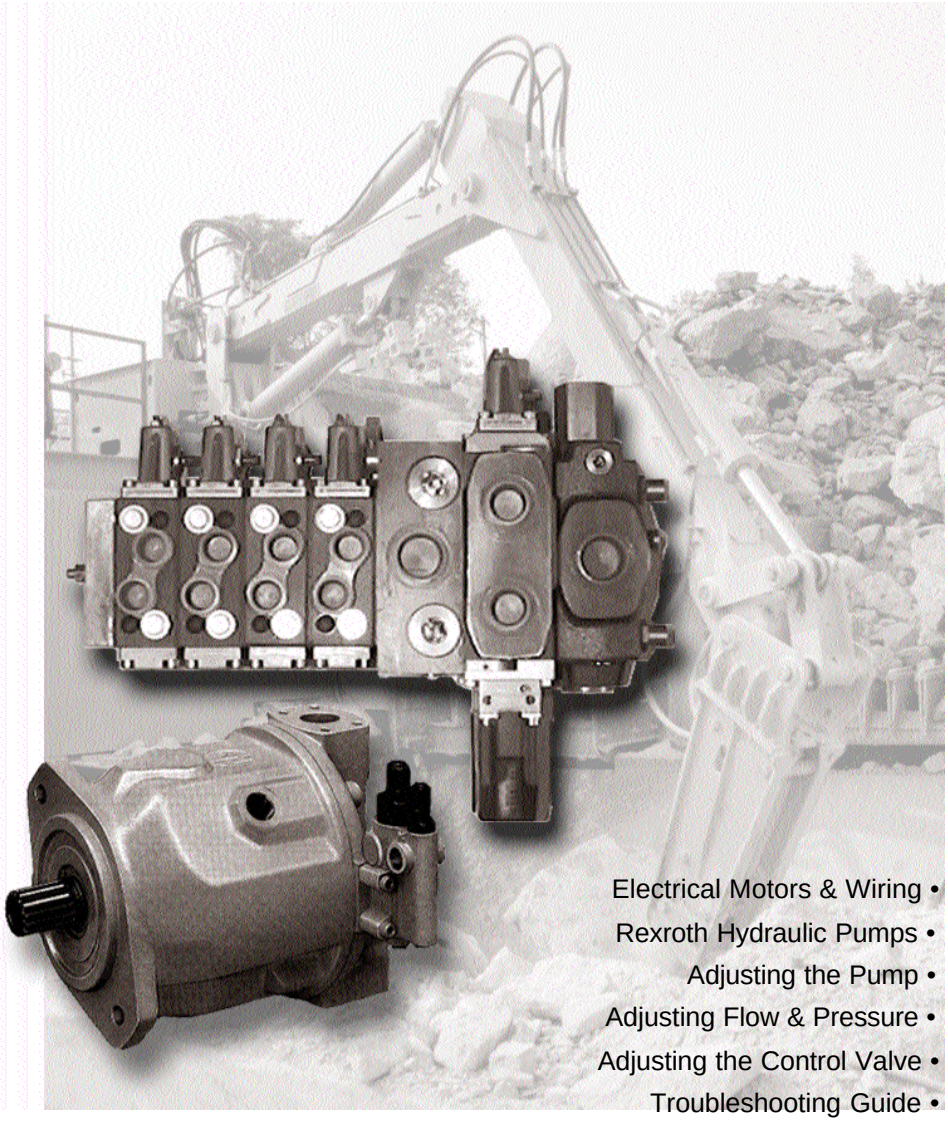
TESTING & ADJUSTING HYDRAULIC PUMPS & CONTROL VALVES

BTI ROCKBREAKER SYSTEMS

BREAKER TECHNOLOGY



- Electrical Motors & Wiring •
- Rexroth Hydraulic Pumps •
- Adjusting the Pump •
- Adjusting Flow & Pressure •
- Adjusting the Control Valve •
- Troubleshooting Guide •
- Formulas & Data •
- Pump Specifications •

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ISO 9001

This section of the installation manual deals with the set up and adjustment procedure for both the Rexroth A11 pump and Danfoss valve, and it gives a general description on the principle of operation of the pump and control valves and is intended to give the Mechanic a better understanding of the importance of the various adjustments and their effect on the system. A trouble shooting guide is also included at the end of this manual.

The model of pump, control valve and electric motors may vary depending on the boom system, however, their installation and adjustment procedures remain much the same. Following the steps in the order as listed in the manual will save you time and possible rework.

1) Install the power pack so that the warm air blown out by the motors will not enter the motors again. The minimum distance between the wall and the inlet should be approximately a quarter of the inlet opening diameter.

2) The electrical wiring of the power pack must be undertaken only by a qualified electrician. Both electric motors used on the hydraulic pump and cooling fan should be wired in a three phase delta configuration to provide optimum power unless stated otherwise.

3) Make sure to use the correct cable specifications, based on the rated current stamped on the name plate. In high altitude applications the motor may be derated.

4) Before energizing the motors make certain the grounding complies with the recommended standards. Also ensure the hydraulic tank is full and the pump has been cleared of all air locks.

