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BDP-10A/16A/21L Hydrostatic Pumps Service and Repair Manual

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FOREWORD

Headquartered in Sullivan, Illinois, Hydro-Gear is a world leader in the design, manufacture, and service of quality hydrostatic transaxles for the lawn and garden industry. The mission of our company is to be recognized by our customers and the industry as a world-class supplier and the quality leader in everything we do.

This Service and Repair Manual is designed to provide information useful in servicing the Hydro-Gear 10cc Bantam Duty Pump (BDP-10A), 16cc Bantam Duty Pump (BDP-16A) and 21cc Bantam Duty Pump (BDP-21L).

Also included is a glossary of terms that are frequently used throughout the industry and in Hydro-Gear service publications. Understanding terminology is very important!

It is necessary, and good shop practice, that your service area be equipped with proper tools and

the mechanics to be supplied with the latest information available. All repair procedures illustrated in this guide are suggested, but preferred methods of repair.

Some repair procedures require that the BDP be removed from the vehicle.

This is not a certification, test or study guide for a certification test. If a technician is interested in certification they should contact an agent representing the ESA (Engine Service Association) (610) 363-3844 or their Hydro-Gear Distributor. Many distributors will be hosting certification testing. These study guides will cover most of the products and manufacturers in our industry.

For more information about Hydro-Gear or our products, please contact your Central Service Distributor, or call our Customer Service Department at (217) 728-2581.

SECTION 1. DESCRIPTION AND OPERATION

INTRODUCTION

The purpose of this manual is to provide information useful in servicing the Hydro-Gear Bantam Duty Pumps (BDP's). This manual includes the BDP's general descriptions, hydraulic schematics, technical specifications, servicing and troubleshooting procedures for BDP models 10A, 16A and 21L.

The BDP's normally will not require servicing during the life of the vehicle in which it is installed. Should other servicing be required, the exterior of the BDP's will need to be thoroughly cleaned before beginning most procedures.

The models BDP -10A, 16A and 21L differ from the BDP model 10L. The physical distinction in appearance of the BDP-10A, 16A and 21L is signified by the design of an aluminum end cap. This end cap improves versatility in the application of these products.

GENERAL DESCRIPTION

The BDP's can be combined with wheel motors and other remotely located units. These pumps provide an infinitely variable speed range between zero and full displacement in both forward and reverse modes of operation.

The BDP-10A, 16A and 21L are of the axial piston design, utilizing spherical nosed pistons. A compression spring, located inside each piston, holds the nose of the piston against a thrust bearing race.

The variable displacement pump features a cradle swashplate with a direct-proportional displacement control. Reversing the direction of the angle of the swashplate reverses the flow of oil from the pump and thus reverses the direction of motor output rotation.

Movement of the directional control shaft produces a proportional swashplate movement and a change in pump flow and/or direction.

A fixed displacement gerotor charge pump is provided in the BDP units. Oil from the external reservoir and filter is pumped into the closed loop by a charge pump. Fluid not required to replenish the closed loop flows either into the pump housing through a cooling orifice, or back to the charge pump inlet through the charge pressure relief valve.

Check valves are included in the pump end cap to control the makeup oil flow for the system. The size and type of check valve can play an important role on the system pressure, response, and amount of heat generated, due to the recirculation of makeup oil flow. Additionally, some BDP's may be equipped with System Check Reliefs (SCR's). SCR's are factory preset pressure regulating check valves.

In some applications of the BDP's, it is desirable to move the machine for short distances at low speeds without operating the engine. An increase in resistance will occur with movement at higher speeds. A screw type bypass valve is utilized in the pumps to permit movement of the machine. The bypass valve is fully opened when unscrewed two (2) turns maximum. The bypass valve allows oil to be routed from one side of the pump/motor circuit to the other, thus allowing the motor to turn with minimal resistance. The bypass valve must be fully closed during normal operation.



WARNING

Actuating the bypass will result in the loss of hydrostatic braking capacity. The machine must be stationary on a level surface and in neutral when actuating the bypass.

Additionally, some BDP's may be equipped with an Auxiliary Pump. The Auxiliary incorporates the principles of the charge gerotor assembly and provides the capability of an external auxiliary flow for an alternate hydraulic circuit to operate accessories without loss of drive.

