55"	7.05"
45/63/80 + 16	9.64"	2.60"	6.05"
45/63/80 + 25/32	9.64"	3.59"	7.05"
45/63/80 + 45/63/80	9.64"	3.80"	9.74"
100/130/164 + 16	12.00"	2.61"	6.05"
100/130/164 + 25/32	12.00"	3.19"	7.05"
100/130/164 + 45/63/80	12.00"	3.80"	9.74"
100/130/164 + 100/130/164	12.00"	4.83"	11.53"

5.2 Bearing Puller for VPV Pump – Instructions for Use

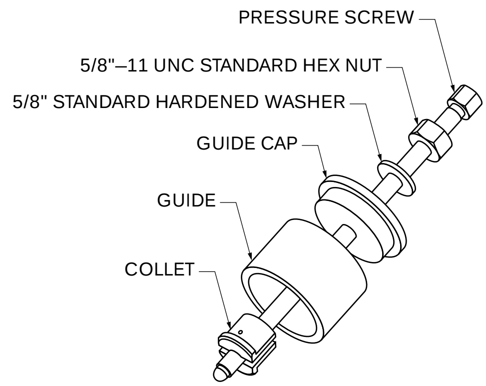
Introduction

This instruction sheet will familarize the technician with the proper use of the bearing puller tool for Bosch VPV series pumps. The bearings are pressed in at the factory with pressures up to 4000 PSI. When rebuilding a pump, a significant amount of force is necessary to back out the bearings without damaging the bore. Four different bearing puller tools are available, covering the frame sizes VPV 16, 25/32, 45–80, and 100–164. It is recommended that the four different sizes of bearing puller tools be purchased as a complete kit to guarantee that the proper tool is on hand for any size VPV.

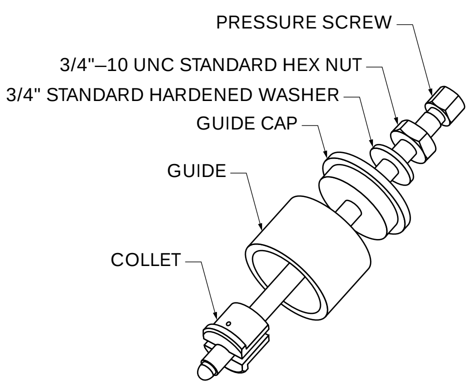
Bearing Puller Kit for VPV Pumps 16–164
Part No.: 9511 230 691



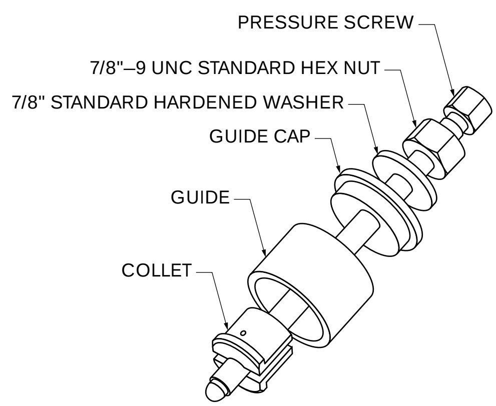
VPV 16 BEARING PULLER



VPV 25/32 BEARING PULLER



VPV 45/63/80 BEARING PULLER



VPV 100/130/164 BEARING PULLER

Getting Started

In addition to the assembled bearing puller, the following tools are recommended:

Box-end wrench
Open-end wrench or adjustable wrench
Vice
Tapping bar

Assemble the bearing puller by threading the hex nut onto the pressure screw, then slide the washer onto the pressure screw until it rests against the hex nut. The guide cap then rests against the washer, flanged side to the washer.

5.2 Bearing Puller for VPV Pump – Instructions for Use

Removing the Bearing

1 Once the pump is disassembled, lay the cover section of the VPV on a flat work surface. NOTE: This procedure can also be performed with cover section stilll in place on the pump, but it is somewhat more difficult and awkward.

Fig. 5.2-1

2 Insert the collet halves into the pump bore as shown in Fig. 5.2-1.

Fig. 5.2-2

3 Insert the neoprene spacers between the collet halves to maintain the proper collet position (Figs. 5.2-2 and 5.2-3).

Fig. 5.2-3

4 Set the guide cylinder in place, centering it over the bore of the VPV cover section (Fig. 5.2-4). It will serve as a guide for the bearing puller and help keep the pressure screw and collet straight while removing the bearing.

Fig. 5.2-4

5 Thread the pressure screw into the collet until it is firmly seated (Fig. 5.2-5), then turn the nut down until it rests against the washer.

Fig. 5.2-5

5.2 Bearing Puller for VPV Pump – Instructions for Use

6 Tighten the hex nut as far down on the pressure screw as easily possible (Fig. 5.2-6).

Fig. 5.2-6

7 Using box-end and/or open-end wrenches, hold the pressure screw in place while tightening the hex-nut, until the bearing breaks loose (Fig. 5.2-7). Continue tightening the hex-nut to back the bearing out of the center bore. NOTE: To simplify bearing removal, it is recommended that the cover and/or pump housing be locked in a vice (as shown in Fig. 5.2-8).

Fig. 5.2-7

8 If the bearing is seated too tight to remove using standard wrenches, a tapping bar can be used for additional leverage (Fig. 5.2-8).

Fig. 5.2-8

9 Remove the bearing from the bore (Fig. 5.2-9). Unthread the pressure screw from the collet to remove the bearing from the bearing puller tool.

Fig. 5.2-9

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