5) The electrician must ensure the direction of rotation of the motors are correct. If the direction of rotation is reversed the hydraulic pump will be seriously damaged in a very short period of time. Jog the motor to verify the direction of rotation.

6) The motors must start up and run smoothly in the correct direction. In case this does not occur, turn it off immediately and check the connections before re-starting.

7) Run the motor and check the current at the rated full load*. Compare the power generated hydraulically to that dissipated in the electric motor and then check it against the maximum current rating stamped on the name plate of the electric motor. The equation to determine the power available in the hydraulic system is as follows:

HORSE POWER = [FLOW (GPM) x PRESSURE (PSI)] / [1714 x efficiency]

And the power consumed by the electric motor is:

HORSE POWER = 1.73 x LINE VOLTAGE x LINE CURRENT x COS Ø ÷ 746

Take cos Ø to be 0.8 and pump efficiency at 93%

8) Grease the motor preferably while it is rotating, and as specified by the manufacturer. Avoid over greasing as this will seriously damage the motor. Manufacturer's instructions are shipped with the motor.

* Rated full load : This condition is achieved when the hydraulic pump is delivering the ***full flow*** at the ***maximum system pressure***. Use a flow meter on the breaker circuit to perform this test.

This type of pump is capable of delivering both the required oil flow and pressure depending on the systems demand. The pump will de-stroke and draw very little power from the electric motor when none of the hydraulic actuators are in use; this type of pump is commonly referred to as a variable displacement hydraulic pump. Used with a control valve having load sensing features utilizes the load sensing capabilities of this pump.

Load Sensing

The load sensing pump is commonly used in the implement and steering systems of mobile equipment. It is also exclusively used in all stationary boom systems. The pump can be set to run at a pre-set standby pressure. The pump will, on demand, supply the required pressure.

Testing and Adjusting Procedure.

There are four external adjusting screws provided to control the operating flow and pressure of the pump.
Maximum Flow - mechanical stop.
Minimum Flow - mechanical stop.
Maximum Pressure - hydraulic spool.
Standby Pressure - hydraulic spool.

Maximum Flow

This controls the maximum flow the pump will deliver. It is a mechanical stop which limits the maximum angle the swash plate is permitted to incline. The screw is used during initial set up of the pump to adjust the maximum flow at a given pressure.

Minimum Flow (Do Not Adjust)

This control the minimum angle the swash plate is permitted to incline. This adjustment is factory set and should only be readjusted by qualified personnel.

Maximum Pressure (Unloading) Valve

This is a externally mounted hydraulic spool which determines the system’s cutoff pressure.

Standby Pressure (Load Sensing) Valve

This adjustment controls the pump standby pressure. A piston and cylinder arrangement within the pump uses the pressure drop from this valve to de-stroke the swash plate against a spring applied force. A typical setting for this would be 450 psi. The pump will then de-stroke and draw very little power from the drive motor. A load sense signal amplifier may be used on the load sensing line to ensure a strong signal. This greatly reduces the pressure drop in the system when there is a sudden demand for oil flow.