EXTERNAL FEATURES BDP-10A

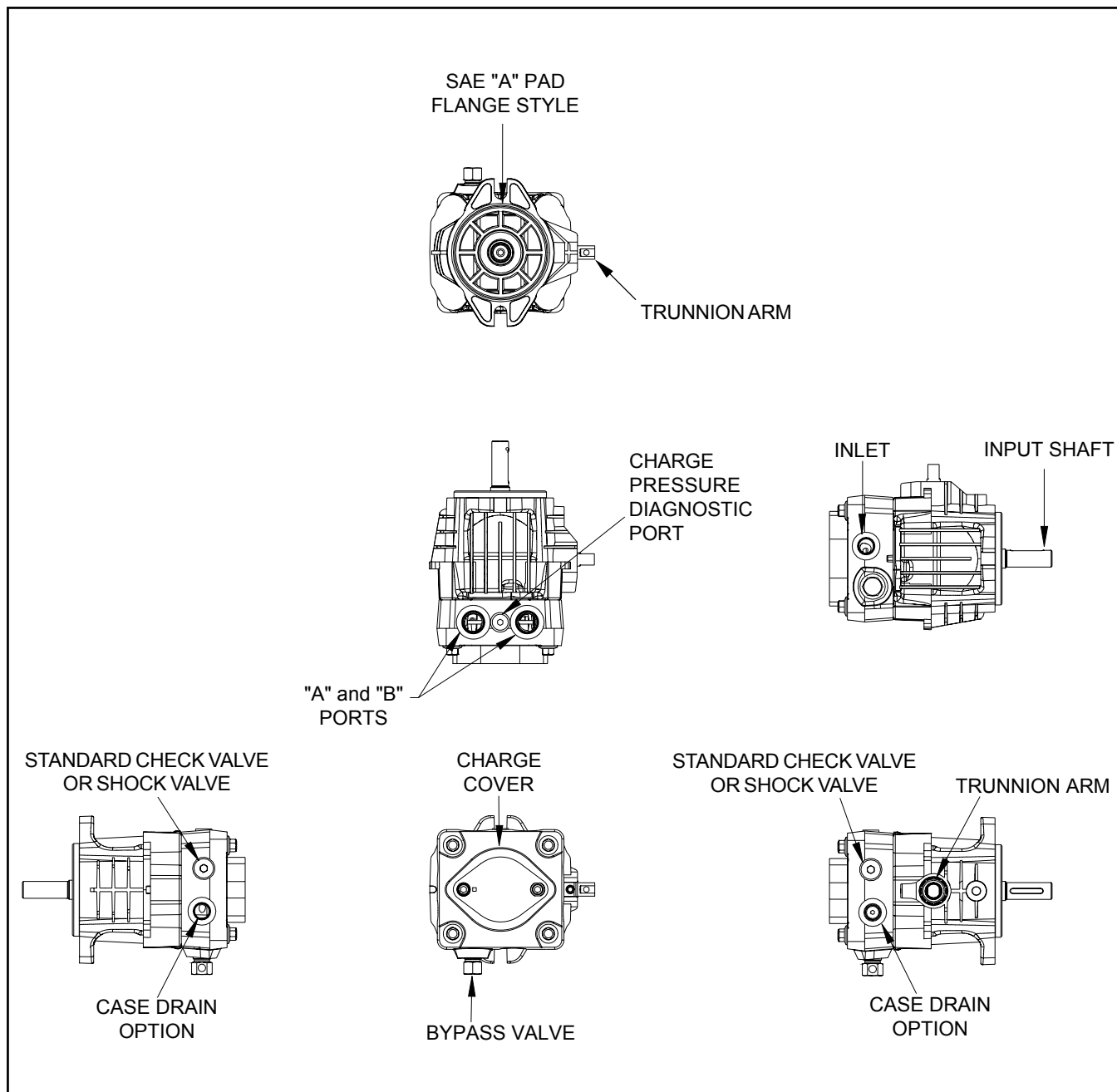


Figure 1. BDP-10A With Standard Charge Pump

EXTERNAL FEATURES BDP-16A

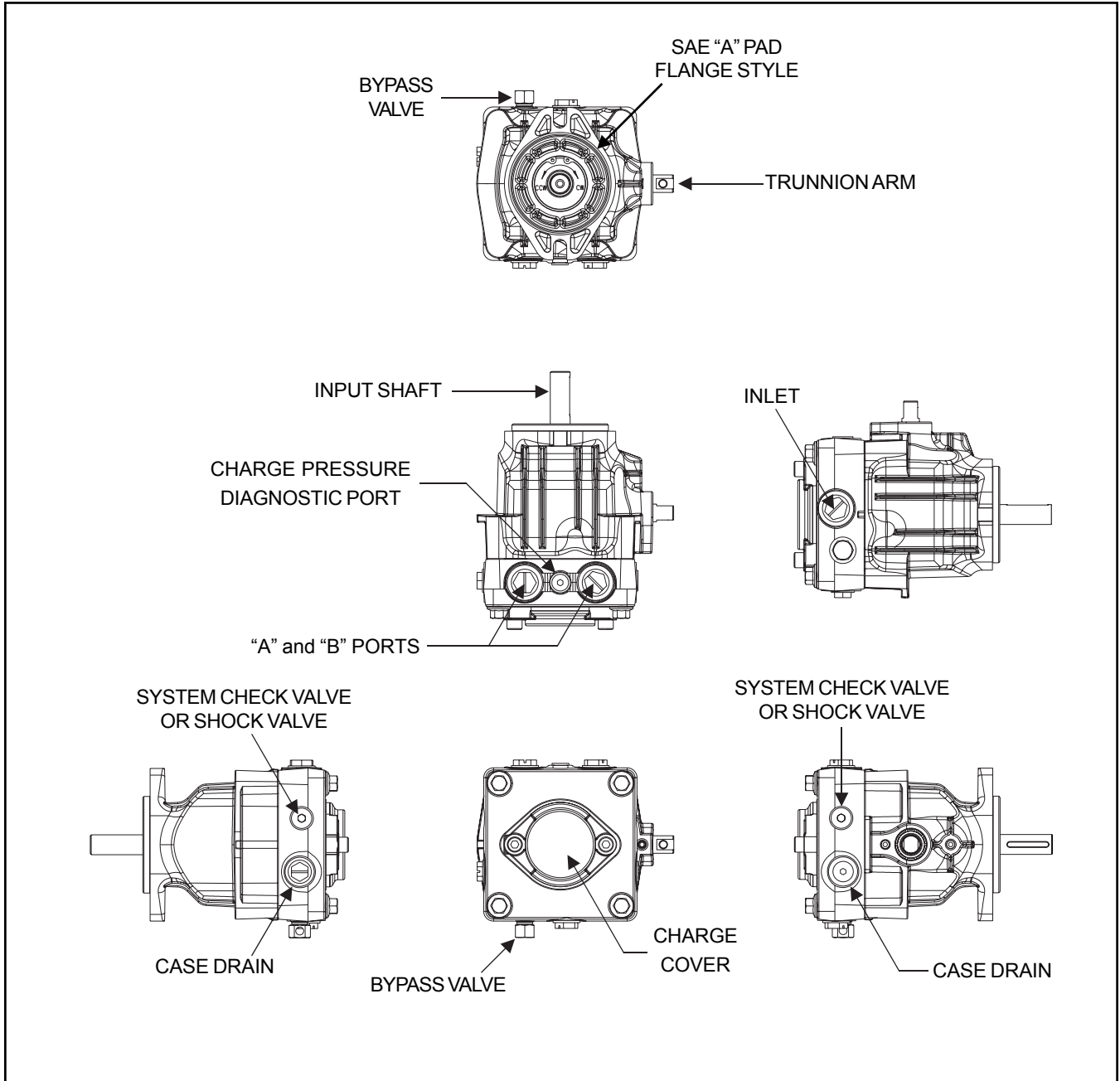


Figure 2. BDP-16A With Standard Charge Pump

EXTERNAL FEATURES BDP-21L

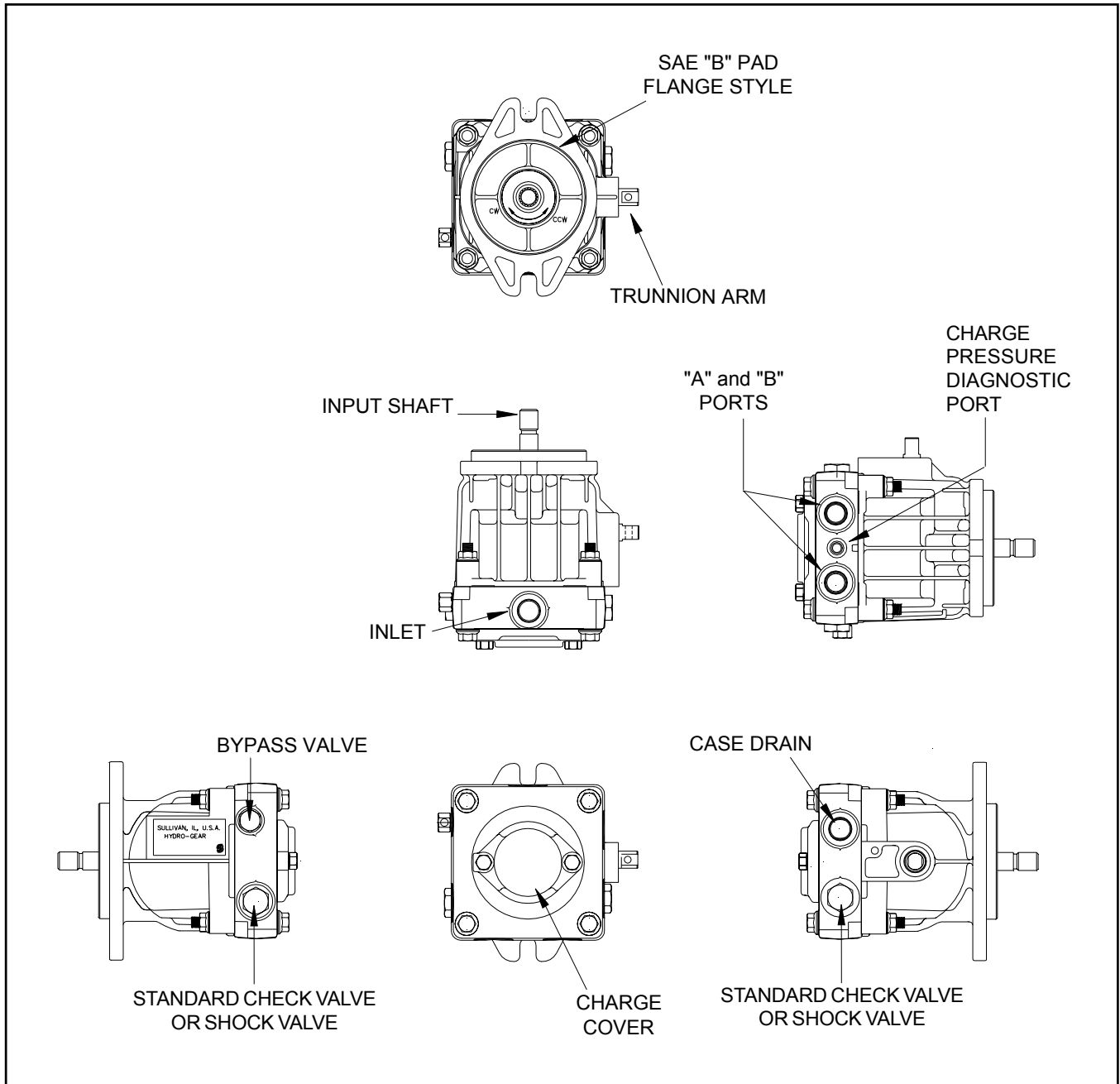


Figure 3. BDP-21L With Standard Charge Pump

HYDRAULIC SCHEMATIC

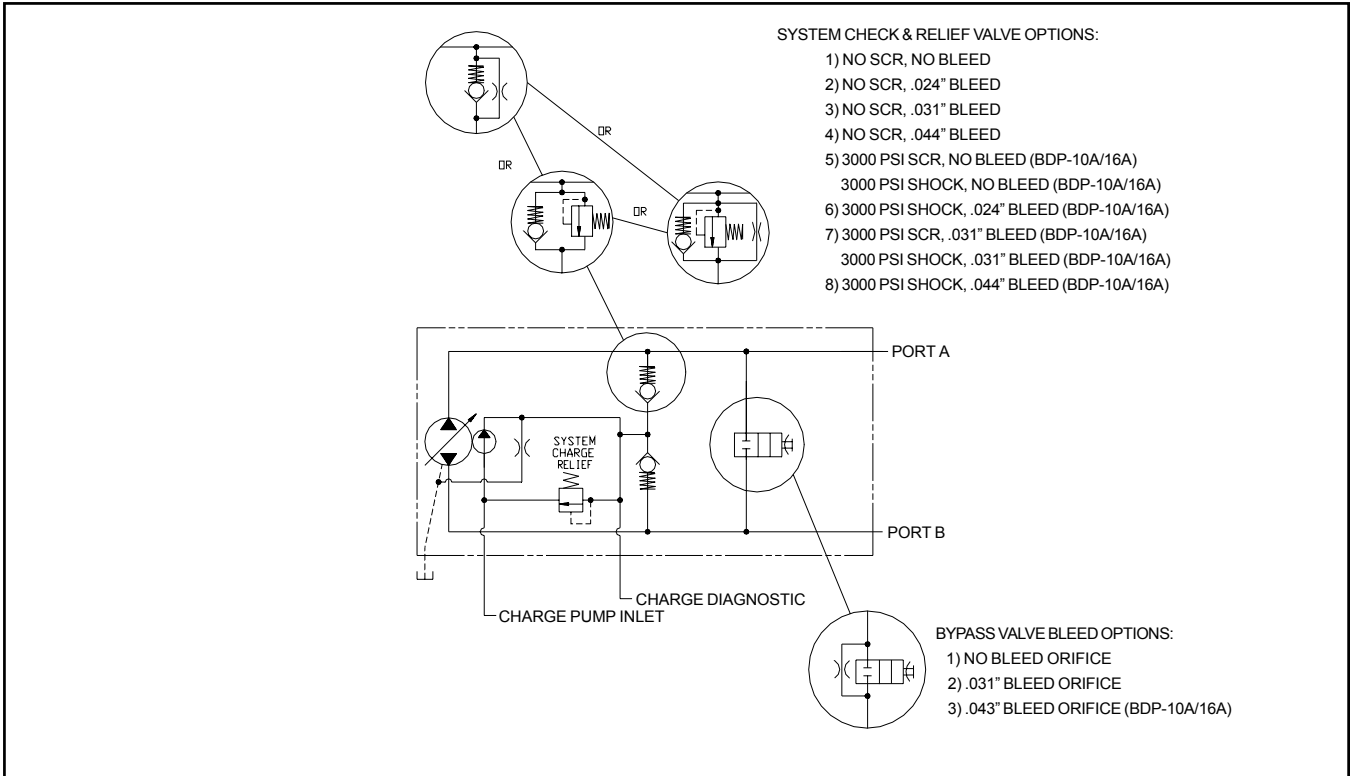


Figure 4. BDP-10A/16A With Standard Charge Pump Hydraulic Schematic

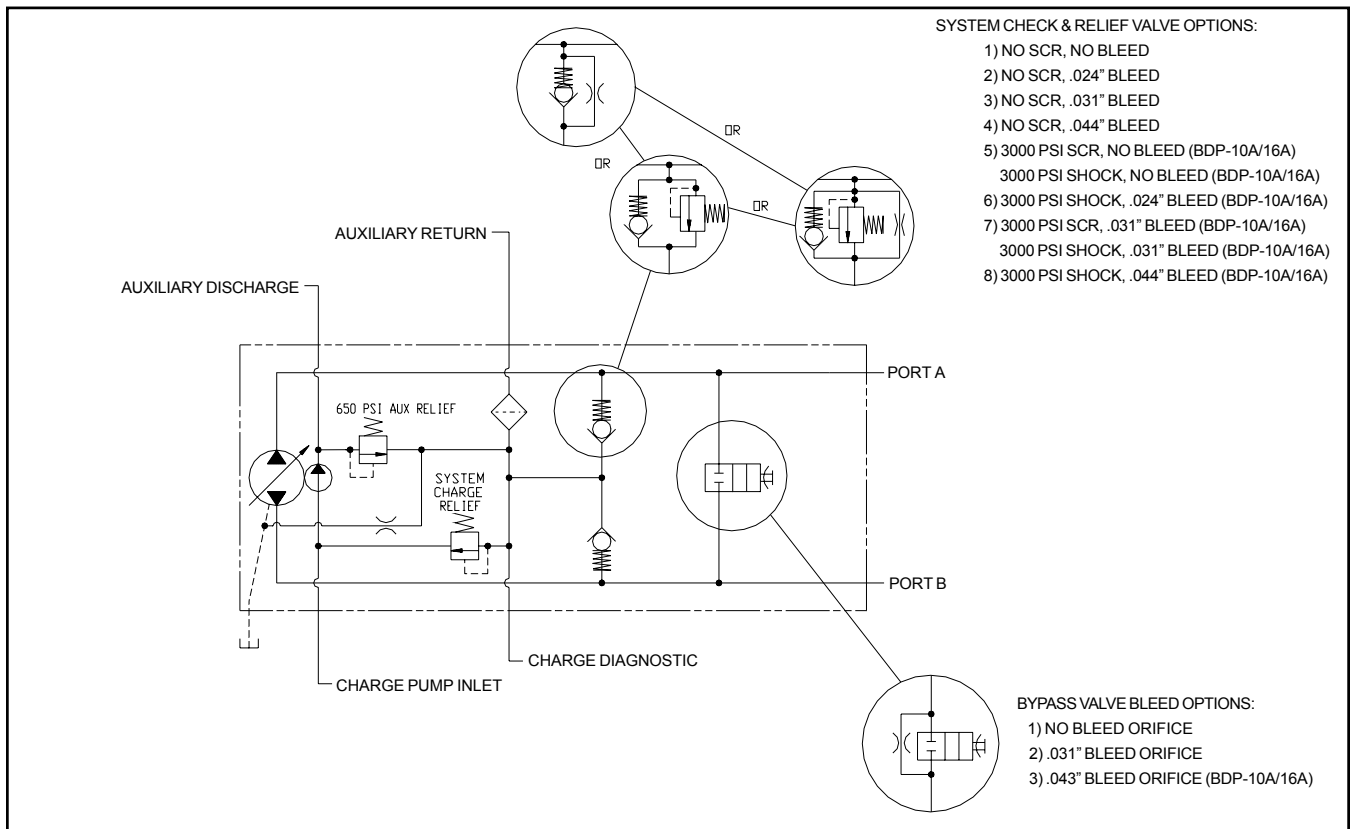


Figure 5. BDP-10A/16A With Auxiliary Charge Pump Hydraulic Schematic

HYDRAULIC SCHEMATIC

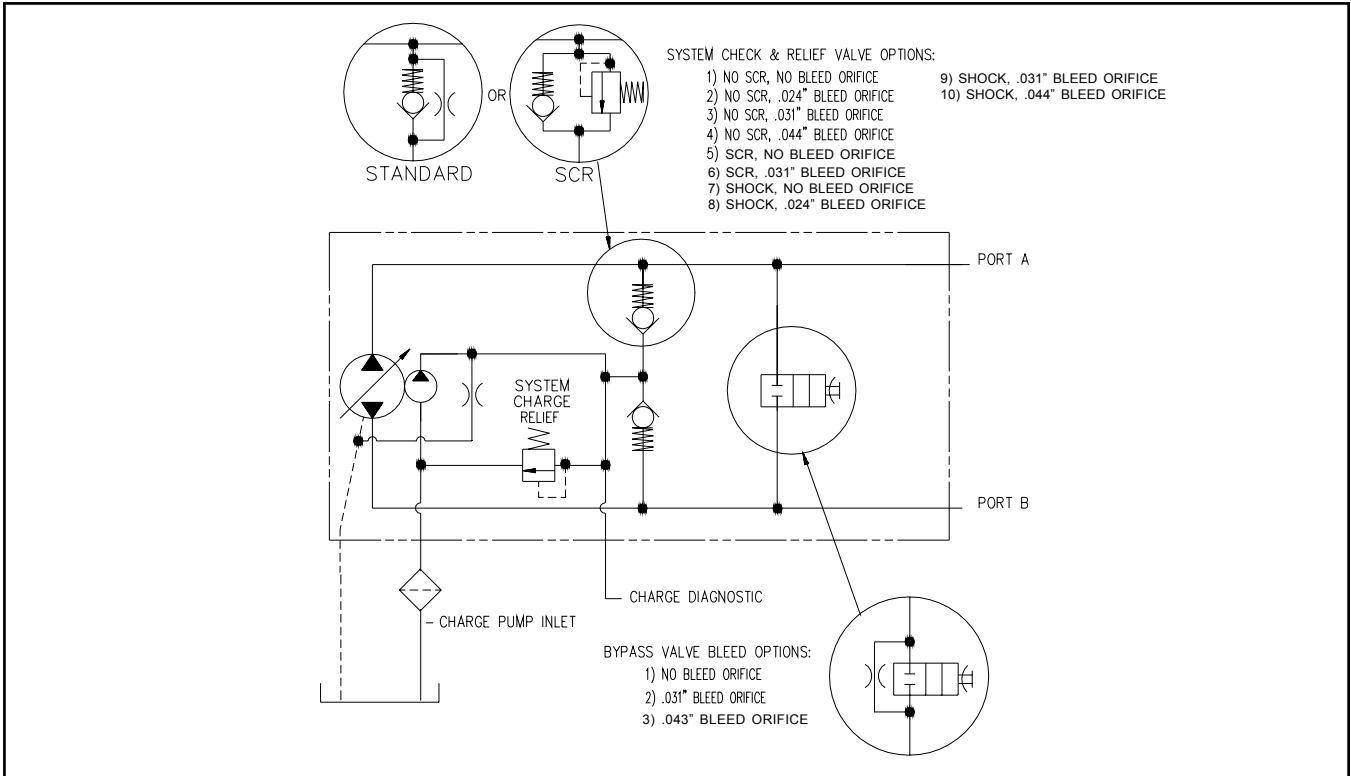


Figure 6. BDP-21L With Standard Charge Pump Hydraulic Schematic

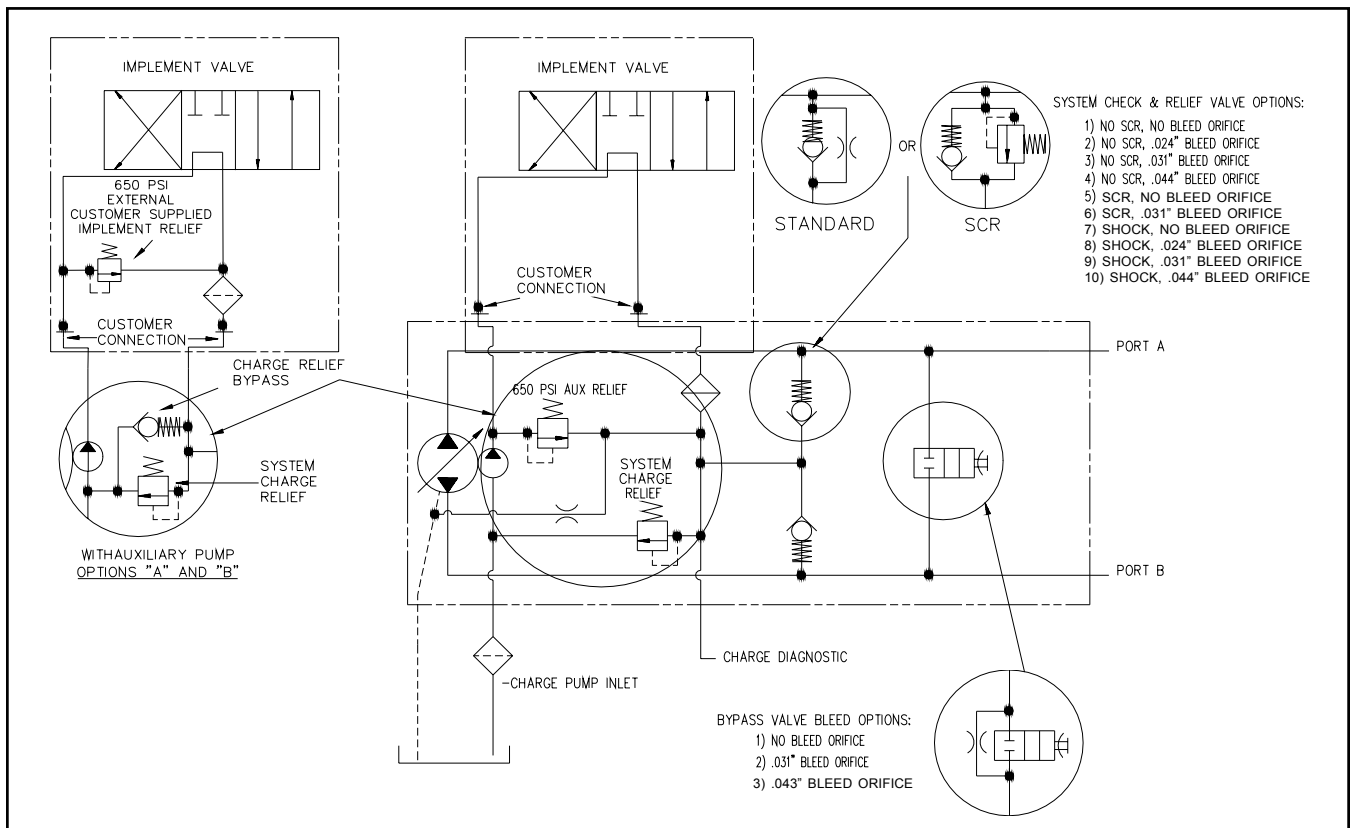


Figure 7. BDP-21L With Auxiliary Charge Pump Hydraulic Schematic

GRAPHICAL SCHEMATIC

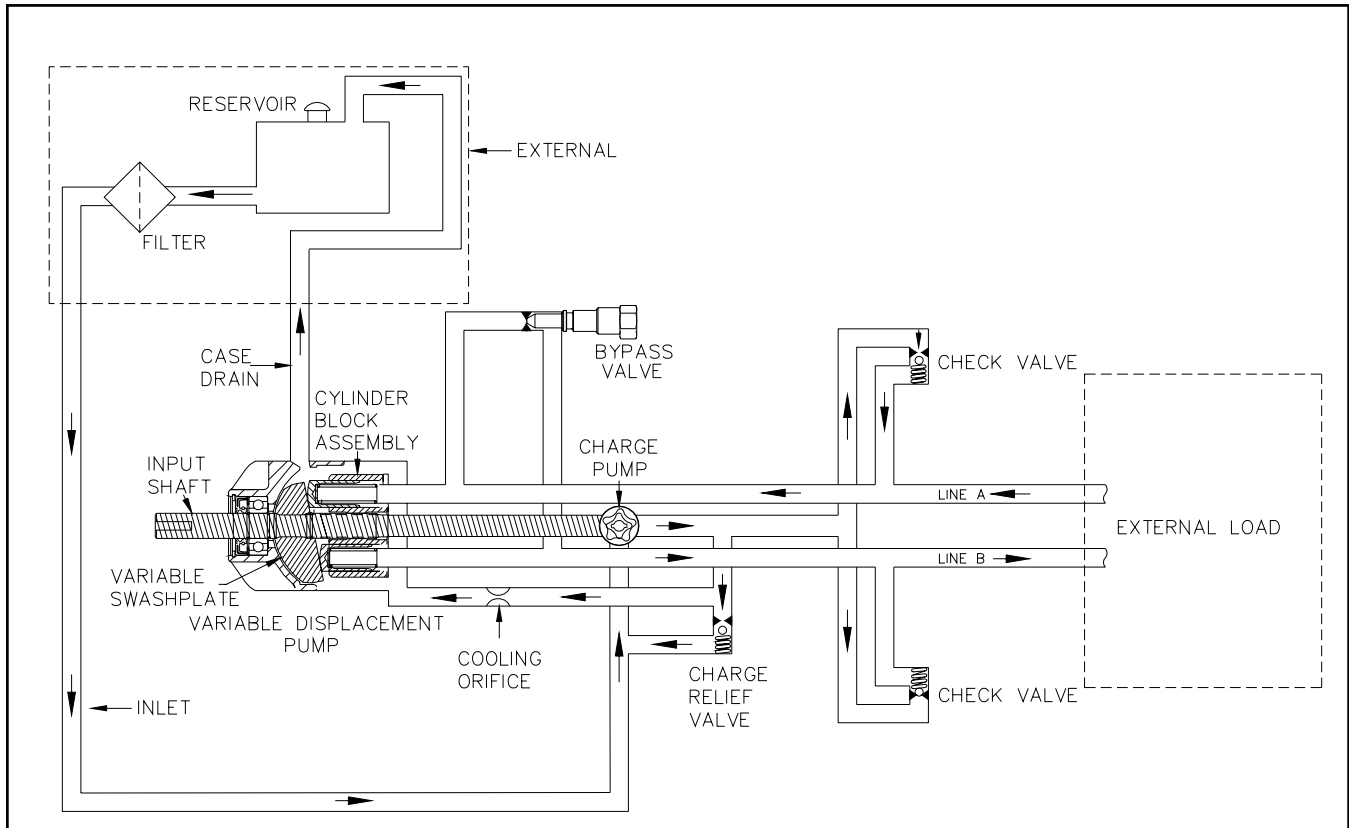


Figure 8. BDP-10A, 16A and 21L Standard Charge Pump Graphical Schematic

Figures 4-7 represent hydraulic schematics of the standard charge and auxiliary charge pump. Figure 8 provides a graphical illustration of the hydraulic oil circuit.

The input shaft and pump cylinder block are turned in one direction only by the engine/ drive belt/ pulley combination or direct drive gear box.

The oil is drawn through an external filter that prevents contaminants within the reservoir from entering into the charge pump gerotor.

The charge pump supplies fluid to keep the closed loop pressurized, preventing cavitation and providing cooling oil flow for the system.

The charge relief valve is used to maintain charge at a predetermined pressure.

Output of the system oil flow is controlled by the direction and amount that the swashplate is angled. As the pump pistons compress, they force oil into one of two passageways ("A" or "B") in the system hydraulic circuit. Oil is supplied ex-

ternally under pressure to an external load, (e.g., a vehicle wheel motor). As the angle of the pump swashplate is increased, the amount of oil being pumped will increase and cause a higher speed output of the wheel motor. Reversing the angle of the swashplate will reverse the direction of the oil flow. During the operation of the pump, fluid is "lost" from the hydraulic loop through leak paths designed into the product for lubrication purposes (around pistons, under the rotating cylinder block, etc.). This "lost" fluid returns to the reservoir through the case drain. This fluid must be made up in the loop. The charge pump makes up this fluid loss.

The makeup flow is controlled (or directed) by the system check valves. The check valves are used to direct makeup fluid into the low pressure side of the closed loop. Each check valve will either be held open or closed, depending upon the direction of the vehicle operation: Closed in a pressurized system passage, open in a low pressure, "charged" system passage.

TECHNICAL SPECIFICATIONS

	BDP-10A	BDP-16A	BDP-21L
Displacement	0.623 in ³ / rev (10.2 cc / rev) 7.6 gpm@3000 rpm (1000 psi)	0.97 in ³ / rev (16 cc / rev) 12 gpm@3000 rpm (1000 psi)	1.33 in ³ / rev. (21.8 cc / rev) 16.4 gpm@3000 rpm (1000 psi)
Input Speeds Maximum: Minimum:	3600 rpm 1800 rpm	3600 rpm 1800 rpm	3600 rpm 1800 rpm
System Operating Pressure Intermittent: Continuous:	2100 psi (145 bar) 1000 psi (70 bar)	2500 psi (172 bar) 1250 psi (86 bar)	2500 psi (172 bar) 1250 psi (86 bar)
Oil Temperature Maximum Intermittent: Normal Operating Range:	230° F (110° C) -10° to 200° F (23° C to 93° C)	230° F (110° C) -10° to 200° F (23° C to 93° C)	230° F (110° C) -10° to 200° F (23° C to 93° C)
Fluid Viscosity Limits @230° F (110° C) Optimum: @230° F (110° C) Minimum:	70 SUS (13 cST) 55 SUS (9.0 cST)	70 SUS (13 cST) 55 SUS (9.0 cST)	70 SUS (13 cST) 55 SUS (9.0 cST)
Weight	8 lbs (3.6 kg)	12 lbs (5.4 kg)	14 lbs (6.3 kg)

Table 1. BDP-10A/16A/21L Technical Specifications

PRODUCT IDENTIFICATION

The label in Figure 9. can be located on the pump housing. It identifies the model and configuration of the BDP.

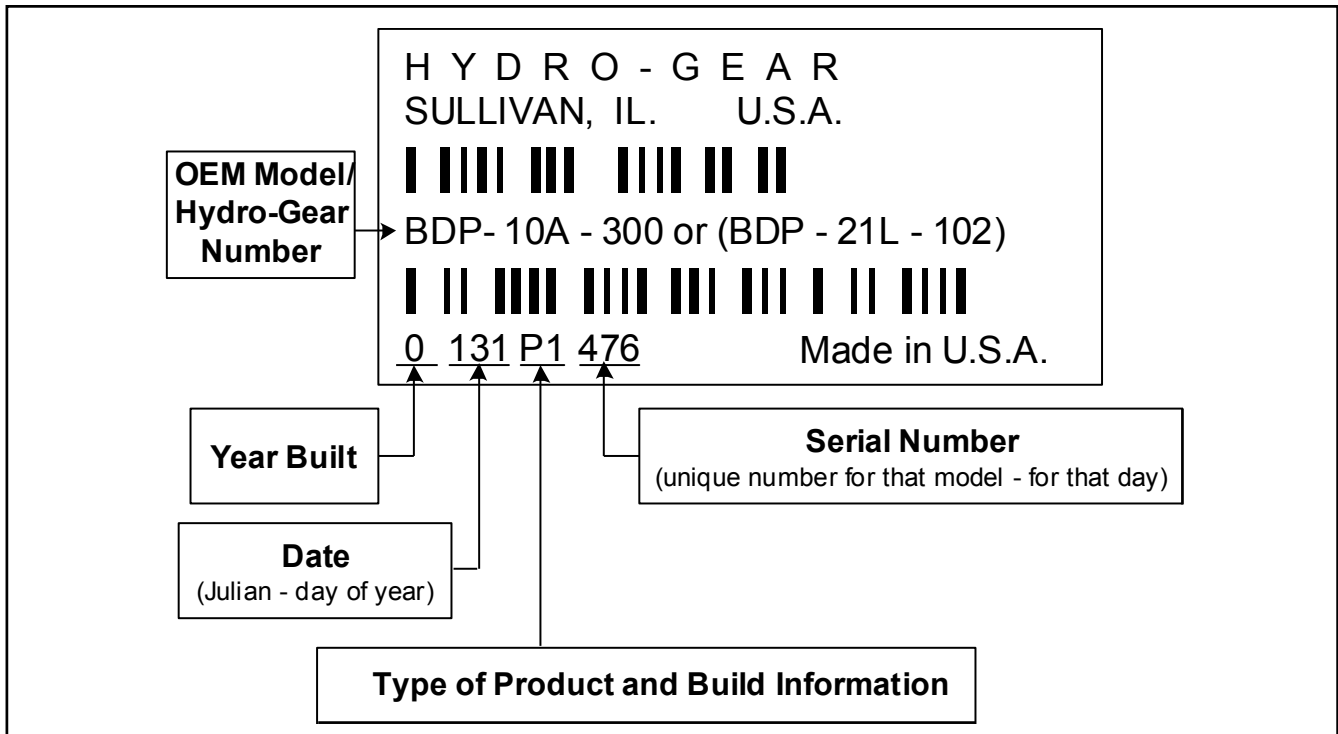


Figure 9. BDP Configuration Label

SECTION 2. SAFETY



This symbol points out important safety instructions which, if not followed, could endanger the personal safety and/or property of yourself and others. Read and follow all instructions in this manual before attempting maintenance on your BDP's. When you see this symbol - **HEED ITS WARNING.**



WARNING

POTENTIAL FOR SERIOUS INJURY

Inattention to proper safety, operation, or maintenance procedures could result in personal injury, or damage to the equipment. Before servicing or repairing the BDP-10A, 16A or 21L, fully read and understand the safety precautions described in this section.

PERSONAL SAFETY

Certain safety precautions must be observed while servicing or repairing the BDP-10A, 16A or 21L. This section addresses some of these precautions but must not be considered an all-inclusive source on safety information. This section is to be used in conjunction with all other safety material which may apply, such as:

- Other manuals pertaining to this machine
- Local and shop safety rules and codes
- Governmental safety laws and regulations

Be sure that you know and understand the equipment and the hazards associated with it. Do not place speed above safety.

Notify your supervisor whenever you feel there is any hazard involving the equipment or the performance of your job.

Never allow untrained or unauthorized personnel to service or repair the equipment.

Wear appropriate clothing. Loose or hanging clothing or jewelry can be hazardous. Use the appropriate safety equipment, such as eye and hearing protection, and safety-toe and slip-proof shoes.

Never use compressed air to clean debris from yourself or your clothing.

TOOL SAFETY

Use the proper tools and equipment for the task.

Inspect each tool before use and replace any tool that may be damaged or defective.

WORK AREA SAFETY

Keep the work area neat and orderly. Be sure it is well lit, that extra tools are put away, trash and refuse are in the proper containers, and dirt or debris have been removed from the working areas of the machine.

The floor should be clean and dry, and all extension cords or similar trip hazards should be removed.

SERVICING SAFETY

Certain procedures may require the vehicle to be disabled in order to prevent possible injury to the servicing technician and/or bystanders.

The loss of hydrostatic drive line power may result in the loss of hydrostatic braking capability.

Some cleaning solvents are flammable. Use only approved cleaning materials: Do not use explosive or flammable liquids to clean the equipment.

To avoid possible fire, do not use cleaning solvents in an area where a source of ignition may be present.

Discard used cleaning material in the appropriate containers.

SECTION 3. TROUBLESHOOTING



WARNING

Do not attempt any servicing or adjustments with the engine running. Use extreme caution while inspecting the drive belt assembly and all vehicle linkage!

Follow all safety procedures outlined in the vehicle owner's manual!

In many cases problems with the BDP-10A, 16A and 21L are not related to a defective pump but are caused by slipping drive belts, partially engaged bypass valves, and loose or damaged control linkages. Be sure to perform all operational checks and adjustments outlined in Section 3. before assuming the pump is malfunctioning. Table 2. below provides a troubleshooting check list to help determine the cause of operational problems.

Table 2. BDP 10A, 16A and 21L Troubleshooting Checklist

Possible Cause	Corrective Action
VEHICLE DOES NOT DRIVE/TRACK STRAIGHT	
Vehicle tires improperly inflated Control linkage bent, loose or out of adjustment Bypass loose Inlet leak	Refer to vehicle manufacturer suggested pressure Repair, adjust or replace vehicle linkage Tighten bypass per page 11 Check all externals to BDP inlet
UNIT IS NOISY	
Excessive input speed Oil level low or contaminated oil Excessive loading Air trapped in hydraulic system Bypass loose Inlet leak, line or filter partially blocked or damaged	Adjust input speed above 1800 rpm and below 3600 rpm Fill to proper level or change oil Reduce vehicle load Purge hydraulic system per page 12 Tighten bypass per page 11 Check all externals to BDP inlet
UNIT HAS NO/ LOW POWER	
Engine speed low Control linkage bent, loose or out of adjustment Drive belt slipping or pulley damaged Oil level low or contaminated oil Excessive loading Bypass loose Air trapped in hydraulic system Inlet leak Inlet filter clogged Suspected internal damage	Adjust to correct setting Repair or replace vehicle linkage Repair or replace drive belt or pulley Fill to proper level or change oil per page 11 Reduce vehicle load Tighten bypass per page 11 Purge hydraulic system per page 12 Check all externals to BDP inlet Replace filter per page 12 Check per page 9
UNIT OPERATING HOT	
Debris buildup Cooling fan or heat exchanger damaged Oil level low or contaminated oil Excessive loading Air trapped in hydraulic system Inlet leak	Remove debris Repair or replace cooling fan or heat exchanger Fill to proper level or change oil per page 11 Reduce vehicle load Purge hydraulic system per page 12 Check all externals to BDP inlet
BDP LEAKS OIL	
Damaged seals or gaskets Air trapped in hydraulic system	Remove debris, replace seals Purge hydraulic system per page 12

Description: BDP Flow Test Kit (Part Number 70661)**(Part Number 70661 Supersedes Part Numbers 70511 and BB-76810)**

Purpose: The design purpose of the BDP Flow Test Kit is to allow the dealer to isolate the BDP from the wheel motor and determine if the BDP is faulty. The following information can be used to install and test the BDP by simulating a wheel motor load.

**WARNING**

Certain procedures require the vehicle engine to be operated and the vehicle to be raised off of the ground. To prevent possible injury to the servicing technician and/or bystanders, insure the vehicle is properly secured.

**WARNING**

Do not attempt any adjustments with the engine running. Use extreme caution while working in or around all vehicle linkage! High temperatures can be generated. Follow all safety procedures outlined in the vehicle owner's manual!

INSTALLATION AND TESTING PROCEDURES:

1. Disconnect the system hoses at the wheel motor, or system hoses from the BDP and connect the BDP Flow TestKit. (Special care should be taken to prevent contamination debris from entering pump or wheel motor system ports).

Note: Using the Bi-Directional Flow Test Kit, determination of directional flow is not necessary. The flow meter may be connected in either direction into the forward and reverse high pressure system lines.

CAUTION: Ensure all fittings and hoses are attached securely. This test is being completed on the vehicle's high pressure system lines. Failure to perform this properly could result in bodily injury.

TESTING PROCEDURES:

1. Raise the drive tires off the ground. Block the remaining tires on the ground to prevent accidental vehicle movement.

2. Open the restriction valve all the way.

3. Make certain all external BDP directional control stops are removed or backed off on the vehicle linkage to obtain full pump directional control arm travel.

4. Start the engine and engage the drive pulley if necessary.

5. Bring the engine to maximum operating speed.

(This should not exceed 3600 rpm input speed on the BDP-10A/10L)

(This should not exceed 3400 rpm input speed on the BDP-16A)

(This should not exceed 2800 rpm input speed when testing the BDP-21L)

Engine speed adjustment may be necessary to obtain 2800 rpm.

CAUTION: Damage to the flow meter and/or re-calibration may result from testing the BDP-21L at input speeds that exceed 2800 rpm.

6. With the directional control lever (on the vehicle) for the pump being tested, move the control arm in full forward motion. (It may be necessary to lock the control arm into full forward position to prevent false readings).

7. Operate without any load for approximately 30 seconds to 1 minute, this allows the system oil temperature to rise.

Note: Raising the system oil temperature will make a difference in the readings you receive. It has been determined that to complete this test accurately, the oil temperature must be near system operating temperatures. Suggested temperature range 160° - 210°F (71.1° - 98.9°C)

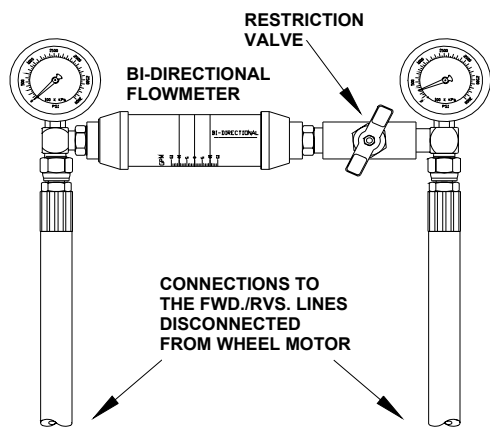
8. On the BDP-10A/10L, BDP-16A and BDP-21L tighten the restriction valve until you read 300 psi (21 bar). Record the flow reading from the Bi-Directional Flow Meter.
9. Increase the pressure to 1100 PSI (76 bar) for all models (BDP-10A/10L, BDP-16A and BDP -21L). Record the flow reading from the Bi-Directional Flow Meter.

10. The acceptable gpm “flow droop” or (difference) is:

- BDP-10A/10L 1.5 gpm (5.6 l/min)
- BDP-16A 2.0 gpm (7.6 l/min)
- BDP-21L 2.0 gpm (7.6 l/min)

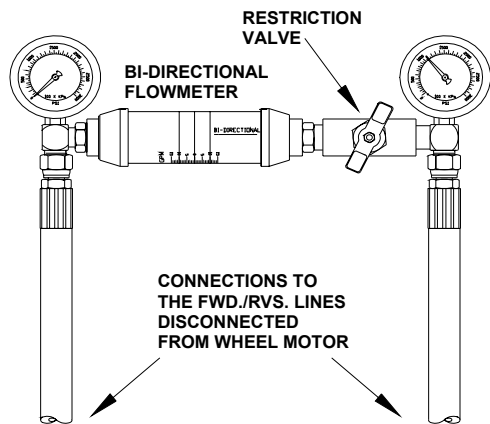
If the difference exceeds these values the pump would not be acceptable.

TEST EXAMPLE: BDP-10A/10L



300 psi (21 bar) reading

7 gpm (26 l/min) (1st reading)



1100 psi (76 bar) reading

3 gpm (11 l/min) (2nd reading)

(BDP-10A/10L)
 300 psi (21 bar) reading
 1100 psi (76 bar) reading

7 gpm (26 l/min) (1st reading)
 - 3 gpm (11 l/min) (2nd reading)

 4 gpm (15 l/min) (the difference)

Subtract the 1st reading from the 2nd.
 (In this example, 4 gpm difference would indicate a defective pump).

SECTION 4. SERVICE AND MAINTENANCE

NOTE: Any servicing dealer attempting a warranty repair must have prior approval before conducting maintenance of a Hydro-Gear product unless the servicing dealer is a current Authorized Hydro-Gear Service Center.

EXTERNAL MAINTENANCE

Regular external maintenance of the BDP should include the following:

1. Check the vehicle operator's manual for the recommended load ratings. Insure the current application does not exceed load rating.
2. Check fluid level in reservoir in accordance with vehicle manufacturer's recommendations.

NOTE: After oil has been drained and maintenance has been performed, clean oil should be poured directly into the pump inlet and high pressure ports prior to plumbing reconnection and start-up.

3. Inspect the vehicle drive belt, idler pulley(s), and idler spring(s). Insure that belt slippage is not causing low input rpm to the pump.
4. Inspect all external plumbing for possible leaks or loose fittings. An air leak may be difficult to detect on the "suction side" or inlet line to the pump. See purging procedures page 12.
5. Insure correct inlet filter(s) has been installed in accordance with the vehicle manufacturer.
6. Insure the reservoir is free of contaminants and is properly vented.
7. Inspect the BDP cooling fan (if applicable) for broken or distorted blades and remove any obstructions (grass clippings, leaves or dirt). Inspect oil cooler (if applicable) for damaged fins and debris.

8. Inspect the vehicle control linkage to the directional control arm on the BDP. Also, insure the control arm is securely fastened to the trunnion arm.
9. Inspect the bypass on the BDP to insure it is properly engaged for operation. If the bypass is not fully engaged (rotated fully clockwise) it will not function properly. For vehicle movement, the bypass may be backed out (2) turns maximum. This is only recommended for movement of short distances at low speeds.



WARNING

Loosening the bypass will result in loss of hydraulic braking capability.

SERVICE AND MAINTENANCE PROCEDURES

NOTE: Damage to BDP's may result from external or internal contamination: Heat from excess debris or lack of lubrication and over-pressurization of the product. Follow guidelines established in this manual and the vehicle manufacturer's recommendations.

All the service procedures presented on the following pages can be performed while the BDP is mounted on the vehicle. Any servicing beyond those given must be performed after the unit has been removed from the vehicle.

FLUIDS

The fluids used in Hydro-Gear products have been carefully selected, and only equivalent, or better products should be substituted.

Typically, an engine oil with a minimum rating of 55 SUS (9.0 cSt) at 230° F (110° C) maximum operating temperature and an API classification of SJ/ CD is allowed. Refer to the vehicle manufacturer for recommended oil.

FLUID VOLUME AND LEVEL

Certain situations may require additional fluid to be added or even replaced. Refer to the vehicle manufacturer's recommendations for the proper fill location and level. After maintenance or oil change, follow purging procedures below and re-check the fluid level once the unit has been operated for approximately 1 minute.

FLUID CHANGE

In the event of oil contamination or degradation, oil addition or change may alleviate certain performance problems. Refer to the vehicle manufacturer's recommended oil change frequency. Refer to purging procedures below.

FILTERS

An inlet filter is required to insure that only clean fluid enters the system. Refer to the vehicle manufacturer for approved filter replacement.

PURGING PROCEDURES

Due to the effects air has on efficiency in hydrostatic drive applications, it is critical that air is purged from the system.

These purge procedures should be implemented anytime a hydrostatic system has been opened to facilitate maintenance or any additional oil has been added to the system.

Air creates inefficiency because it has compression and expansion rates that are higher than that of oil.

Entrained air in the oil may cause the following symptoms:

1. Noisy operation
2. Lack of power or drive after short-term operation
3. High operation temperature and excessive expansion of oil.

Before starting, make sure the reservoir is at the proper oil level. If it is not, fill to the vehicle manufacturer's specifications.

The following procedures should be performed with the vehicle drive wheels off the ground, then repeated under normal operating conditions.



WARNING

POTENTIAL FOR SERIOUS INJURY
Certain procedures require the vehicle engine to be operated and the vehicle to be raised off of the ground. To prevent possible injury to the servicing technician and/or bystanders, insure the vehicle is properly secured.

1. With the bypass valve open and the engine running, slowly move the directional control in both forward and reverse directions (5 to 6 times), as air is purged from the unit, the oil level will drop.
2. With the bypass valve closed and the engine running, slowly move the directional control in both forward and reverse directions (5 to 6 times). Check the oil level, and add oil as required after stopping engine.
3. It may be necessary to repeat Steps 1 and 2 until all the air is completely purged from the system. When the BDP's move forward and reverse at normal speed purging is complete.

Cleanliness is a key factor in the successful repair of BDP's. Thoroughly clean all exposed surfaces prior to any type of maintenance. Cleaning of all parts by using a solvent wash and air drying is usually adequate. As with any precision equipment, all parts must be kept free of foreign material and chemicals. Protect all exposed sealing areas and open cavities from damage and foreign material.

Upon removal, all seals, O-rings, and gaskets should be replaced. During installation, lightly lubricate all seals, O-rings, gaskets with clean petroleum jelly prior to assembly. Also protect the inner diameter of seals by covering the shaft machined features with plastic wrap or equivalent.

SECTION 5. REPAIR

HOW TO USE THIS MANUAL

Each assembly is provided with an exploded view showing the parts involved. **The item reference numbers in each illustration are for assembly instructions only.** See pages 35-40 for part names and descriptions. A complete exploded view and item list of the pump is provided at the end of this section.

GENERAL INSTRUCTIONS

Cleanliness is a primary means of assuring satisfactory life on repaired pumps. Thoroughly clean all exposed surfaces prior to any type of maintenance. Cleaning of all parts by using a solvent wash and air drying is usually adequate. As with any precision equipment, all parts must be kept free of foreign material and chemicals.

Protect all exposed sealing surfaces and open cavities from damage and foreign material. The external surfaces should be cleaned before beginning any repairs.

Lip type seals (shaft seals) are used on the input shaft and directional control shaft of the BDP-10A, 16A and 21L. These seals can be replaced without major disassembly of the unit. However, replacement of these seals generally requires removal of the pump from the machine. Upon removal, it is recommended that all seals, O-rings and gaskets be replaced. During installation lightly lubricate all seals, O-rings and gaskets with a clean petroleum jelly prior to assembly. Also protect the inner diameter of the seals by covering the shaft with a cellophane (plastic wrap, etc.) material.

Parts requiring replacement must be replaced from the appropriate kits identified in the Items Listing, found at the end of this manual. Use only original Hydro-Gear replacement parts found listed in BLN-50937 (microfiche) or BLN-51427 (CD).