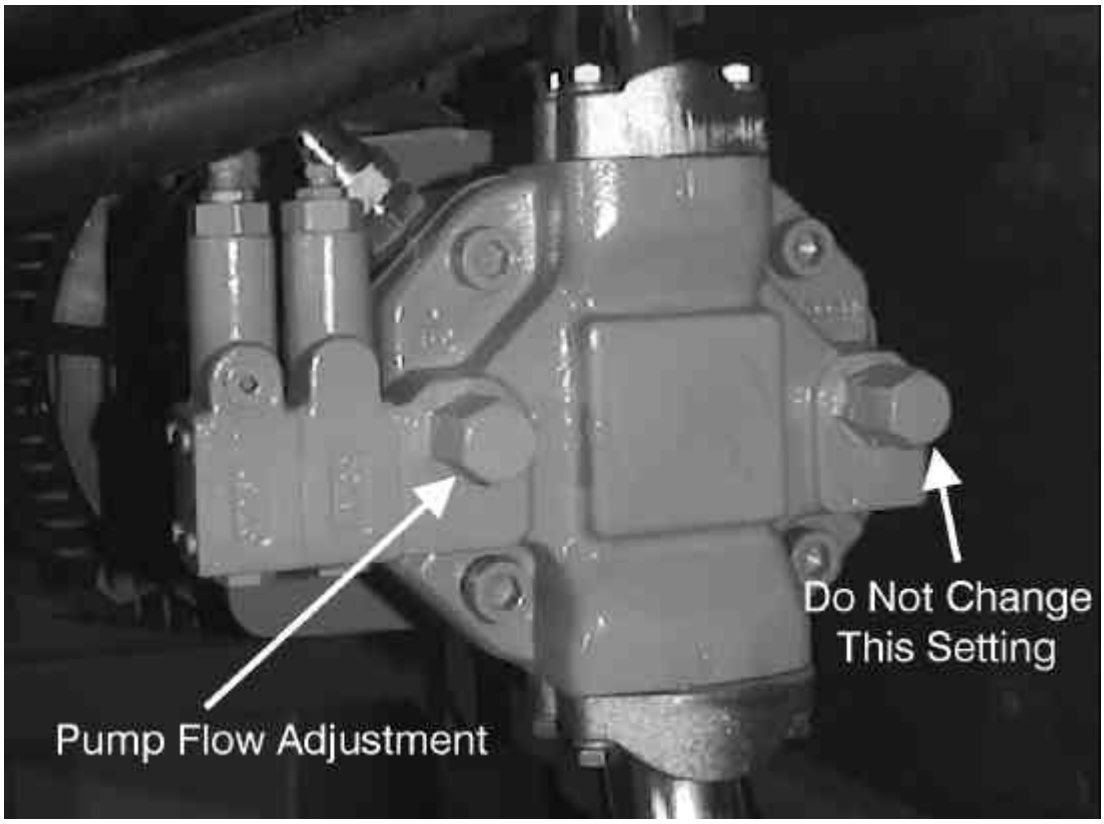

Fig. 1

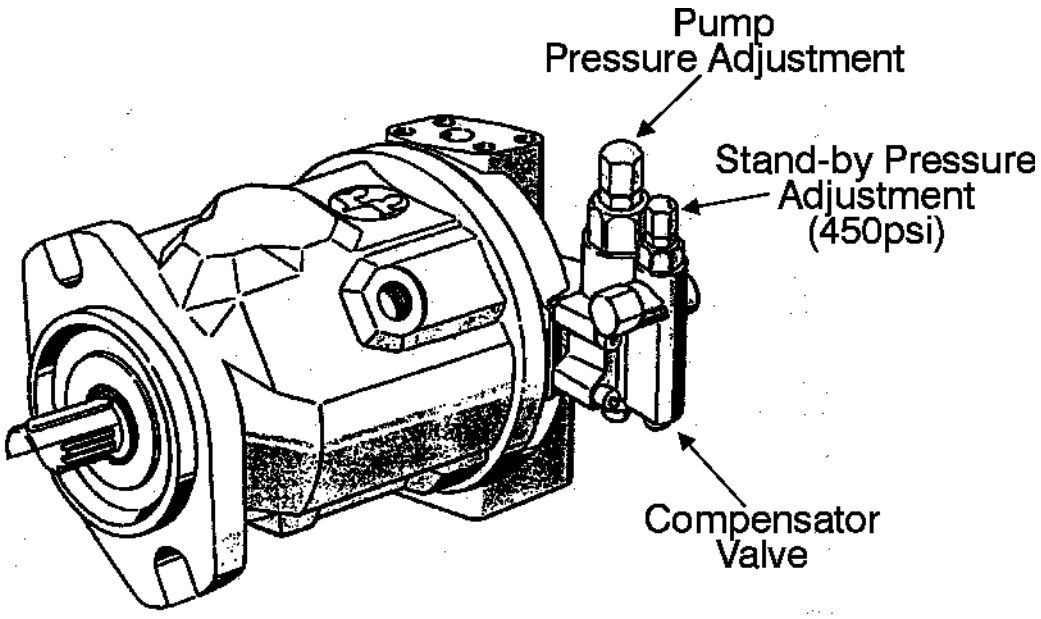

Fig. 2

Typical Rexroth Pump

BLEEDING THE HYDRAULIC PUMP

Fill the hydraulic tank with the recommended oil. Slacken the case drain line at the pump and release any air that may be trapped. The head of oil in the hydraulic tank will help to push the air through. Once a clean flow of oil passes through the case drain port of the pump, tighten the hose and wipe up any oil that has spilled.

TOOLS REQUIRED

Pressure Gauge (1000453) - *Supplied in Tool kit*
Hydraulic Flow Meter with Pressure Gauge- *Not supplied*
Hexagon keys (3 - 8 mm)- *Not supplied*
Combination Wrenches (8 to 28 mm)- *Not supplied*
Main Relief Adjustment Tool (V9000-10, PVG 120/32 Only)- *Not supplied*

Ensure the flow meter meets the maximum flow rate and pressure of the hydraulic pump or the meter will be damaged!

The hydraulic pump has three adjustments which must be checked and set to the required specification as called for in breaker service manual. The system standby pressure must be also set to 450 PSI.
At this stage it is assumed that all hydraulic lines have been connected as illustrated in the installation manual for the boom system, the hydraulic tank has been filled with the recommended oil, the pump bled of all air locks and the wiring to the entire electrical system is completed.

ADJUSTING THE PUMP STANDBY PRESSURE

1) Connect the 1000453 pressure gauge to the Danfoss control valve main pressure port; (P) on a PVG 32 valve and (MA) on a PVG 120/32 (See Figure 3).
2) Start the hydraulic pump and observe the reading on the gauge. The pressure should be adjusted to 450 PSI.
3) The adjustment for the standby pressure is done through the compensator valve which is mounted on the hydraulic pump. Remove the cap (if fitted), loosen the lock nut and turn the adjustment screw until the standby pressure is 450 psi at the main pressure port on the Danfoss valve.
4) Turning the screw clockwise increases pressure while turning counter-clockwise decreases the pressure.
5) Hold the adjustment screw in place and tighten the locknut.
6) Check standby pressure gauge again to verify the reading.