TOOLS AND TORQUES

Table 3. Required Tools

Miscellaneous	Sockets
BDP-10A/16A/21L Service & Repair Manual	3/8" Drive Ratchet
Torque Wrench	9/16"
Scribe, Paint Pen, or Marker	1/2"
Seal Hook with a Magnet	5/8"
Flat Blade Screw Driver	10 mm
Pliers	Combination Wrenches
Internal Snap Ring	9/16"
Allen Wrenches	1/2"
5 mm	5/8"
3/16"	7/8"
1/4"	10 mm

Table 4. BDP-10A Plug Fitting Torque Values

Item # or Description	Torque
Case Drain (fitting torque)	200-250 lb-in (22.6-28.2 N-m)
System Port (fitting torque)	370-470 lb-in (41.8-53.1 N-m)
Inlet (fitting torque)	200-250 lb-in (22.6-28.2 N-m)
42A, 42B, Check Valves/Shock Valves	180-240 lb-in (20.3-27.1 N-m)
42A, 42B, Check Reliefs (cap)	200-275 lb-in (22.6-31.0 N-m)
15, Bypass Valve	84-120 lb-in (9.5-13.6 N-m)
56, Diagnostic Plug	84-120 lb-in (9.5-13.6 N-m)
10, Cap Screw (non-auxiliary)	87-118 lb-in (9.8-13.3 N-m)
4, End Cap Bolts	167-217 lb-in (18.8-24.5 N-m)

Table 5. BDP-16A Plug Fitting Torque Values

Item # or Description	Torque
Case Drain (fitting torque)	200-250 lb-in (22.6-28.2 N-m)
System Port (fitting torque)	370-470 lb-in (41.8-53.1 N-m)
Inlet (fitting torque)	370-470 lb-in (41.8-53.1 N-m)
42A, 42B Check Valves/Shock Valves	180-240 lb-in (20.3-27.1 N-m)
42A, 42B Check Reliefs (cap)	200-275 lb-in (22.6-31.0 N-m)
50, Bypass Valve	95-120 lb-in (10.7-13.6 N-m)
52, Diagnostic Plug	85-120 lb-in (9.6-13.6 N-m)
56, Charge Cover Cap Screw (non-auxiliary)	180-220 lb-in (20.3-24.9 N-m)
58, End Cap Bolts	255-300 lb-in (28.8-33.9 N-m)

Table 6. BDP-21L Plug Fitting Torque Values

Item # or Description	Torque
Case Drain fitting (fitting torque)	370-470 lb-in (41.8-53.1 N-m)
System Port (fitting torque)	370-470 lb-in (41.8-53.1 N-m)
Inlet (fitting torque)	370-470 lb-in (41.8-53.1 N-m)
42A, 42B, Check Valves/Shock Valves	180-240 lb-in (20.3-27.1 N-m)
42A, 42B, Check Reliefs (cap)	200-275 lb-in (22.6-31.0 N-m)
50, Bypass Valve	84-120 lb-in (9.5-13.6 N-m)
52, Diagnostic Plug	84-120 lb-in (9.5-13.6 N-m)
56, Charge Cover Cap Screw (non-auxiliary)	200-275 lb-in (22.6-31.0 N-m)
58, End Cap Bolts	255-345 lb-in (28.8-38.9 N-m)

REMOVAL, INSPECTION AND/OR REPLACEMENT OF INPUT SHAFT SEAL BDP-10A

Refer to Figure 10.

Disassembly BDP-10A

1. Remove retaining ring (22) from housing.
2. Remove lip seal (20). Care must be taken to prevent damage to the housing bore, shaft sealing surface, or bearing. Once removed, the seal is not reusable.

Inspection BDP-10A

1. With seal removed inspect the spacer (21), input shaft bearing (19) and housing (1) bore for damage, corrosion or wear.

Assembly BDP-10A

1. Lubricate the new lip seal (20) with petroleum jelly.
2. Wrap the input shaft (18) with plastic wrap to prevent damage to the inner surface of the lip seal (20).
3. Slide seal (20) over shaft (18) so that lettering on the seal faces out.
4. Press the lip seal (20) into the housing bore. Insure the lip seal (20), shaft (18) or housing (1) bore does not become damaged.
5. Install the retaining ring (22) into the housing (1) bore groove.

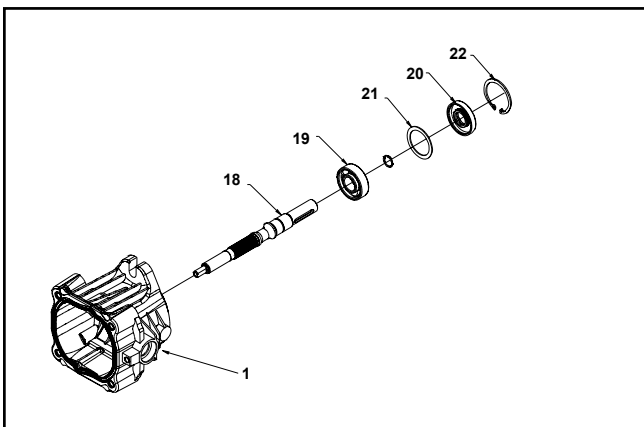


Figure 10. BDP-10A

REMOVAL, INSPECTION AND/OR REPLACEMENT OF INPUT SHAFT SEAL BDP-16A/21L

Refer to Figure 11.

Disassembly BDP-16A/21L

1. Remove retaining ring (3) from housing (15).
2. Remove lip seal (6). Care must be taken to prevent damage to the housing bore, shaft, sealing surface, or bearing. Once removed the seal is not reusable.

Inspection BDP-16A/21L

1. With the lip seal (6) removed, inspect the spacer (4) the shaft bearing (5) and housing (15) bore.

Assembly BDP-16A/21L

1. Lubricate the new lip seal (6) with petroleum jelly.
2. Wrap the input shaft (1) with plastic wrap to prevent damage to the inner surface of the lip seal (6).
3. Slide the seal (6) over shaft (1) so that lettering on the seal (6) faces out.
4. Press the lip seal (6) into the housing (15) bore. Insure seal (6), shaft (1) or housing (15) bore does not become damaged.
5. Install the retaining ring (3) into the housing (15) bore groove.

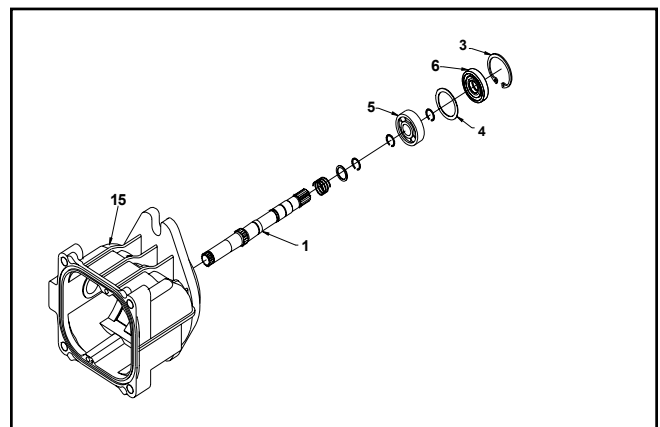


Figure 11. BDP-16A/21L

REMOVAL, INSPECTION AND/OR REPLACEMENT OF TRUNNION ARM (CONTROL ARM) SEAL BDP-10A/16A

Refer to figure 12.

Disassembly BDP-10A/16A

1. Remove the retainer and lip seal (49/12) from the housing (1/15). Care must be taken to prevent damage to the housing trunnion bore, trunnion arm (37/13) and sealing surface. Once removed the retainer and lip seal is not reusable.

Inspection BDP-10A/16A

1. With the lip seal (49/12) removed, inspect the area for corrosion and wear. Inspect the trunnion bore area sealing surface for damage or wear.

Assembly BDP-10A/16A

1. Lubricate the new lip seal (49/12) with petroleum jelly.
2. Wrap the trunnion arm (37/13) with plastic wrap to prevent damage to the inner surface of the lip seal (49/12).
3. Slide the lip seal (49/12) over the trunnion arm (37/13) so that the lettering on the seal (49/12) faces out.
4. Press the lip seal (49/12) into the housing bore (1/15). Insure the seal (49/12), trunnion arm (37/13), and housing bore does not become damaged.
5. Install the retainer from (49/12) over the trunnion arm (37/13) on top of the lip seal from (49/12). Press into the trunnion seal bore in the housing until it mates against the trunnion seal.

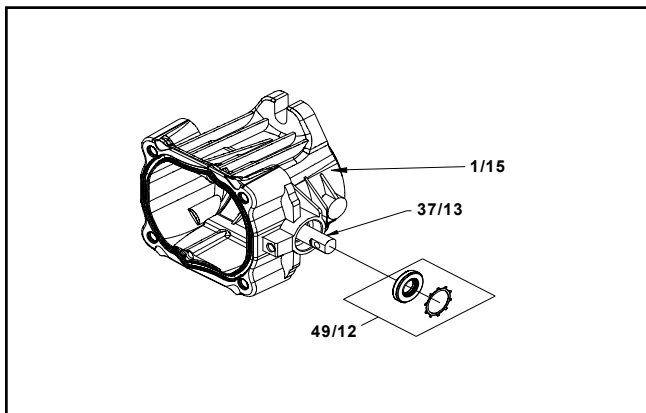


Figure 12. BDP-10A/16A

REMOVAL, INSPECTION AND/OR REPLACEMENT OF TRUNNION ARM (CONTROL ARM) SEAL BDP-21L

Refer to figure 13.

Disassembly BDP-21L

1. Remove the retainer (10) and lip seal (2). Care must be taken to prevent damage to the housing trunnion bore, trunnion arm (13) and sealing surface. Once removed lip seal (12) is not reusable.

Inspection BDP-21L

1. With the lip seal (12) removed, inspect the area for corrosion and wear. Inspect the trunnion bore area sealing surface for damage or wear.

Assembly BDP-21L

1. Lubricate the new lip seal (12) with petroleum jelly.
2. Wrap the trunnion arm (13) with plastic wrap to prevent damage to the inner surface of the lip seal (12).
3. Slide the lip seal (12) over the trunnion arm (13) so that lettering on the seal (13) faces out.
4. Press the lip seal (12) into the housing bore (15). Insure the seal (12), trunnion arm (13), and housing bore does not become damaged.
5. Install the retainer (10) over the trunnion arm (13) on top of the lip seal (12). Press into the trunnion seal bore in the housing (15) bore ring groove.

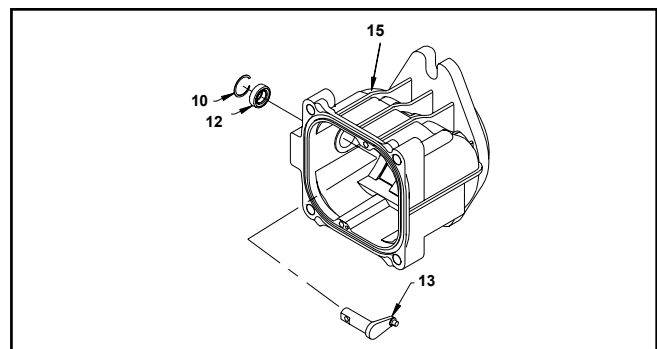


Figure 13. BDP-21L

REMOVAL, INSPECTION AND/OR REPLACEMENT OF CHECK VALVES BDP-10A/16A

Refer to Figure 14.

Disassembly BDP-10A/16A

Perform disassembly, inspection and assembly on check valves one side at a time. Some units vary in “A” side to “B” side check configuration.

1. Remove the check valve (42) with 1/4” allen wrench.
2. Remove the valve spring and poppet from the BDP end cap (2/25).

Inspection BDP-10A/16A

1. Inspect the poppets and mating seats in the end cap (2/25) for damage or foreign material.

Assembly BDP-10A/16A

1. Lay the BDP on its side, so the check plug port is horizontal.
2. Insert the check plug, spring and poppet (42) as one assembly into the check plug port. Tighten, reference Tables 4 & 5, page 16, for torque values.

Repeat disassembly, inspection and assembly for the opposite port side.

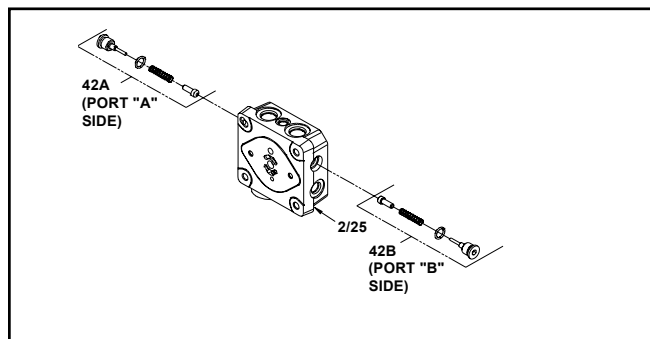


Figure 14. BDP-10A/16A

REMOVAL, INSPECTION AND/OR REPLACEMENT OF CHECK VALVES BDP-21L

Refer to Figure 15.

Disassembly BDP-21L

Perform disassembly, inspection and assembly on check valves one side at a time. Some units vary in “A” side to “B” side check configuration.

1. Remove the check valve (42) with 1/4” allen wrench.
2. Remove the valve spring and poppet from the BDP end cap (25).

Inspection BDP-21L

1. Inspect the poppet and mating seats in the end cap (25) for damage or foreign material.

Assembly BDP-21L

1. Lay the BDP on its side, so the check plug port is horizontal.
2. Insert the check plug, spring and poppet (42) as one assembly into the check plug port. Tighten, reference Table 6, page 16, for torque values.

Repeat disassembly, inspection and assembly for the opposite port side.

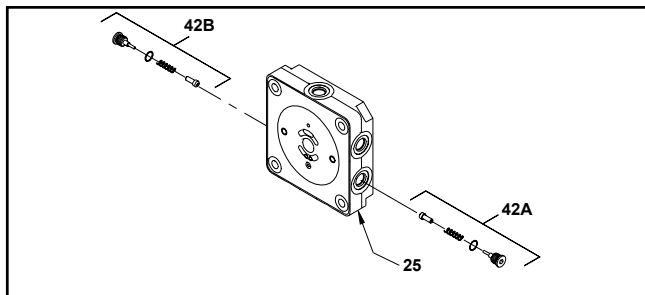


Figure 15. BDP-21L

REMOVAL, INSPECTION AND/OR REPLACEMENT OF SYSTEM CHECK RELIEFS (SCR's) OR SHOCK VALVES BDP-10A/16A

Refer to Figure 16.

Disassembly BDP-10A/16A

Perform disassembly, inspection and assembly on SCR/shock valve one side at a time. Some units vary in "A" side to "B" side configuration.

1. Remove the SCR (42) with a 7/8" wrench or the shock valve (42) with an 11/16" wrench.
2. Remove the check relief/shock valve spring and the check relief/shock valve from the BDP end cap (2/25).

Inspection BDP-10A/16A

1. Inspect the check relief or shock valve (42) and mating seat in the end cap (2/25) for damage or foreign material.

Assembly BDP-10A/16A

1. Lay the BDP on its side, so the check plug port is horizontal.
2. Insert the system check relief spring and check relief or shock valve spring and shock valve as one assembly into the check plug port. Tighten to the correct torque value. See page 16.

Repeat disassembly, inspection and assembly for the opposite port side.

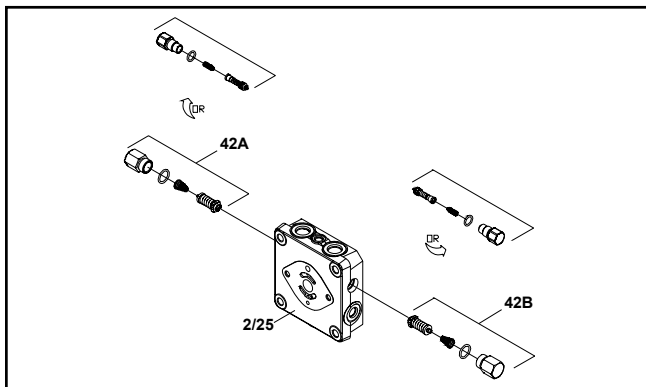


Figure 16. BDP-10A/16A

REMOVAL, INSPECTION AND/OR REPLACEMENT OF SYSTEM CHECK RELIEFS (SCR's) OR SHOCK VALVES BDP-21L

Refer to Figure 17.

Disassembly BDP-21L

Perform disassembly, inspection and assembly on SCR/shock valve one side at a time. Some units vary in "A" side to "B" side configuration.

1. Remove the SCR (42) with a 7/8" wrench or the shock valve (42) with an 11/16" wrench.
2. Remove the check relief/shock valve spring and the check relief/shock valve from the BDP end cap (25).

Inspection BDP-21L

1. Inspect the check relief or shock valve (42) and mating seat in the end cap (25) for damage or foreign material.

Assembly BDP-21L

1. Lay the BDP on its side, so the check plug port is horizontal.
2. Insert the system check relief spring and check relief or shock valve spring and shock valve as one assembly into the check plug port. Tighten, reference Table 6, page 16, for torque values.

Repeat disassembly, inspection and assembly for the opposite port side.

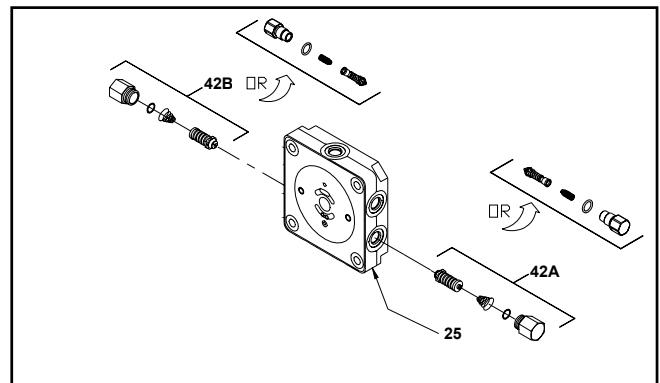


Figure 17. BDP-21L

REMOVAL, INSPECTION AND/OR REPLACEMENT OF THE BYPASS BDP-10A/16A

Refer to Figure 18.

Disassembly BDP-10A/16A

1. Loosen the bypass valve (15/50) using a 5/8" wrench.
2. Remove the bypass (15/50) from the BDP end cap (2/25).

Inspection BDP-10A/16A

1. Inspect the bypass O-rings and mating seats in the end cap (2/25) for damage or foreign material.
2. If damaged or worn replace bypass (15/50).

Assembly BDP-10A/16A

1. Lay the BDP on its side, so the bypass port is horizontal.
2. Insert the bypass (15/50) into the bypass port on the end cap (2/25). Tighten to the proper torque value. See page 16.

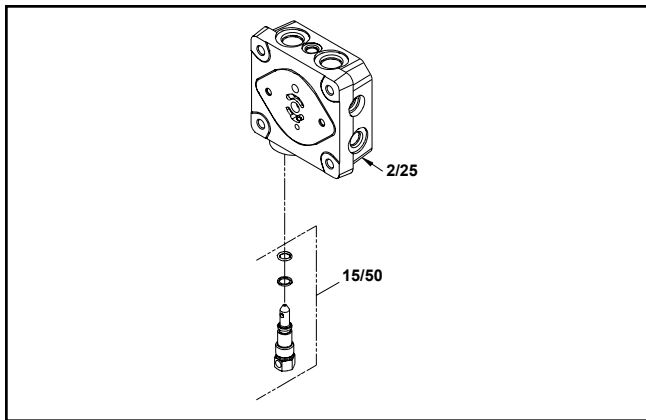


Figure 18. BDP-10A/16A

REMOVAL, INSPECTION AND/OR REPLACEMENT OF THE BYPASS BDP-21L

Refer to Figure 19.

Disassembly BDP-21L

1. Loosen the bypass valve (50) using a 5/8" wrench.
2. Remove the bypass (50) from the BDP end cap (25).

Inspection BDP-21L

1. Inspect the bypass O-rings and mating seats in the end cap (25) for damage or foreign material.
2. If damaged or worn replace bypass (50).