Note:
The main relief pressure on the Danfoss valve must be set at this point. Refer to page 8. The pump pressure adjustment setting determines the maximum pressure the pump can reach. Therefore this setting must be higher than 450psi before the standby pressure can be adjusted.

METHOD 'A': SETTING THE PUMP USING A FLOW METER

1) Connect the flow meter to the two hydraulic lines of the breaker. Make sure the pressure line is connected to the inlet port and the return to the outlet port of the flow meter. ***Wrong connections may damage the flow meter!***
2) With the pump operating activate the breaker fire button.
3) Slowly close the restrictor valve on the flow meter. At a certain point the flow rate will drop off very rapidly. Take the flow and pressure readings just prior to this.
4) If the figures for the flow rate and /or pressure are not met as set out in the breaker service manual proceed to adjust as follows:

SYSTEM MAXIMUM PRESSURE ADJUSTMENT (Unloading)

The adjustment for this is on the pressure compensator mounted on the hydraulic pump. The pressure will increase when the screw is turned in and decrease when turned out. Adjust the pressure as set out in the boom or vehicle service manual. On completion, lock the adjusting screw and replace the protective cover.

PUMP FLOW ADJUSTMENT

The rate of discharge from the pump is controlled by the angle the swash plate is permitted to incline. This maximum angle is limited by the length of the adjusting screw. Turning the screw out, increases the flow rate. Turning it in, reduces the flow. Due to the opposing spring forces of the rotary group the swash plate will not follow the adjustment screw when the pump is not rotating. Therefore, the adjustment must be done with the pump delivering close to the maximum flow, in a no load situation. To adjust, remove the protective cap, loosen the lock nut and turn the hex screw until the pump is delivering the correct flow at the specified pressure. See page 13 for adjustment per revolution of stroke limiter.

METHOD 'B': SETTING THE PUMP UNLOADING WITHOUT A FLOW METER

In the event a flow meter is not available the pump unloading pressure can be set using the 1000453 Pressure Gauge. The pump flow set at the factory is approximate and will generally function within acceptable limits.
1) Connect the Pressure Gauge (p/n 1000453) to the pressure port ("P" on PVG32 and "MA" on PVG120/32).
2) Pull the breaker fire lever to fully open position.
3) Note the pressure reading on the Pressure Gauge.
4) Adjust the pump unloading pressure (max press) as specified in the hydraulic schematic.
see *System Maximum Pressure Adjustment,* above.

The Danfoss Control valve is built up of individual sections and each section has four adjustments. Two of these control load sensing pressure to their respective ports, while the other two control the flow rate. The installation manual for the boom system sets out the required pressure for each circuit. The flow rate governs the speed at which the various hydraulic cylinders extend and retract and is generally set to suit the operator and the application for which the boom system is used. Flow & Pressure adjustments are covered on page 9. All adjustments are done with the hydraulic pump in operation and the respective control lever actuated.

ADJUSTMENT OF THE MAIN RELIEF VALVE (Figure 3 & 4)
The main relief valve is located on the main section of the Danfoss control valve and must be set to 200 PSI higher than the pump unloading pressure.

1) Connect the flow meter as described in page 7. Note: If no flow meter is available connect the 1000453 pressure gauge to the main pressure port, pull the breaker fire lever back on the control valve and omit step 3.
2) Turn in the main relief valve in three full turns.
3) Fully close the flow restrictor valve on the flow meter.
4) Adjust the maximum pump pressure to 300 PSI greater than specified in the hydraulic schematic. (refer to page 7 for pressure adjustment).
5) With the breaker circuit activated, back off the main relief valve until the circuit pressure drops to 200 PSI higher than the specified pump unloading pressure.
6) Return to page 7 and adjust hydraulic oil flow and pressure to the breaker circuit.

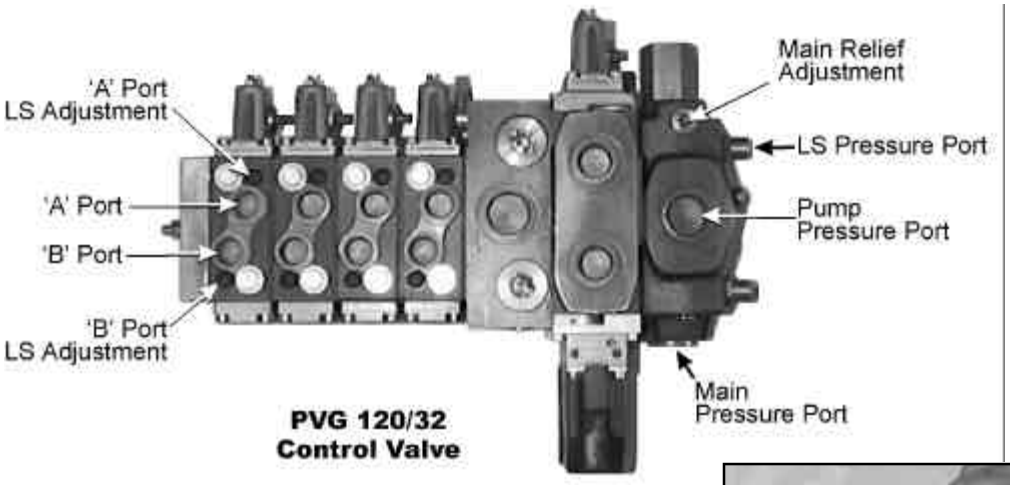

Figure 3

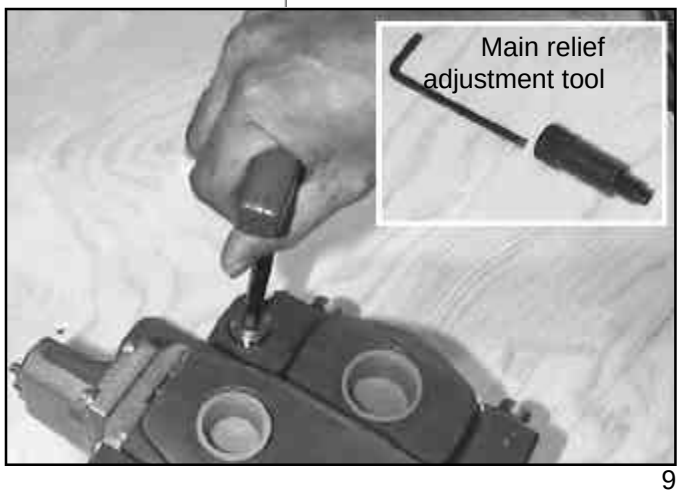

Figure 4

PORT PRESSURE ADJUSTMENT (Fig. 5).

1) Connect the 1000453 pressure gauge to the circuit pressure port (stamped 'LS') as shown.
2) Pry out the rubber plugs over the adjusting screws.
3) Move the hydraulic cylinder in the circuit being adjusted to its full stroke.
4) Hold the valve open and make the adjustment to the circuit using a 6 mm Allan wrench (8mm on PVG120/32 Valves). Turning the screw in increases this pressure while turning it out will reduce circuit pressure.
5) Replace the rubber plug over the adjusting screw.
6) Repeat the above procedure for all of the other hydraulic circuits with the exception of the breaker.

ADJUSTMENT OF THE BOOM DOWN PRESSURE CIRCUIT ON THE TT AND SX SERIES BOOMS

The SX and TT series booms require a special procedure to adjust the down pressure of the boom's hoist cylinders.
Fig (1) shows the pressure reducing valve and Anti blank fire switch. Fig (2) shows the pressure relief valve.

ADJUSTMENT PROCEDURE

1) Start by loosening the lock nut and fully turning in the adjustment on the pressure Relief valve.
2) Loosen the lock nut and fully decrease the pressure setting of the pressure reducing valve to a minimum setting.
3) Install a 1000 psi pressure gauge on the pressure Relief valve as shown in Fig(1)
4) Start the pump and lower the boom using the hoist down circuit. Adjust the pressure reducing valve to 325 psi with the use of the gauge while the boom down lever on the Danfoss valve is activated.
5) Disconnect the Hersman plug. Using an electrical Multi Meter across pin 1 & 3 and adjust the Anti Blank Fire switch to just close at this pressure of 325 PSI. Replace the Hershman plug.
6) Increase the setting of the pressure reducing valve to 600psi.
7) Adjust the pressure relief valve on the boom down circuit so that the gauge on the pressure reducing valve reads 475 PSI. Lock the adjustment.
8) Re adjust the pressure reducing valve so that the gauge reads 350PSI and lock the adjustment.

The adjustment procedure is now complete. Test the adjustment by firing the breaker. The breaker must fire only when Hoist down pressure is applied.

SPEED ADJUSTMENT (FLOW) (Fig 5A)

1) Loosen the lock nut on the adjusting screw.
2) Move the respective lever to its fully open position and turn the adjusting screw until the desired speed is obtained.
3) Hold adjustment screw in place and lock it using the lock nut.
4) Repeat the above procedure for all of the other circuits.
5) The adjustment for the breaker circuit should be set to the fully open position to permit maximum flow when the circuit is activated.