Assembly BDP-21L

1. Lay the BDP on its side, so the bypass port is horizontal.
2. Insert the bypass (50) into the bypass port on the end cap (25). Tighten, reference Table 6, page 16, torque values.

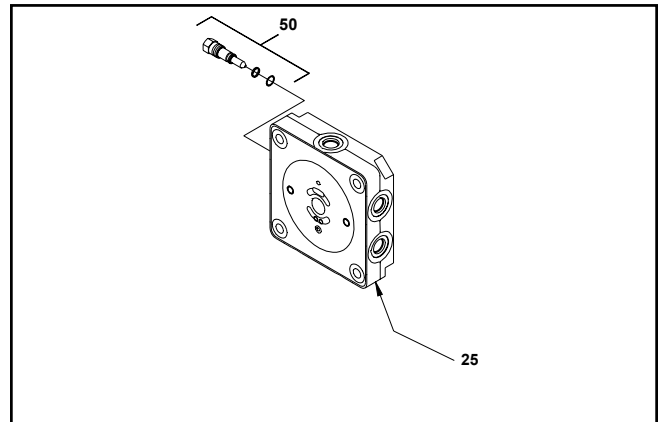


Figure 19. BDP-21L

REMOVAL, INSPECTION AND ASSEMBLY OF THE STANDARD CHARGE PUMP BDP-10A

Refer to Figure 20.

Disassembly BDP-10A

1. Prior to removal of the charge cover, place a mark on the charge cover and end cap for re-alignment.
2. Using a 5 mm allen wrench, loosen the charge cover bolts (10) from the BDP end cap (2). While holding the charge cover in place, remove the charge cover bolts (10).
3. Remove the charge cover, O-ring, gerotor items (6), charge spring and charge ball (44).

Inspection BDP-10A

1. Inspect the charge cover O-ring and running surfaces for damage. Inspect the spring, check ball (44), and mating seat in the end cap (2) for damage or foreign material.

Note: If end cap (2) is to be removed, delay charge components reassembly.

Assembly BDP-10A

1. Lay the BDP (input shaft down), so the end cap (2) is horizontal. Place the charge ball (44) in the end cap (2) charge pocket so it mates to the end cap (2) charge ball seat. Place the charge spring, also identified as item (44), on top of the charge ball.
2. Insert the inner gerotor over input shaft (18).
3. Align the outer gerotor to fit over the inner gerotor.
4. Insert the O-ring into the charge cover.
5. Position the charge cover and O-ring with the aligning mark on the end cap. Place the charge cover and O-ring as one piece over the charge spring and gerotor assembly. Insure the spring fits into the charge cover spring retaining groove.
6. Align and insert the allen screws (6) into the end cap (2). Tighten, reference Table 4, page 16, torque values.

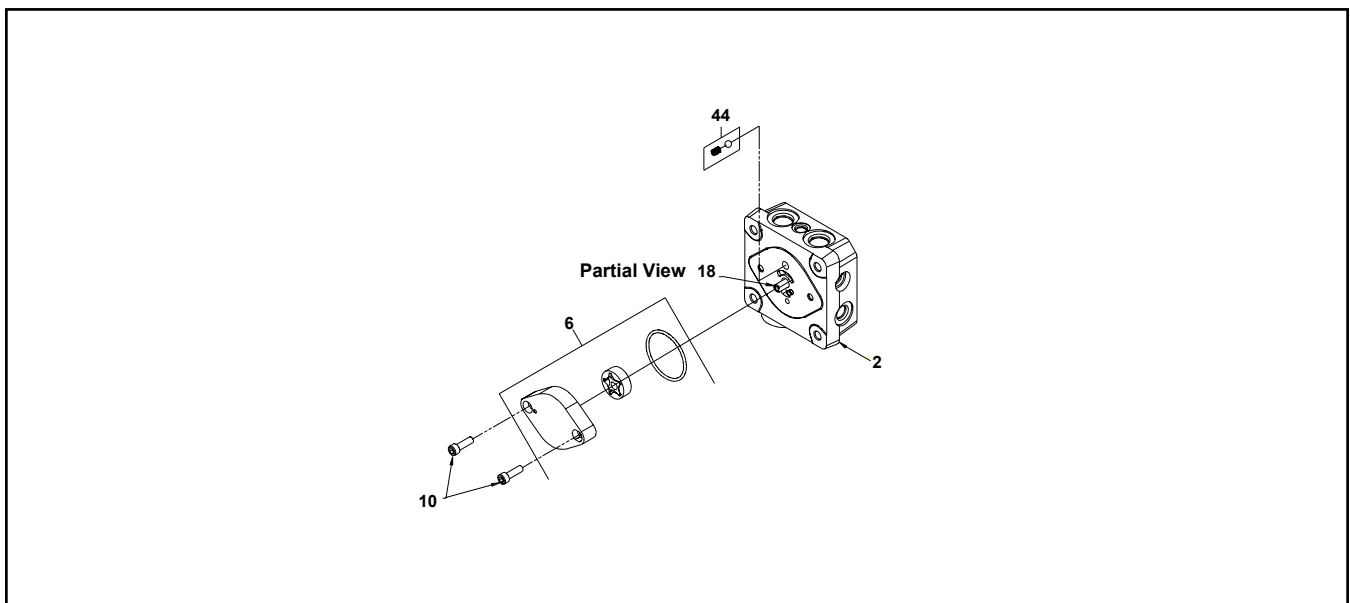


Figure 20. BDP-10A

REMOVAL, INSPECTION AND ASSEMBLY OF THE STANDARD CHARGE PUMP BDP-16A/21L

Refer to Figure 21.

Disassembly BDP-16A/21L

1. Prior to removal of the charge cover, place a mark on the charge cover and end cap for re-alignment.
2. Using a 1/2" wrench loosen the charge cover bolts from the BDP end cap (25). While holding the charge cover in place, remove the charge cover bolts (56).
3. Remove the charge cover, O-ring, gerotor items (40), charge spring and charge ball (44).

Inspection BDP-16A/21L

1. Inspect the charge cover O-ring and running surfaces for damage. Inspect the spring, check ball (44), and mating seat in the end cap (25) for damage or foreign material.
2. If damaged or worn, replace O-ring and gerotor assembly (40), charge spring and charge ball (44) and end cap (25).

Note: If end cap (25) is to be removed, delay charge components reassembly.

Assembly BDP-16A/21L

1. Lay the BDP (input shaft down), so the end cap is horizontal. Place the charge ball in the end cap (25) charge pocket so it mates to the end cap (25) charge ball seat. Place the charge spring on top of the charge ball.
2. Insert the inner gerotor over input shaft (1).
3. Align the outer gerotor to fit over the inner gerotor.
4. Insert the O-ring into the charge cover.
5. Position the charge cover and O-ring with the aligning mark on the end cap (25). Place the charge cover and O-ring as one piece over the charge spring and gerotor assembly. Insure the spring fits into the charge cover spring retaining groove.
6. Align and insert the cap screws (56) into the charge cover. While holding the charge cover in place tighten the cap screws (56) per Tables 5 and 6, page 16.

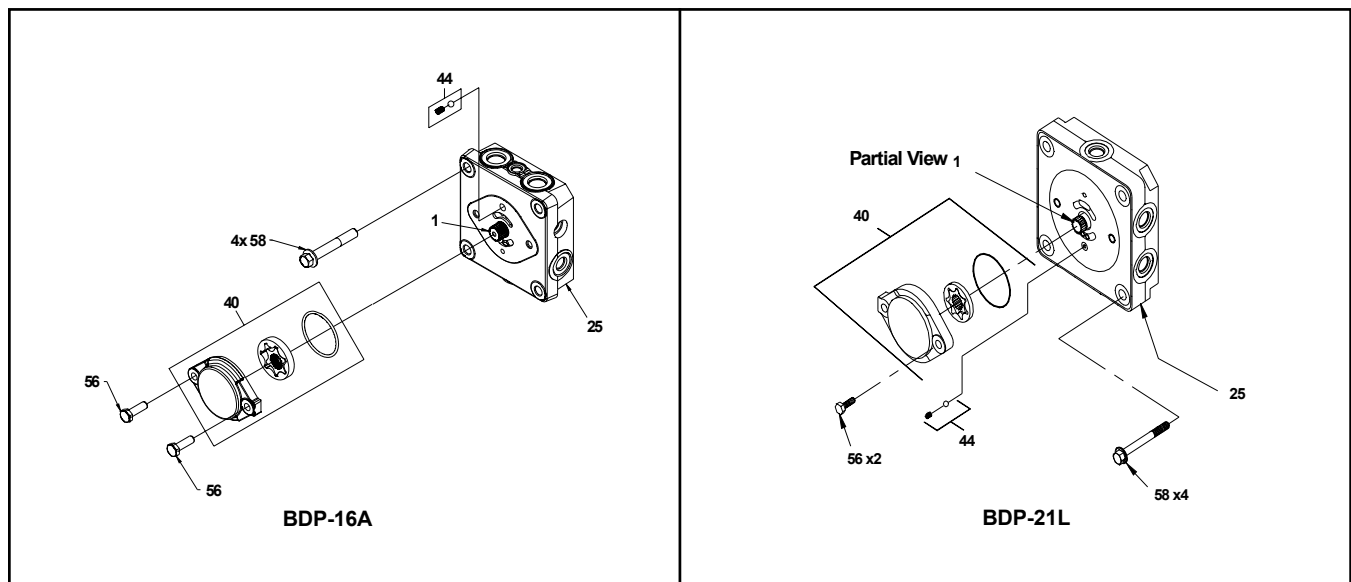


Figure 21. BDP-16A/21L

REMOVAL, INSPECTION AND ASSEMBLY OF THE END CAP AND VALVE PLATE BDP-10A

Refer to Figure 22.

Disassembly BDP-10A

1. Using a 10 mm wrench, loosen the end cap bolts (4) evenly.
2. Keeping the end cap (2) held in place, remove the four end cap bolts (4).
3. Slowly remove the end cap (2).
4. Remove the valve plate (31).
5. Remove housing alignment pins (3).
6. Remove housing gasket (5).

Inspection BDP-10A

1. Inspect the end cap (2) body for damage, nicks or unusual wear patterns. Replace if necessary.
2. Inspect the running surface (side that contacts the cylinder block) of the valve plate (31). The running surface may show evidence of minor abrasive rings.

This is normal. Grooving in the plate, or material transfer that is evident when the surface is checked by dragging a fingernail across it, would be cause for replacement of the valve plate.

3. Inspect and replace alignment pins (3) if bent or distorted.
4. Replace the housing gasket (5) with a new gasket before reassembly.

Assembly BDP-10A

1. Install housing gasket (5) into housing gasket seat in housing (1).
2. Install alignment pins (3) into housing (1).
3. Lubricate the valve plate prior to installation. Install valve plate (31) so the stamped letters "CL" on the valve plate are facing up toward the endcap.
4. Install end cap (2). Before installing the four end cap bolts (4), push down on end cap (2) verifying alignment and insuring that the cylinder block pistons spring back and forth. Install end cap bolts (4). Tighten, reference Table 4, page 16, torque values.

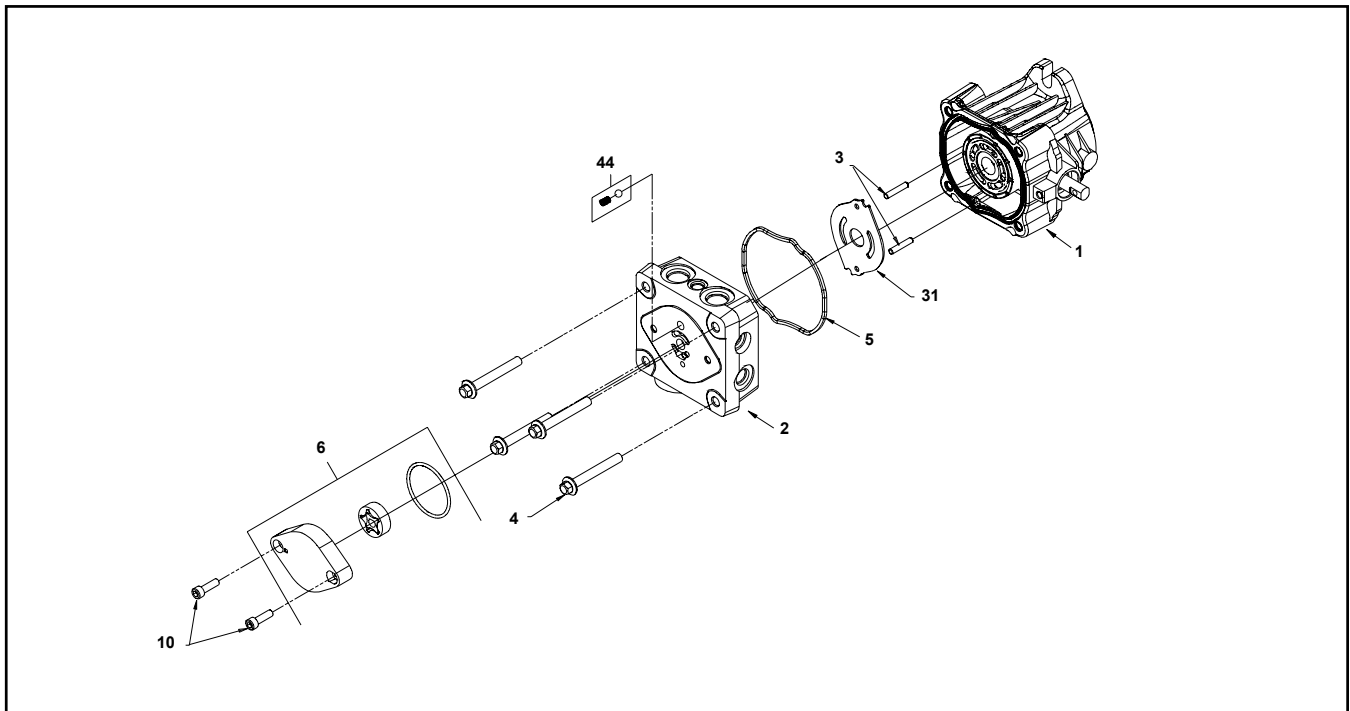


Figure 22. BDP-10A

REMOVAL, INSPECTION AND ASSEMBLY OF THE END CAP AND VALVE PLATE BDP-16A

Refer to figure 23.

Disassembly BDP-16A

1. Using any combination of two, 9/16" wrenches or 9/16" socket and ratchet drive, loosen the end cap bolts (58) evenly.
2. Keeping the end cap (25) held in place remove the four end cap bolts (58).
3. Slowly remove the end cap (25).
4. Remove the valve plate (29).
5. Remove housing alignment pins (26).
6. Remove housing gasket (28).

Inspection BDP-16A

1. Inspect the end cap (25) body for damage, nicks or unusual wear patterns. Replace if necessary.
2. Inspect the running surface (side that contacts the cylinder block) of the valve plate (29). The running surface may show evidence of minor abrasive rings.

This is normal. Grooving in the plate, or material transfer that is evident when the surface is checked by dragging a fingernail across it, would be cause for replacement of the valve plate.

3. Inspect and replace alignment pins (26) if bent or distorted.
4. Replace the housing O-ring (28) with a new O-ring before reassembly.

Assembly BDP-16A

1. Install housing O-ring (28) into housing O-ring seat in housing (15).
2. Install alignment pins (26) into housing (15).
3. Lubricate the valve plate prior to installation. Install valve plate (29) so the stamped letters "UP" on the valve plate are facing up toward the endcap.
4. Install end cap (25). Before installing the four end cap bolts (58), push down on end cap (25) verifying alignment and insuring that the cylinder block pistons spring back and fourth. Install end cap bolts. Tighten, per Table 5, page 16, torque values.

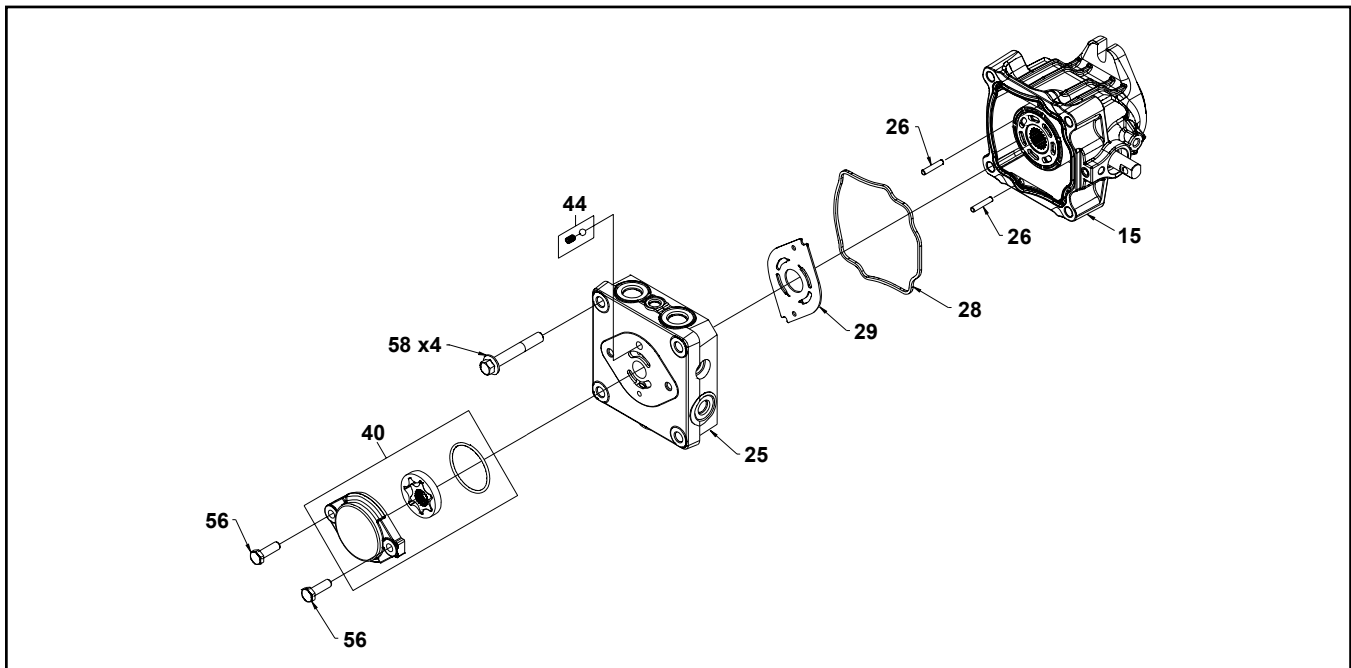


Figure 23. BDP-16A

REMOVAL, INSPECTION AND ASSEMBLY OF THE END CAP AND VALVE PLATE BDP-21L

Refer to figure 24.

Disassembly BDP-21L

1. Using any combination of two, 9/16" wrenches or 9/16" socket and ratchet drive, loosen the end cap bolts (58) evenly.
2. Keeping the end cap (25) held in place remove the four end cap bolts (58).
3. Slowly remove the end cap (25).
4. Remove the valve plate (29).
5. Remove housing alignment pins (26).
6. Remove housing gasket (28).