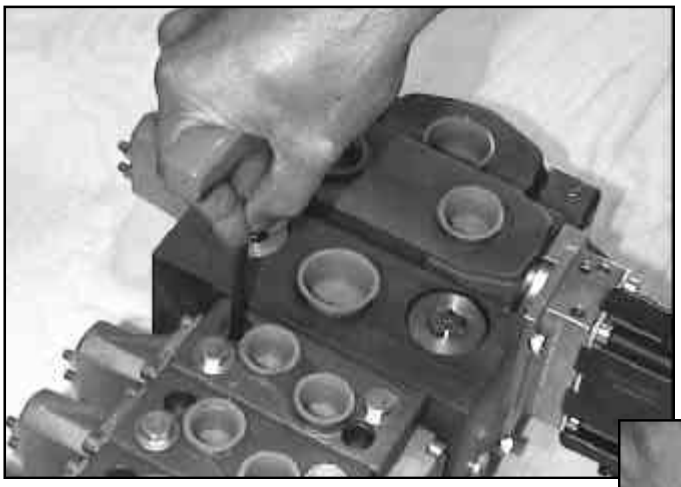

Figure 5

Figure 5A

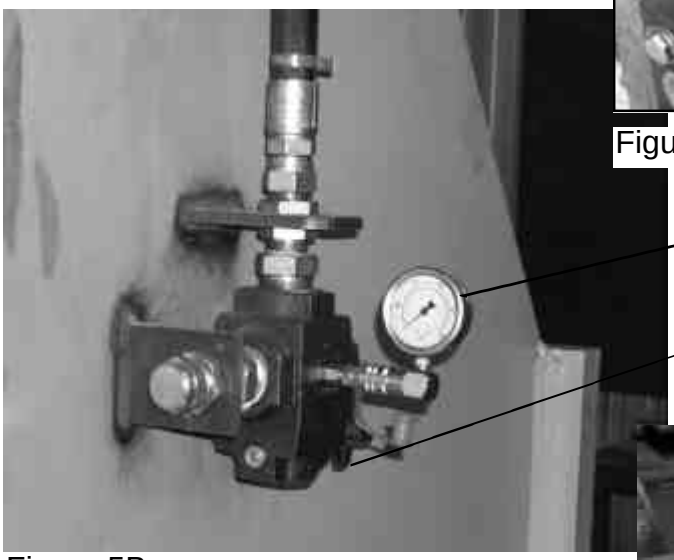

Figure 5B

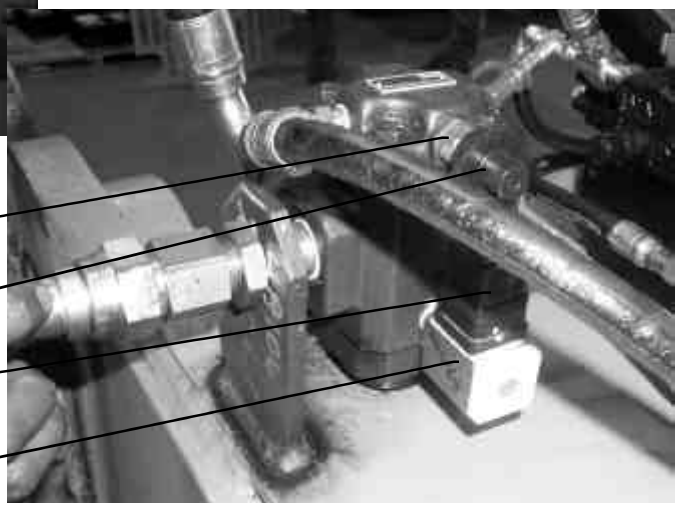

Figure 5C

TROUBLESHOOTING GUIDE

PROBLEM	POSSIBLE CAUSE	SOLUTION
Motor turns backwards.	Phase reversal.	Interchange any two phases.
Pump slows down or stalls on load.	Motor not wired in a three phase delta configuration. Low voltage supply. High unloading pressure.	Re-wire in Delta configuration. Check power source. Adjust unloading pressure.
Line current too high.	Wrong wiring configuration.	Re -wire motor.
Oil temperature too high.	Cooling fan not operational. Thermostat not activating at specified temp. Wrong plumbing on cooling system. Main Relief valve set too low.	Check sensor, wiring, & motor. Replace Thermostat. Re-plumb as per schematic. Adjust relief to specification.
Flow rate of pump below specification.	Wrong adjustment on SWASH plate. Wrong grade of oil. Worn pump. Pump speed too low. Sticky spools on Compensator valve.	Adjust pump. Re-fill with recommended oil. Replace pump. Check motor and wiring. Remove and clean spools.
Boom movement too slow.	Insufficient spool movement.	Adjust control lever stops.
Loud noise from pump.	Pump starving for oil.	Aeration or inlet restricted. Check inlet side of pump.
Long response time.	Low stand-by pressure. Amplifier valve incorrectly plumbed or damaged.	Adjust pressure to 450 PSI. Replace and re-plumb.
Slow hammer fire.	Low flow rate on hammer circuit. Contaminated hydraulic system.	Adjust flow on pump. Clean affected components.
Hammer lacks power.	Low Nitrogen pressure.	Charge accumulator.

REQUIRED FLOW RATE:

a) For cylinders:

$$\mathbf{GPM = \frac{A \times V}{231}}$$

A = area in (in²)
V = Velocity in (in/min.)

b) For motors:

$$\mathbf{GPM = \frac{D \times RPM}{231}}$$

D = displacement in (in³/rev)

VELOCITY OF FLOW THROUGH PIPES:

$$\mathbf{V = \frac{GPM \times 0.3208}{A}}$$

V = Velocity in feet per second
A = inside opening area in (in²)

REQUIRED PRESSURE:

a) Cylinders:

$$\mathbf{PSI = \frac{F}{A} \text{ or } F = PSI \times A}$$

F = force in (lbs)
A = Area in (in²)

b) Motors:

$$\mathbf{PSI = \frac{2\pi T}{D}}$$

T = torque in (lb - in.)
D = displacement (in³/rev)