Inspection BDP-21L

1. Inspect the end cap (25) body for damage, nicks or unusual wear patterns. Replace if necessary.
2. Inspect the bronze side of the valve plate (29). The running surface may show evidence of minor abrasive rings.

This is normal. Grooving in the plate, or material transfer that is evident when the surface is checked by dragging a fingernail across it, would be cause for replacement of the valve plate.

3. Inspect and replace alignment pins (26) if bent or distorted.
4. Replace the housing O-ring (28) with a new O-ring before reassembly.

Assembly BDP-21L

1. Install housing O-ring (28) into housing O-ring seat in housing (15).
2. Install alignment pins (26) into housing (15).
3. Lubricate the valve plate prior to installation. Install valve plate (29) with the bronze side down, contacting the cylinder block.
4. Install end cap (25). Before installing the four end cap bolts (58), push down on end cap (25) verifying alignment and insuring that the cylinder block pistons spring back and fourth. Install end cap bolts. Tighten, per Table 6, page 16, torque values.

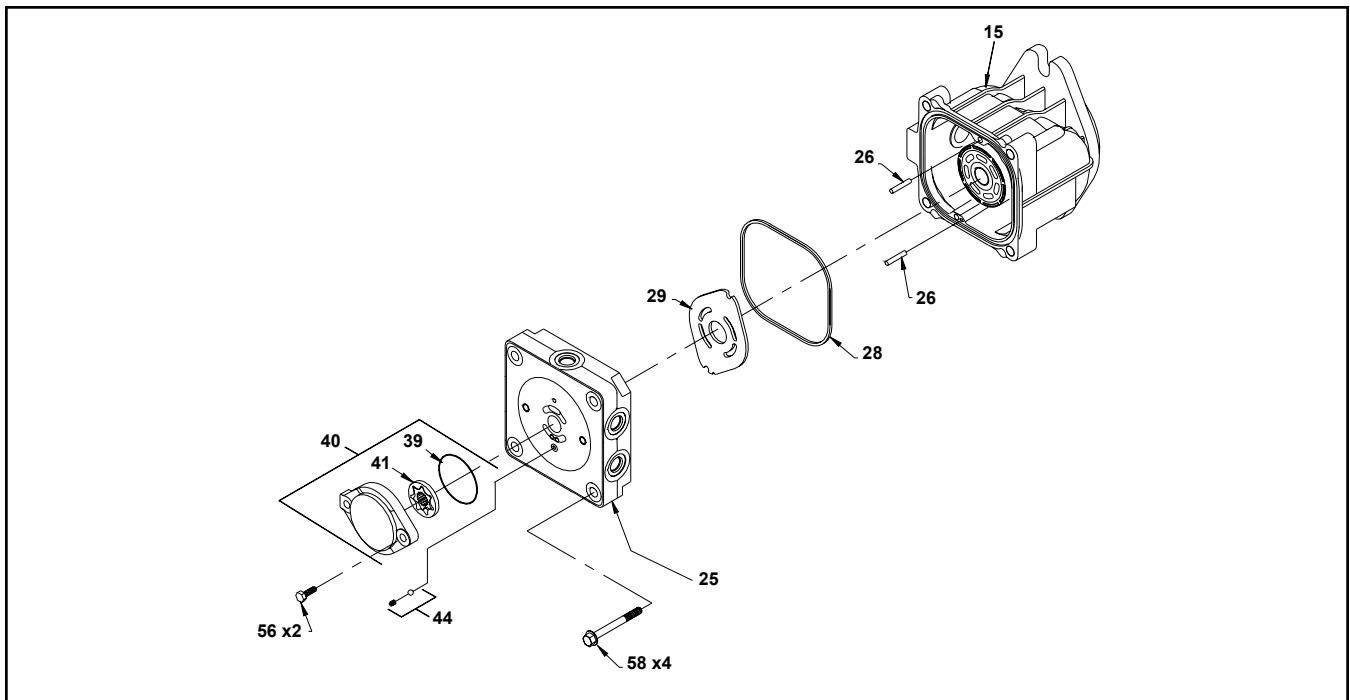


Figure 24. BDP-21L

REMOVAL, INSPECTION AND ASSEMBLY OF THE CYLINDER BLOCK BDP-10A

Refer to Figure 25.

Disassembly BDP-10A

1. Tilt the BDP on its side, drain remaining oil. Lift out the cylinder block assembly (25).
2. Remove the pistons, springs and piston seats.

Inspection BDP-10A

1. Inspect the running surface of the cylinder block and piston ends for damage, nicks or unusual wear patterns. The running surface may show evidence of minor abrasion. This will be a normal wear. If grooved or smeared, replace with a new cylinder block assembly.
2. Inspect the piston springs for distortion or breakage. If necessary, replace with new cylinder block kit.
3. Inspect the piston seats. Residual oil may cause these to remain stuck to the inside of the pistons.

Assembly BDP-10A

1. Install piston seats into the end of the pistons.
2. Install springs into the pistons.
3. Install one at a time, pistons, springs and seats as one assembly into the cylinder block.
4. With the BDP housing tilted on its side, install the cylinder block assembly (25) with pistons contacting the thrust bearing.

NOTE: To check that piston placement is correct, push downward on the cylinder block assembly (38). If this results in a spring action the block assembly has been installed correctly. If this cannot be accomplished, remove and reassemble the block assembly. Place a rubber band around the cylinder block pistons to hold them in position during installation. Then after installation cut the rubber band and remove it. Check for cylinder block assembly for spring action.

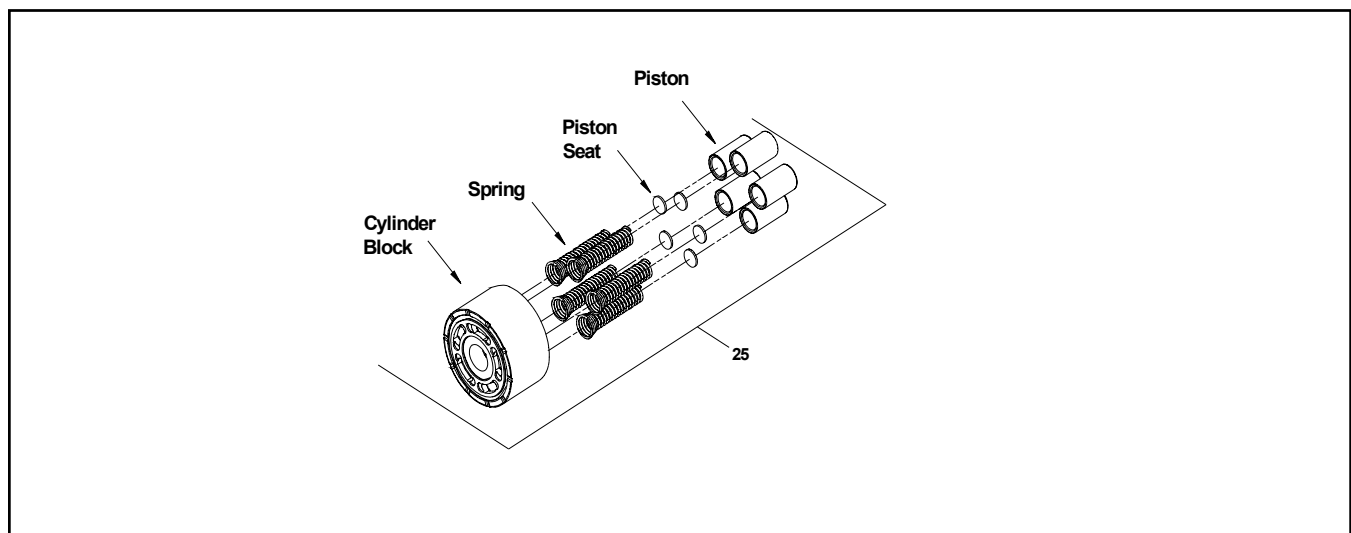


Figure 25. BDP-10A

REMOVAL, INSPECTION AND ASSEMBLY OF THE CYLINDER BLOCK BDP-16A/21L

Refer to Figure 26.

Disassembly BDP-16A/21L

1. Tilt the BDP on its side, drain remaining oil. Lift out the cylinder block assembly (38).
2. Remove the pistons, springs and piston seats.

Inspection BDP-16A/21L

1. Inspect the running surface of the cylinder block and piston ends for damage, nicks or unusual wear patterns.

The running surface may show evidence of minor abrasion. This will be normal wear. If grooved or smeared, replace with a new cylinder block assembly.

2. Inspect the piston springs for distortion or breakage. If necessary, replace with new cylinder block kit.
3. Inspect the piston seats. Residual oil may cause these to remain stuck to the inside of the pistons.

Assembly BDP-16A/21L

1. Install piston seats into the end of the pistons.
2. Install springs into the pistons.
3. Install one at a time, pistons, springs and seats as one assembly into the cylinder block.
4. With the BDP housing tilted on its side, install the cylinder block assembly (38) so that the pistons contact the thrust bearing.

NOTE: To check that piston placement is correct, push downward on the cylinder block assembly (38). If this results in a spring action the block assembly has been installed correctly. If this cannot be accomplished, remove and reassemble the block assembly. Place a rubber band around the cylinder block pistons to hold them in position during installation. Then after installation cut the rubber band and remove it. Check for cylinder block assembly for spring action.

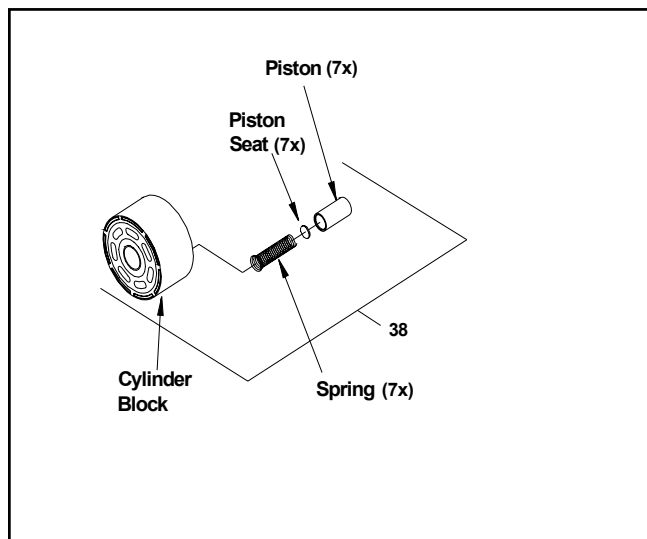


Figure 26. BDP-16A/21L

REMOVAL, INSPECTION AND ASSEMBLY OF BLOCKSPRING, THRUST WASHER, AND THRUST BEARING, BDP-10A/16A

Refer to Figure 27.

Disassembly BDP-10A/16A

1. Remove the block spring (29/20).
2. Remove the thrust washer (30/19).
3. Remove the thrust bearing and race (34/17).

Inspection BDP-10A/16A

1. Inspect and replace the block spring (29/20) and thrust washer (30/19) if they are distorted or broken.
2. Inspect the running surface of the bearing race for damage, nicks or unusual wear patterns. The running surface may show evidence of minor abrasion. This will be normal wear. Inspect the bearings for free movement. Inspect the bearing cage for distortion or damage. Replace if necessary.

Assembly BDP-10A/16A

1. Install thrust bearing and race assembly (34/17).

NOTE: The difference in race thickness: The thin race seats into the swashplate (32/31). The thicker race will be installed toward the piston noses.

2. Install thrust washer (30/19).
3. Install block spring (29/20).

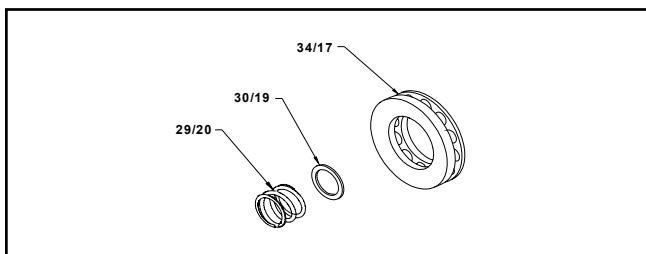


Figure 27. BDP-10A/16A

REMOVAL, INSPECTION AND ASSEMBLY OF THRUST BEARING, BDP-21L

Refer to Figure 28.

Disassembly BDP-21L

1. Remove the thrust bearing and race (17).

Inspection BDP-21L

1. Inspect the running surface of the bearing race for damage (17), nicks or unusual wear patterns. The running surface may show evidence of minor abrasion. This will be normal wear. Inspect the bearings for free movement. Inspect the bearing cage for distortion or damage. Replace if necessary.

Assembly BDP-21L

1. Install bearing and race assembly (17).

NOTE: The difference in race thickness: The thin race seats into the swashplate. The thicker race will be installed toward the piston noses.

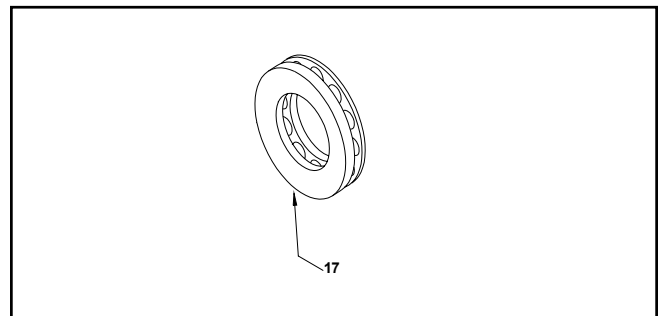


Figure 28. BDP-21L

REMOVAL, INSPECTION OF SWASHPLATE, INSPECTION OF CRADLE BEARINGS BDP-10A/16A

Refer to Figure 29.

Disassembly BDP-10A/16A

1. Remove the swashplate(32/31).

Inspection BDP-10A/16A

1. Inspect the running surface of the bearing pocket for damage (32/31), nicks or unusual wear patterns. The running surface may show evidence of minor abrasion . This will be normal wear. Inspect the cradle bearing side of the swashplate (32/31) for damage. Replace if necessary.
2. Inspect the cradle bearings attached to the inside of housing (1/15) for normal wear patterns, placement, and insure they are staked in place. If damaged, replace housing (1/15).

NOTE: The cradle bearings will have discoloration due to normal wear. This, under normal circumstances, will not warrant replacement.

Assembly BDP-10A/16A

1. Install swashplate (32/31) by holding trunnion arm's (37/13) slot guide (38/14) with the aide of a flat tip screwdriver. Use the screwdriver to hold the slot guide (38/14) in place while positioning the swash plate (32/31) onto the cradle bearing in the housing (1/15).
2. Rotate trunnion arm (37/13) to assure swashplate pivoting action.

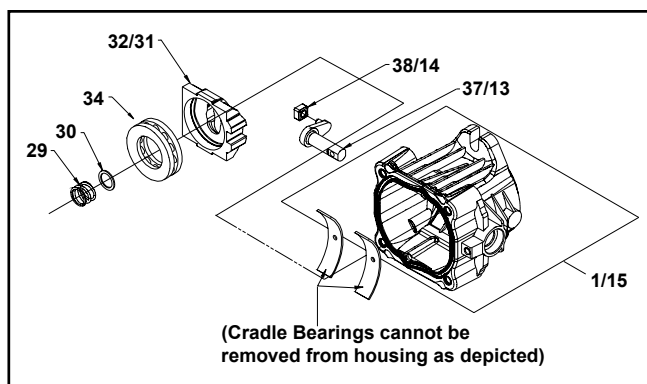


Figure 29 . BDP-10A/16A

REMOVAL, INSPECTION AND ASSEMBLY OF SWASHPLATE, AND CRADLE BEARINGS, BDP-21L

Refer to Figure 30.

Disassembly BDP-21L

1. Remove the swashplate (31).

Inspection BDP-21L

1. Inspect the running surface of the bearing pocket for damage (31), nicks or unusual wear patterns. The running surface may show evidence of minor abrasion . This will be normal wear. Inspect the cradle bearing side of the swashplate (31) damage. Replace if necessary.
2. Inspect the cradle bearings attached to the inside of housing (15) for normal wear patterns, placement, and insure they are staked in place. If damaged, replace housing (15).

NOTE: The cradle bearings will have discoloration due to normal wear. This under normal circumstances will not warrant replacement.

Assembly BDP-21L

1. Install swashplate (31) by holding trunnion arm's (13) slot guide (14) with the aide of a flat tip screwdriver. Use the screwdriver to hold the slot guide (14) in place while positioning the swash plate (31) onto the cradle bearing in the housing (15).
2. Rotate trunnion arm (13) to assure swashplate pivoting action.

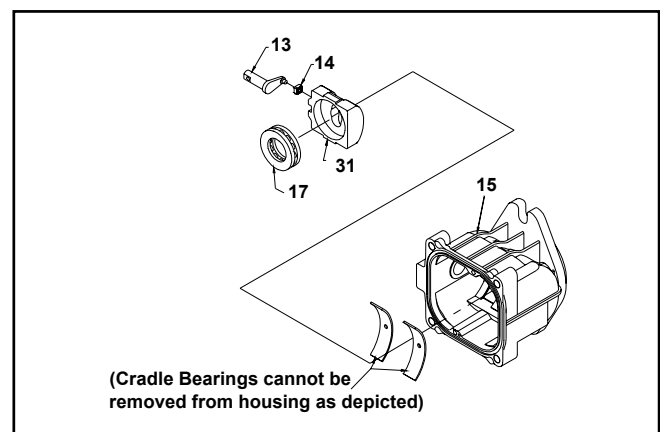


Figure 30 . BDP-21L

REMOVAL, INSPECTION AND ASSEMBLY OF INPUT SHAFT BDP-10A

Refer to Figure 31.

Disassembly BDP-10A

1. Remove the retaining ring (22).
2. Remove the lip seal (20).
3. Remove the spacer (21).
4. Remove the shaft assembly (18) from the BDP.

Inspection BDP-10A

1. Inspect the input shaft (18) for worn splines, surface damage, or keyway damage. Replace shaft assembly if necessary.
2. Inspect the bearing (19) for evidence of scoring, corrosion, or damage. Replace shaft assembly if necessary.
3. Inspect and replace the spacer (21) if it is bent or broken.
4. Inspect and replace the retaining ring (22) if it is bent or broken.

Note: Replace the input shaft seal (20) after removal.

Note: If trunnion arm is to be removed, delay reassembly of input shaft assembly.

Assembly BDP-10A

Note: Upon removal, it is recommended that all seals, O-rings and gaskets be replaced. During installation, lightly lubricate all seals, O-rings and gaskets with clean petroleum jelly prior to assembly. Also, protect the inner diameter of seals by covering the shaft with plastic wrap.

1. Install input shaft assembly (18) into the housing (1) bore. Light tapping with a rubber mallet may be necessary on the input shaft (18) once the bearing is aligned with the housing (1) bore. Rotate the input shaft (18) to insure free movement.
2. Install spacer (21).
3. Install new lip seal (20).
4. Install retaining ring (22).

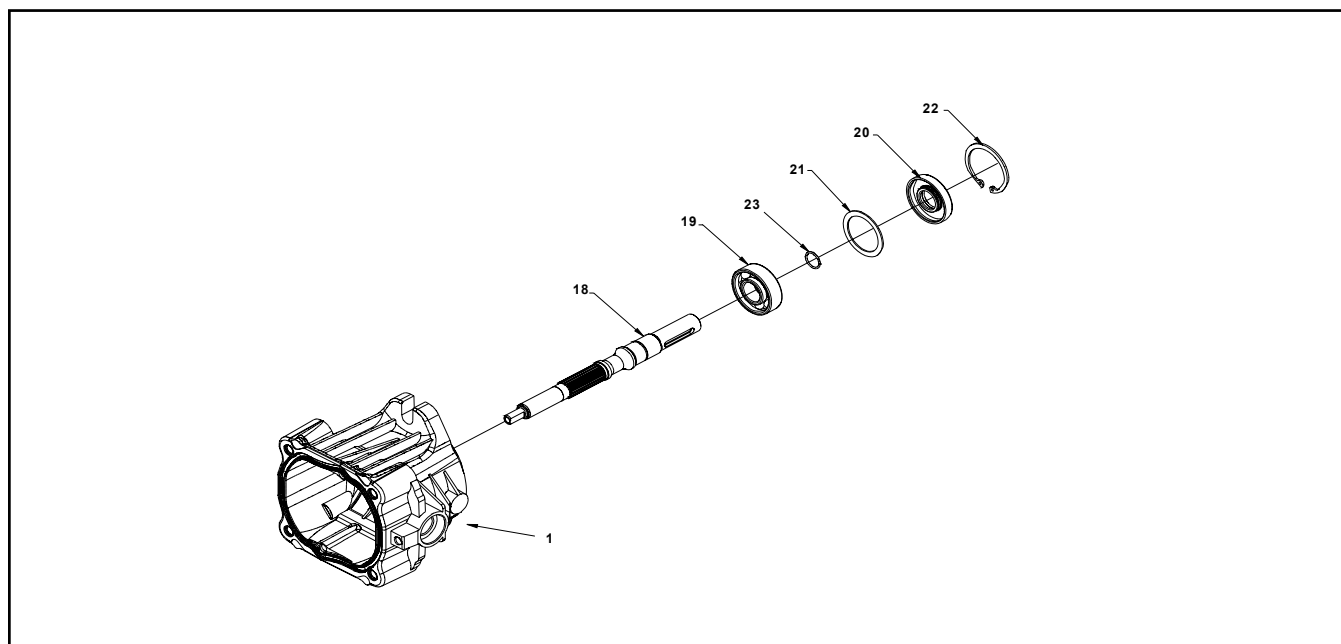


Figure 31. BDP-10A

REMOVAL, INSPECTION AND ASSEMBLY OF INPUT SHAFT, BDP-16A/21L

Refer to Figure 32.

Disassembly BDP-16A/21L

1. Remove the retaining ring (3).
2. Remove the lip seal (6).
3. Remove the spacer (4).
4. Remove the shaft assembly (1) from the BDP.

Inspection BDP-16A/21L

1. Inspect the input shaft (1) for worn splines, damage, or keyway damage. Replace shaft assembly if necessary.
2. Inspect the bearing (5) for evidence of scoring, corrosion, or damage. Replace shaft assembly if necessary.
3. Inspect and replace the spacer (4) if it is bent or broken.

Note: Replace the input shaft seal (6) after removal.

4. Inspect and replace the retaining ring (3) if it is bent or broken.

Note: If trunnion arm is to be removed, delay reassembly of input shaft assembly.

5. Inspect and replace the thrust spring (20) and thrust washer (19) if they are distorted or broken.

Assembly BDP-16A/21L

Note: Upon removal, it is recommended that all seals, O-rings and gaskets be replaced. During installation, lightly lubricate all seals, O-rings and gaskets with clean petroleum jelly prior to assembly. Also, protect the inner diameter of seals by covering the shaft with plastic wrap.

1. Install the shaft (1) assembly, into the housing (15) bore. Light tapping with a rubber mallet may be necessary on the input shaft (1) once the bearing is aligned with the housing bore (15). Rotate the input shaft (1) to insure free movement.
2. Install the spacer (4).
3. Install a new lip seal (6).
4. Install the retaining ring (3).

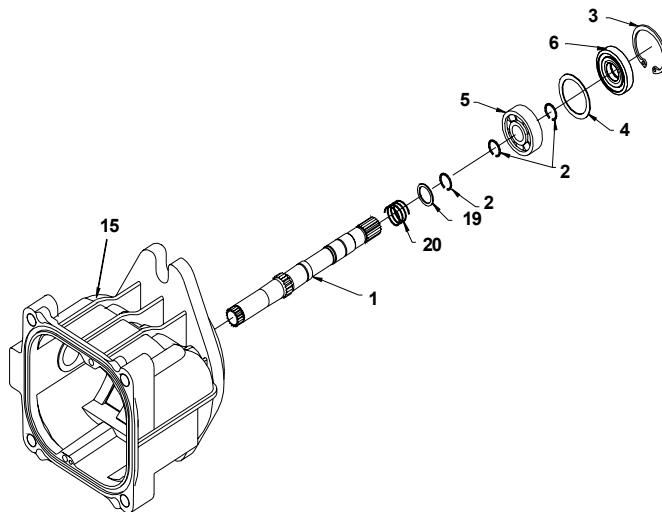


Figure 32. BDP-16A/21L

REMOVAL, INSPECTION TRUNNION ARM BDP-10A/16A

Refer to Figure 33.

Disassembly BDP-10A/16A

1. Remove and discard the trunnion seal retainer and seal (49/12).
2. Remove the slot guide (38/14).
3. Remove the trunnion arm (37/13).

Inspection BDP-10A/16A

1. Inspect the trunnion arm (37/13) for wear or damage. Replace the trunnion arm if necessary.

Assembly BDP-10A/16A

1. Install the trunnion arm (37/13) into the housing (1/15) bore. Rotate the trunnion arm to insure free movement.
2. Install a new seal and seal retainer.
3. To completely reassemble the pump, refer to the assembly steps on pages 19-33. Begin with the trunnion arm assembly steps listed on page 33 and complete the assembly steps in reverse order working towards the front of the manual.

Note: Upon removal, it is recommended that all seals, O-rings, and gaskets be replaced. During installation, lightly lubricate all seals, O-rings and gaskets with clean petroleum jelly prior to assembly. Also protect the inner diameter of seals by covering the shaft with plastic wrap. Remove the plastic wrap after the seal is installed.

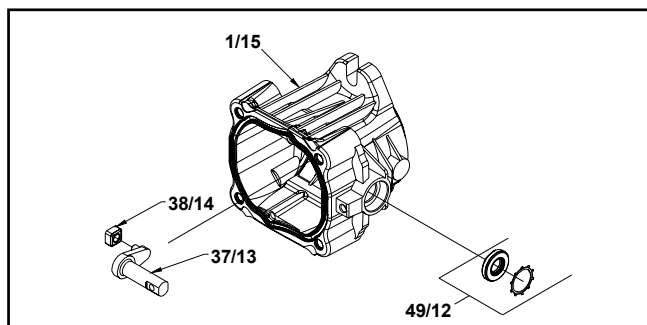


Figure 33. BDP-10A/16A

REMOVAL, INSPECTION TRUNNION ARM BDP-21L

Refer to Figure 34.

Disassembly BDP-21L

1. Remove trunnion seal retainer (10) and seal (12).
2. Remove slot guide (14).
3. Remove trunnion arm (13).

Inspection BDP-21L

1. Inspect the trunnion arm (13) for wear or damage. Replace trunnion if necessary.

Assembly BDP-21L

1. Install the trunnion arm (13) into the housing (15) bore. Rotate the trunnion arm to insure free movement.
2. Install a new seal and seal retainer.
3. To completely reassemble the pump, refer to the assembly steps on pages 19-33. Begin with the trunnion arm assembly steps listed on page 33 and complete the assembly steps in reverse order working towards the front of the manual.

Note: Upon removal, it is recommended that all seals, O-rings, and gaskets be replaced. During installation, lightly lubricate all seals, O-rings and gaskets with clean petroleum jelly prior to assembly. Also protect the inner diameter of seals by covering the shaft with plastic wrap. Remove the plastic wrap after the seal is installed.

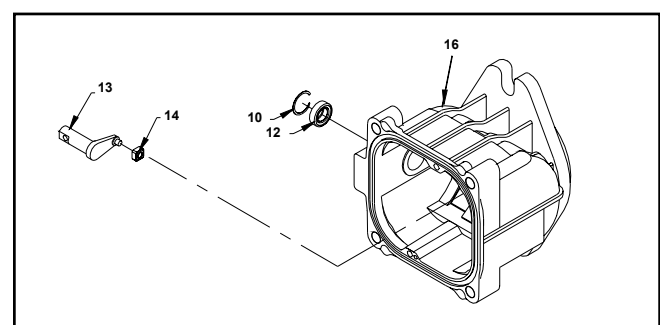
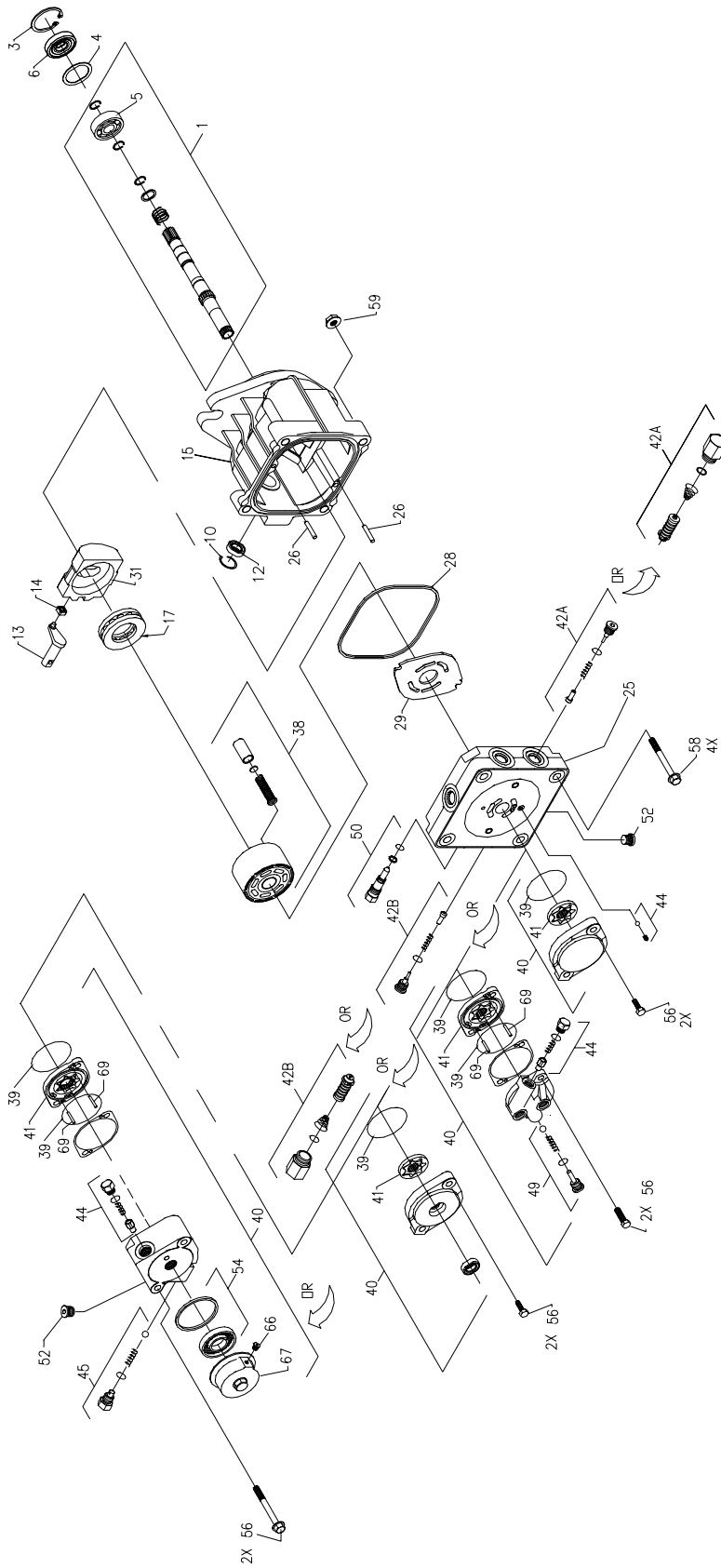


Figure 34. BDP-21L

NOTES

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BDP-21L



85 - Overhaul Seal Kit

BRACKETS INDICATE ITEMS INCLUDED IN KITS.
ITEMS IN KITS CANNOT BE ORDERED SEPARATELY.

Figure 35. BDP-21L

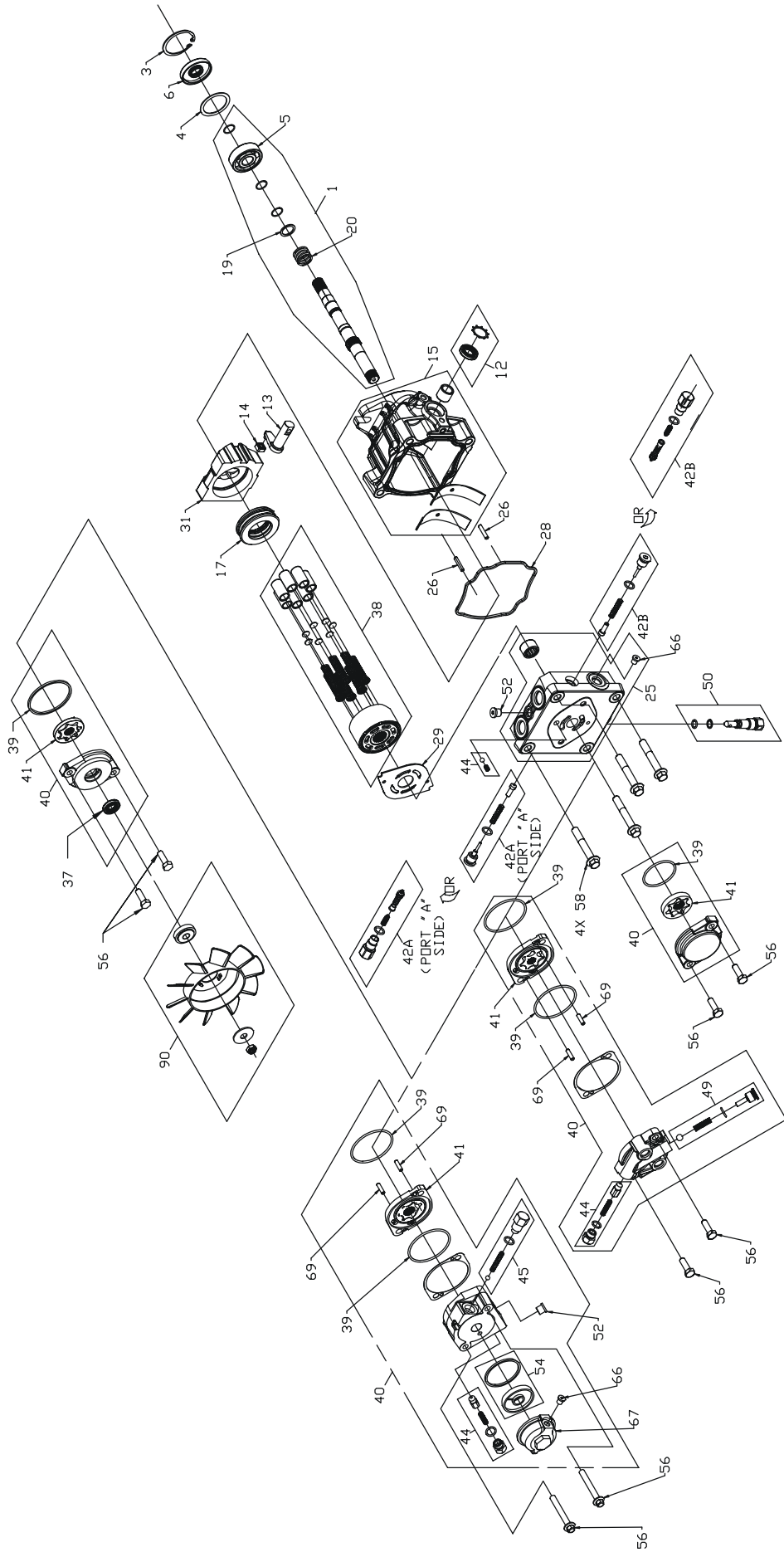
ITEMS LIST BDP-21L

Part numbers are not provided in this manual. See microfiche or CD for part numbers.