PRESSURE DROP THRU PIPE:

$$\mathbf{P = \frac{V \times F}{18300\ D^4}}$$

P = pressure drop (psi/foot)
V = viscosity in SUS
D = inside diameter (in)
F = flow in GPM

HYDRAULIC HORSEPOWER:

a) $\mathbf{HP_T = \frac{GPM \times PSI}{1714}}$

HP_T = Theoretical HP

b) Input to pump:

$$\mathbf{HP_{in} = \frac{GPM \times PSI}{1714 \times (et)}}$$

e_T = overall pump efficiency

c) output of Hydraulic Motor:

$$\mathbf{HP_{out} = \frac{GPM \times PSI \times (et)}{1714}}$$

e_T = overall motor efficiency

HEAT GENERATION:

$$\mathbf{BTU/hr = 1.5 \times GPM \times PSI}$$

PSI=Pressure loss which does not produce work

HEAT RADIATION OF A HYDRAULIC RESERVOIR:

$$\mathbf{BTU/hr = 2.54\ (Av)\ (\Delta T)}$$

BTU/hr	=	Heat radiated
Av	=	Vertical tank area in contact with oil
ΔT	=	Desired oil temp minus ambient air temperature in degrees Fahrenheit

ESTIMATING IMMERSION HEATERS:

$$\mathbf{KW = \frac{V \times \Delta T}{800\ T}}$$

V	=	Tank capacity gallons
ΔT	=	(desired - ambient) temperature in degrees Fahrenheit
T	=	Time in hours
KW	=	Input heat required.

USEFUL CONVERSION FACTORS

The equivalents given can be used per the following example:

12 in. = 1 ft.

a) to convert 36 in into feet :

$$36(in) \times \frac{1\,(ft)}{12(in)} = 3 \text{ feet}$$

b) To convert 4 ft into inches:

$$4\,(ft) \times \frac{12\,(in)}{1\,(ft)} = 48 \text{ inches}$$

VOLUME:

1 gallon = 231 in.³
1 gallon = 3.785 liters
1 liter = 61.02 in.³

PRESSURE:

1 bar = 14.5 PSI
1 atmosphere = 14.7 PSI
1 kg/cm² = 14.2 PSI
1 in-hg = .4912 PSI
1 bar = 100 kpa
1 PSI = 6.89 kpa

SPEED:

1 ft/sec = 0.3048 M/sec

LENGTH:

1 inch = 25.4 mm
1 meter = 39.37 inches
1 micron = .000039 inches

POWER:

1 HP = 1.014 metric HP
1 HP = .7457 KW
1 HP =42.4 BTU/min
1 HP = 2545 BTU/Hr.
1 HP = 550 ft - lb/sec

FORCE:

1 N (newton) = 0.2248 lbs.

USEFUL DATA

HORSEPOWER INPUT TO PUMP:
1 HP = 1 GPM at 1500 PSI

ENTRAINED AIR:
At room temperature standard hydraulic oil contains 8 - 9% air by volume.

FLOW VELOCITIES:
Suction Lines 2-4 ft/sec
Return lines 10-15 ft/sec
Working lines (500 to 3000 PSI) 15 to 20 ft/sec
Working lines (3000 to 5000 PSI) 20 to 30 ft/sec

HEAD PRESSURE:
Oil creates a pressure due to its weight of 0.4 PSI per foot of depth.

OIL COMPRESSIBILITY:
For every 1000 PSI there is a reduction in oil volume of ½%.

OIL TEMPERATURE:
Oil temperature should never be allowed to exceed 140°F.

PUMP MOUNTING:
Hydraulic pumps should never be mounted higher than 3 ft above the minimum oil level in the reservoir.

PUMP & MOTOR CASE DRAINS:
Most pump or motor case drains cannot exceed 15 PSIG.

VISCOSITY AT START-UP:
Maximum viscosity at start-up ranges from 1000 for inline piston pumps to 4000 SUS for gear and vane equipment.