No.	Description	No.	Description
1	Kit Pump Shaft (19T spline)	41	Gerotor Assembly (0.19 in ³ /rev)
	Kit Pump Shaft (closed key)		Aux Gerotor & HSG Assembly (0.19 in ³ /rev)
	Kit Pump Shaft (thru shaft spline)		Gerotor Assembly (0.13 in ³ /rev)
	Kit Pump Shaft (tapered thru shaft)	42	Check Valve Kit (0.031")
	Kit Pump Shaft (shaft - thru pump)		Check Valve Kit (0.044")
	Retaining Ring		Check Valve Kit (blank)
4	Spacer		System Check/Relief Kit
5	Shaft Ball Bearing	44	Charge Relief Kit (w/ 1/2" SAE valve plug, 40-70 psi)
6	Lip Seal 17 x 47 x 8 PTCN1		Charge Relief Kit (w/ 1/2" SAE valve plug, 135-165 psi)
10	Trunion Seal Retaining Ring		Charge Relief Kit (w/ 9/16" SAE valve plug)
12	Lip Seal 15 x 27 x 7		Charge Relief Kit (w/ 9/16" SAE valve plug, 75-105 psi)
13	Trunnion Arm		Charge Relief Kit (7/32" plastic ball & spring)
14	Slot Guide		Charge Relief Kit (1/4" plastic ball & spring)
15	Housing Kit	45	Aux Relief Valve Kit
17	Thrust Ball Bearing Assembly	49	Aux Bypass/Check Kit
19	Block Thrust Washer	50	Bypass Valve Kit (blank)
20	Block Spring		Bypass Valve Kit (0.031")
25	Endcap Kit (w/poppets)	54	Auxiliary Filter Kit
	End Cap Kit (w/ poppets, .078" cooling orifice)	56	Hex Screw, 5/16-18 x 1.0
	End Cap Kit (w/SCR'S)		Hex Hd Cap Screw, 5/16-18 x 1.38
	End Cap Kit (Aux w/ poppets)		Flange Hd Screw, 5/16-18 x 2.5
	End Cap Kit (Aux w/ SCR's)	58	Hex Screw, Flanged Head
	End Cap Kit (Aux w/LH:SCR and RH:poppet)	59	Hex Flange Nut
	End Cap Kit (w/LH: poppet and RH:SCR)	69	Pin
26	Pin	85	Overhaul Seal Kit
28	O-Ring		
29	Valve Plate		
31	Variable Swashplate		
38	Cylinder Block Kit		
39	O-Ring		
	R-Ring (-144)		
40	Charge Pump Kit (0.19 std splined)		
	Charge Pump Kit (0.13 std splined)		
	Charge Pump Kit (0.13 std thru shaft)		
	Charge Pump Kit (0.13 std spline, clear zinc cover)		
	Charge Pump Kit (CW - splined Aux, 40-70 psi)		
	Charge Pump Kit (CW - splined Aux, 135-165 psi)		
	Charge Pump Kit (CCW - splined Aux, 40-70 psi)		
	Charge Pump Kit (AL Aux, 7/16 SAE port, 40-70 psi)		
	Charge Pump Kit (AL Aux, 7/16 SAE port, 75-105 psi)		

Table 7. BDP-21L

BDP-16A



99 - OVERHAUL SEAL KIT

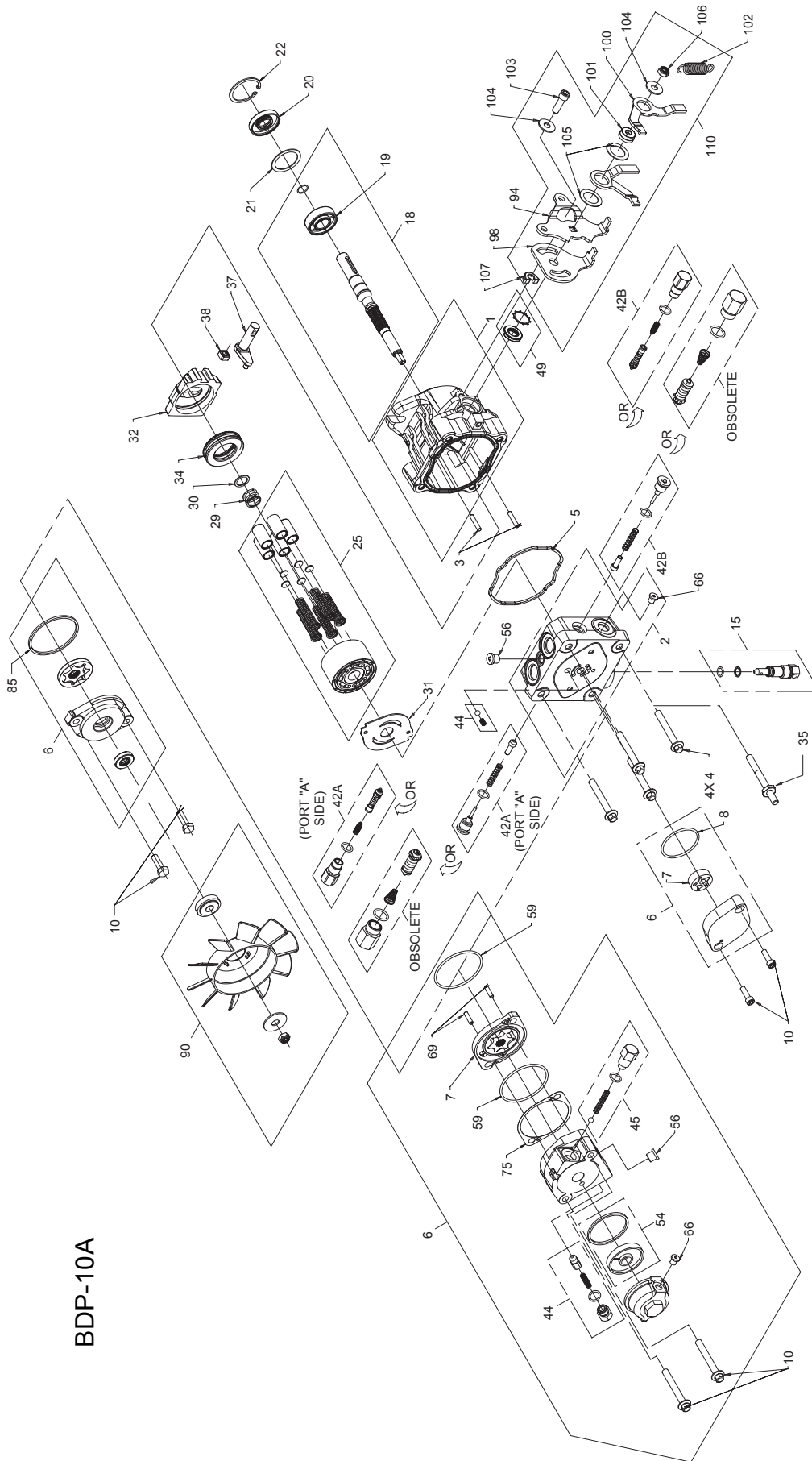
Figure 36. BDP-16A

ITEMS LIST BDP-16A

Part numbers are not provided in this manual. See microfiche or CD for part numbers.

No.	Description	No.	Description
1	Pump Shaft Kit (19T spline)	41	Gerotor Assembly (.13 cu.in./rev)
	Pump Shaft Kit (17mm keyed)		Gerotor Assembly (.19 cu.in./rev.)
	Pump Shaft Kit (17mm keyed thru taper)		Aux Gerotor & Hsg Assembly (0.19 cu.in./rev.)
	Pump Shaft Kit (double tapered thru shaft)	42	Check Valve Kit (blank orifice)
3	Retaining Ring		Check Valve Kit (.024" orifice)
4	Spacer		Check Valve Kit (.031" orifice)
5	Shaft Ball Bearing		Check Valve Kit (.044" orifice)
6	Lip Seal 17 x 47 x 8 PTCN1		Shock Valve Kit (blank orifice)
12	Trunnion Seal Kit		Shock Valve Kit (.024" orifice)
13	Trunnion Arm		Shock Valve Kit (.031" orifice)
14	Slot Guide		Shock Valve Kit (.044" orifice)
15	Housing Kit	44	Charge Relief Kit (1/4" plastic ball & spring)
17	Thrust Ball Bearing Assembly		Charge Relief Kit (1/4" plastic ball & spring)
19	Block Thrust Washer		Charge Relief Kit (w/ 9/16" SAE valve plug, 40-70 psi)
20	Block Spring		Charge Relief Kit (w/ 9/16" SAE valve plug, 75-105 psi)
25	End Cap Kit (w/poppets & std chg)		Charge Relief Kit (w/ 1/2" SAE valve plug, 40-70 psi)
	End Cap Kit (w/poppets & aux chg)		Charge Relief Kit (w/ 1/2" SAE valve plug, 135-165 psi)
26	Pin	45	Aux Relief Valve Kit
28	O-Ring	49	Aux Bypass/Check Kit
29	Valve Plate	50	Bypass Valve Kit (blank orifice)
31	Variable Swashplate		Bypass Valve Kit (.031" orifice)
38	Cylinder Block Kit (16cc)		Bypass Valve Kit (.043" orifice)
39	O-Ring	54	Auxiliary Filter Kit
	R-Ring (-144)	56	Socket Hd Cap Screw (M8 x 1.25-25mm)
40	Charge Pump Kit (.19 std splined)		Flange Hd Screw (5/16-18 x 2.5)
	Charge Pump Kit (.13 std thru shaft)	58	Hex Screw, Flanged Hd (M10 x1.50-65mm)
	Charge Pump Kit (CW-Iron Aux, 40-70 psi, .001" shim)	69	Dowel Pin
	Charge Pump Kit (CW-Iron Aux, 135-165 psi, .001" shim)	99	Overhaul Seal Kit
	Charge Pump Kit (CCW-Iron Aux, 40-70 psi, .001" shim)		
	Charge Pump Kit (Al Aux, 7/16 SAE port, 40-70 psi, .001" shim)		
	Charge Pump Kit (Al Aux 7/16 SAE port, 75-105 psi, .001" shim)		

Table 8. BDP-16A



BDP-10A

100 - Overhaul Seal Kit

BOXES INDICATE ITEMS INCLUDED IN KITS.
 ITEMS IN KITS CANNOT BE ORDERED SEPARATELY.

Figure 37. BDP-10A

ITEMS LIST BDP-10A

Part numbers are not provided in this manual. See microfiche or parts manual for part numbers.

No.	Description	No.	Description
1	Housing Kit	34	Ball Thrust Bearing
2	End Cap Kit (W/ Poppets, Standard Charge)	35	Stud, Torque
	End Cap Kit (W/ SCR'S, Standard Charge)	37	Trunnion Arm
	End Cap Kit (W/ Poppets, Auxiliary Charge)		Trunnion, RTN
	End Cap Kit (W/ SCR'S & Auxiliary Charge)	38	Slot Guide
	End Cap Kit (STD CHG) LH:SCR / RH:Poppet	42	Check Valve Kit (Blank Orifice)
	End Cap Kit (STD CHG) LH:Poppet / RH:SCR		Check Valve Kit (0.024"Orifice)
	End Cap Kit (AUX CHG) LH:SCR / RH:Poppet		Check Valve Kit (0.031"Orifice)
	End Cap Kit (AUX CHG) LH:Poppet / RH:SCR		Check Valve Kit (0.044"Orifice)
	End Cap Kit (STD CHG) LH:SCR / RH:Poppet,Thru		System Check / Relief Kit
	End Cap Kit (STD CHG) W/Poppets, Thru		System Check Relief Kit
	End Cap Kit (STD CHG) W/SCR's, Thru		(.031" Orifice)
	End Cap Kit (STD CHG) LH:Poppet/ RH:SCR,Thru		Shock Valve Kit
3	Straight Headless Pin	44	Charge Relief Valve Kit (1/4"
4	Hex Flange Bolt M8-1.25 X 60mm LG		Plastic Ball & 50654 Spring)
5	Housing O-Ring		Charge Relief Valve Kit (9/16"
6	Charge Pump Kit (STD)		SAE Plug & 3101536 Spring)
	Charge Pump Kit (STD CHG), Thru	45	Aux Relief Valve Kit (1/4" Steel
	Aux Pump Kit (AL., 15T Splined, 2-7/16 SAE Ports)		Ball)
	Aux Pump kit (AL., 15T Splined, 3-7/16 SAE Ports)		Aux Relief Valve Kit (Aux
7	STD Gerotor Assy (.11 cu. In/rev D-Drive)		Poppet)
	Auxiliary Gerotor & Housing Assembly	49	Trunnion Seal/ Retainer Kit
8	O-Ring	54	Auxiliary Filter Kit
10	Socket Head Screw M6 x 1.0-20mm Lg (STD Chg)	56	Straight Thread Plug
	Hex Flange Bolt 8M-1.25 x 60mm (Aux Chg)	59	O-Ring
	Cap Screw, Hex 5/16-18 x 1.00 (Thru Chg) Supplied	66	5/16" SAE Plug
	with item #2 only	67	Filter Cover
15	Bypass Valve Kit (Blank)	69	Straight Headless Pin
	Bypass Valve Kit (0.031")	75	Shim - Charge Pump (.002-
	Bypass Valve Kit (0.043")		Red)
18	Pump Shaft Kit (Blind 15mm Keyway W/ Std Chg)	85	R-Ring -144
	Pump Shaft Kit (Blind 15mm Keyway W/Aux Chg)	90	Hub / 6" Fan Kit
	Pump Shaft Kit (9 Tooth W/Std Chg)		Hub / 7" CCW Fan Kit
	Pump Shaft Kit (9 Tooth W/Aux Chg)		Hub / 7" CW Fan Kit
	Pump Shaft Kit (15mm Keyed, Std Chg, Thru)		Hub / 7" Fan Kit
	Pump Shaft Kit (9 tooth Thru Chg)	100	Overhaul Seal Kit
	Pump Shaft Kit (Tapered)	101	Spacer RTN
19	Ball Bearing 17 x 40 x 12	102	Spring, Extension
20	Lip Seal 17 x 40 x 7 PTC	103	Screw, 5/16 x .875 (patch)
21	Spacer	104	Washer .34 x .88 x .06
22	Retaining Ring	105	Washer, Nylon
25	Cylinder Block Kit	106	Nut, Hex Lock 5/16-24 UNF
29	Block Spring	107	Spacer
30	Block Thrust Washer	110	Kit, RTN, STD
31	Valve Plate (Steel N-Tec:Black)		Kit, RTN, CW
32	Swashplate		Kit, RTN, CCW

Table 9. BDP-10A

GLOSSARY OF TERMS

Axial Piston: Type of design for hydraulic motors and pumps in which the pistons are arranged parallel with the spindle (input or output shaft).

Bantam Duty: A descriptive term relating to the product capacity (meaning: light duty).

Bypass Valve: A valve whose primary function is to open a path for the fluid to bypass the motor or pump. Also referred to occasionally as the freewheel valve or dump valve.

Case Drain Line (Return Line): A line returning fluid from the component housing to the reservoir.

Cavitation: A phenomenon of boiling in a flowing liquid at normal temperatures, as a result of low pressure condition. The gas liberated from the fluid implodes rapidly and damages pump components.

Center Section: A device which acts as the valve body and manifold of the transmission.

Charge Pump: A device which supplies replenishing fluid to the fluid power system (closed loop).

Charge Pressure: The pressure at which replenishing fluid is forced into a fluid power system.

Charge Relief Valve: A pressure control valve whose primary function is to limit pressure in the charge circuit.

Check Valve: A valve whose primary function is to restrict flow in one direction.

Closed Loop: A sealed and uninterrupted circulating path for fluid flow from the pump to the motor and back.

Decay Rate: The ratio of pressure decay over time.

End Cap: See “Center Section”

Entrained Air: A mechanically generated mixture of air bubbles having a tendency to separate from the liquid phase.

Gerotor: A fixed displacement pump frequently used as a charge pump.

Hydraulic Motor: A device which converts hydraulic fluid pressure and flow into mechanical force and motion.

Hydraulic Pump: A device which converts mechanical force and motion into hydraulic fluid pressure and flow.

Hydrostatic Motor: See “Hydraulic Motor”

Hydrostatic Pump: See “Hydraulic Pump”

Hydrostatic Transaxle: A multicomponent assembly including a gear case and a hydrostatic transmission.

Hydrostatic Transmission: The combination of a hydraulic pump and motor in one housing to form a device for the control and transfer of power.

Inlet Line: A supply line to the pump.

Integrated Hydrostatic Transaxle (IHT): The combination of a hydrostatic transmission and gear case in one housing to form a complete transaxle.

Manifold: A conductor which provides multiple connection ports.

Neutral: Typically described as a condition in which fluid flow and system pressure is below that which is required to turn the output shaft of the motor.

Pressure Decay: A falling pressure.

Priming: The filling of the charge circuit and closed loop of the fluid power system during start up, frequently achieved by pressurizing the fluid in the inlet line.

Purging: The act of replacing air with fluid in a fluid power system.

Rated Flow: The maximum flow that the power supply system.

Scoring: Scratches in the direction of motion of mechanical parts caused by abrasive contaminants.

Swash Plate: A mechanical device used to control the displacement of the pump pistons in a fluid power system.

System Charge Check Valve: A valve controlling the replenishing flow of fluid from a charge circuit to the closed loop in a fluid power system.

System Pressure: The pressure which overcomes the total resistance in a system, including all efficiency losses.

Valve: A device which controls fluid flow direction, pressure, or flow rate.

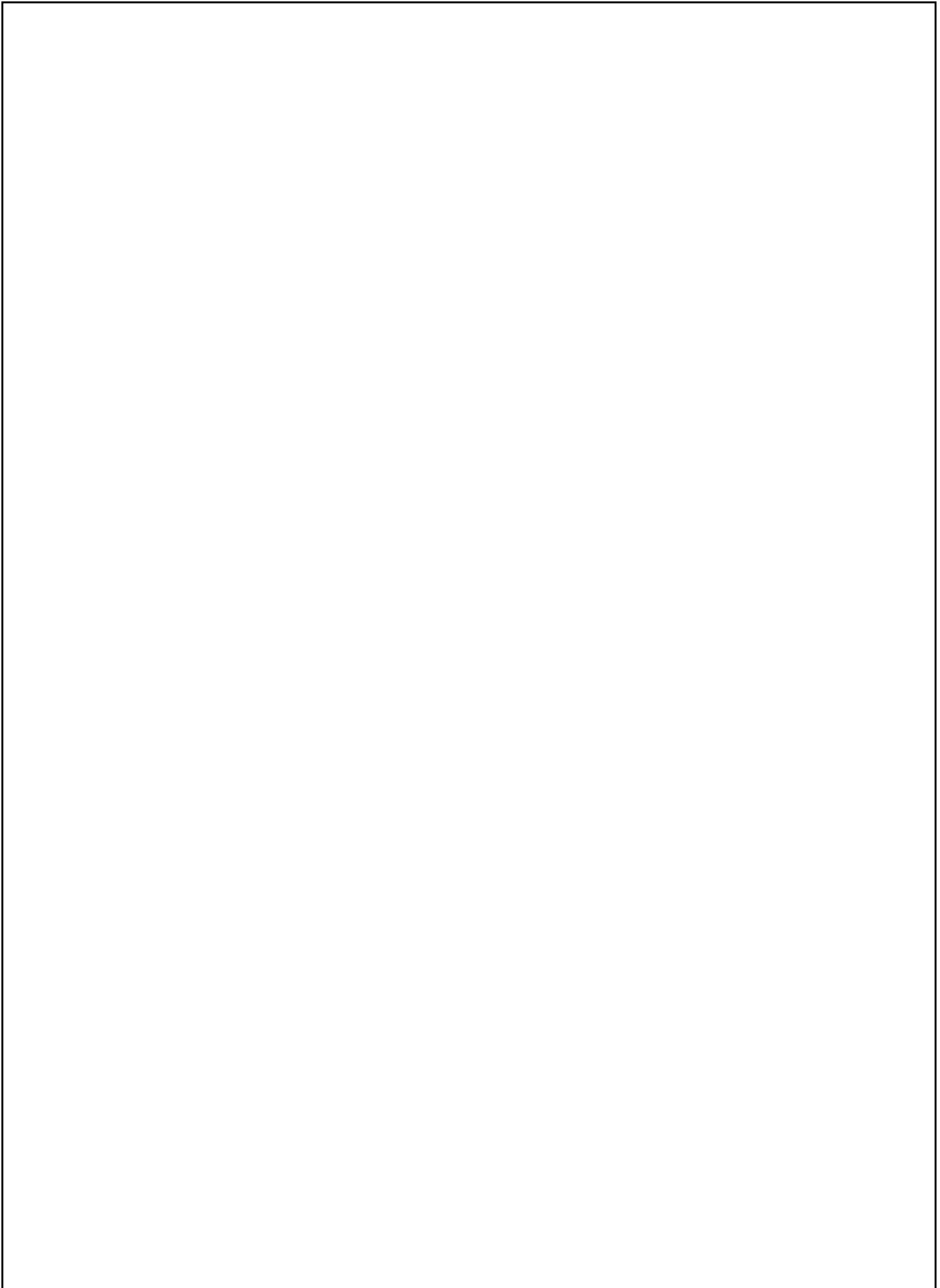
Variable Displacement Pump: A pump in which the displacement per revolution can be varied.

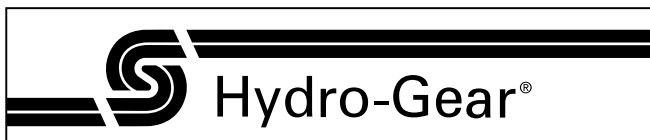
Volumetric Displacement: The fluid volume for one revolution.

NOTES

A large empty rectangular box intended for taking notes.

NOTES





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