Boom system pump / motor assemblies and adjustments

Hammer	Motor size (hp)	Actual motor output (hp)	Max. breaker flow	Max. breaker pressure (psi)	Voltage	Frequency	Approx. motor amperage draw	Motor frame size	Motor (F2) standard part no.	Motor (F1) optional part no.	Pump model (cc)	Pump flow (gpm)	Pump input speed (rpm)	Pump stroke limiter turns +0 -0.10	Pump part no.	Pump/motor assembly	Drawing number
TB325	30	21.5	16	2300	440v	60	28	286TC	1005302	1001217	71	16	1750	7.69	1005098	216-0488	216-0423D
						50		286TC	*	*			1450	6.16	1005097	216-0489	
					380-415v	50	30	324TC	1005303	1001220			1450	6.16	1005097	216-0490	
					575v	60	21	286TC	1005304	1001216			1750	7.69	1005098	216-0491	
						50		326TC	1005305	1002240			1450	6.16	1005097	216-0492	
TB425	30	28.2	21	2300	440v	60	35	286TC	1005302	1001217	71	21	1750	5.37	1004872	216-0460	
						50		286TC	*	*			1450	3.36	1004871	216-0461	
					380-415v	50	37	324TC	1005303	1001220			1450	3.36	1004871	216-0462	
					575v	60	27	286TC	1005304	1001216			1750	5.37	1004872	216-0463	
						50		326TC	1005305	1002240			1450	3.36	1004871	216-0464	
TB625	40	37.6	29	2400	440v	60	46	324TC	1005255	1000421	71	27	1750	2.59	1004874	216-0465	
						50		326TC	*	*			1450	0	1004873	216-0466	
					380-415v	50	49	326TC	1005306	1001083			1450	0	1004873	216-0467	
					575v	60	35	324TC	1005307	1000522			1750	2.59	1004874	216-0468	
						50		326TC	1005308	1002869			1450	0.00	1004873	216-0469	
TB725	40	37.8	29	2400	440v	60	46	324TC	1005255	1000421	71	27	1750	2.59	1004874	216-0465	
						50		326TC	1004135	*			1450	0	1004873	216-0466	
					380-415v	50	49	326TC	1005306	1001083			1450	0	1004873	216-0467	
					575v	60	35	324TC	1005307	1000522			1750	2.59	1004874	216-0468	
						50		326TC	1005308	1002869			1450	0	1004873	216-0469	
TB830	50	51.8	37	2400	440v	60	62	326TC	1005309	1001357	100	37	1750	3.16	1004828	216-0457	216-0420D
						50		364TC	*	*			1450	0.45	1004827	216-0456	
					380-415v	50	66	364TC	1005310	1003410			1450	0.45	1004827	216-0458	
					575v	60	48	326TC	1005311	1001426			1750	3.16	1004828	216-0545	
						50		364TC	1005312	1003411			1450	0.45	1004827	216-0455	
TB925	60	63.0	45	2400	440v	60	78	364TC	1005313	1002434	100	45	1750	0.32	1004829	216-0442	
						50		365TC	*	*	140		1450	3.08	1004859	216-0470	
					380-415v	50	83	365TC	1005314	1003101	140		1450	3.08	1004859	216-0471	
					575v	60	60	364TC	1005315	1002435	100		1750	0.32	1004829	216-0459	
						50		365TC	1005316	1003102	140		1450	3.08	1004859	216-0472	
TB980	75	79.2	53	2550	440v	60	93	365TC	1005317	1003044	140	53	1750	3.40	1004860	216-0473	216-0421D
						50		405TC	*	*			1450	0	1004861	216-0474	
					380-415v	50	99	405TC	1005318	1003105			1450	0	1004861	216-0475	
					575v	60	71	365TC	1005319	1002481			1750	3.40	1004860	216-0476	
						50		405TC	1005320	1003106			1450	0	1004861	216-0477	
TB1025	75	80.8	53	2600	440v	60	95	365TC	1005317	1003044	140	53	1750	3.40	1004860	216-0473	
						50		405TC	*	*			1450	0	1004861	216-0474	
					380-415v	50	101	405TC	1005318	1003105			1450	0	1004861	216-0475	
					575v	60	73	365TC	1005319	1002481			1750	3.40	1004860	216-0476	
						50		405TC	1005320	1003106			1450	0	1004861	216-0477	
TB1280	75	78.9	55	2550	440v	60	93	365TC	1005317	1003044	140	53	1750	3.40	1004860	216-0473	
						50		405TC	*	*			1450	0	1004861	216-0474	
					380-415v	50	98	405TC	1005318	1003105			1450	0	1004861	216-0475	
					575v	60	71	365TC	1005319	1002481			1750	3.40	1004860	216-0476	
						50		405TC	1005320	1003106			1450	0	1004861	216-0477	
TB1430	75	74.6	58	2400	440v	60	88	365TC	1005317	1003044	140	53	1750	3.40	1004862	216-0473	
						50		405TC	*	*			1450	0	1004863	216-0474	
					380-415v	50	93	405TC	1005318	1003105			1450	0	1004863	216-0475	
					575v	60	67	365TC	1005319	1002481			1750	3.40	1004862	216-0476	
						50		405TC	1005320	1003106			1450	0	1004863	216-0477	
TB1680	75	79.2	61	2550	440v	60	93	365TC	1005317	1003044	140	53	1750	3.40	1004862	216-0473	
						50		405TC	*	*			1450	0	1004863	216-0474	
					380-415v	50	99	405TC	1005318	1003105			1450	0	1004863	216-0475	
					575v	60	71	365TC	1005319	1002481			1750	3.40	1004862	216-0476	
						50		405TC	1005320	1003106			1450	0	1004863	216-0477	
TB2080	150	119.8	79	2600	440v	60	150				260	79	1750	4.72			
						50							1450	2.81			
					380-415v	50	159	447TC	1007616				1450	2.81	1007621		
					575v	60	115						1750	4.72			
						50							1450	2.81			
TB2580	150	150.0	103	2600	440v	60	188				260	99	1750	2.39			
						50							1450	0.00			
					380-415v	50	199	447TC	1007616				1450	0.00			
					575v	60	144						1750	2.39			

Pump Seal Kits: 71cc - 1004192, 100cc - 1005010, 140cc - 1005342

Adjustment /1 Rev of Stroke Limiter: 71cc = .287ci , 100cc = .375ci , 140cc = .43ci

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