

Installation, Operating & Maintenance Manual

(Original Instructions)

WITTIG



AQUALINE With Mechanical Sealing

Models

1600

2100

2700

Applicable For Machines
Produced From:
September 2011



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Dear customer,

Your new Water Ring Pump is the outcome of intensive development based on decades of experience as a supplier of vacuum pumps and compressors to the suction vehicle market. Advanced manufacturing methods in combination with highest quality standards and extensive testing ensure reliability, a high degree of availability and long life of your machine.

This machine requires proper handling, especially under severe operating conditions. Startup, operation and maintenance must therefore be performed only by trained and authorised personnel.

These Operating Instructions contain all required information and have been written for those in charge of the unit. The machine will give smooth service over a long period provided these Instructions are followed. The Operating Instructions are a component part of the product and must be kept available for the operating personnel. You will appreciate that we cannot be held responsible for any damage caused due to non-compliance with these Instructions.

Please note that repairs should only be undertaken by authorized repair centres using original parts. Otherwise our guarantee will be void.

We wish you success with your water ring pump from Gardner Denver Drum. If you have any questions which are not answered in this manual, please call us.

Sincerely yours,

Gardner Denver Drum Ltd.

Mode of operation

Liquid compressor vacuum pumps, like rotary compressor vacuum pumps, work on the displacement principle, providing uniform, low-pulsation flow.

Single-shaft liquid ring machines have a housing with cylindrical bore and an eccentrically mounted rotor. The housing is partly filled with liquid, which the rotation of the rotor forms into a rotating liquid ring in contact with the housing. Together with the hub of the eccentrically mounted rotor, it forms a sickle-shaped working space divided by the vanes of the rotor.

The rotation of the rotor causes the cell volume to become large at the intake side. This creates a vacuum which sucks air into the cell, which is open towards the air intake. As the rotation continues, the cell closes and the cell volume becomes smaller. As a result of this, the enclosed air is compressed and pushed out of the pressure outlet.

The cells are charged and drained through openings in the housing covers located on either side of the rotor faces.

This functional principle causes the machine to work at nearly isothermal compression due to internal cooling.



The first digit of the references to illustrations in these Operating Instructions refers to the chapter in which you find the illustration. The illustrations within each chapter are numbered consecutively. The last number of an illustration reference denotes the position number of the item in the references illustration.

For example, the reference (7.2 / 3):

second illustration in chapter 7, item number 3.



This symbol precedes information that refers to units used in a potentially explosive atmosphere.

Design versions

The design versions differ in their direction of rotation.

Type code:

AQUALINE	2100	R
Liquid ring pump, operating medium: water ¹⁾	Machine size	R = CW rotation L = CCW rotation

¹⁾ Water is the working liquid commonly used by suction vehicles.

1. Technical data

1.1 Machine data

Liquid ring pumps of the Aqualine series use water as operating fluid.

Conveyed medium

Air of maximum intake temperature of 60 °C.


Operating fluid

Water or water-glycol mixture

Maximum outlet temperature

The temperature at the outlet of the liquid compressor vacuum pump should be restricted to maximum 65 °C.

The machine number and other important machine data are given on the machine's nameplate.

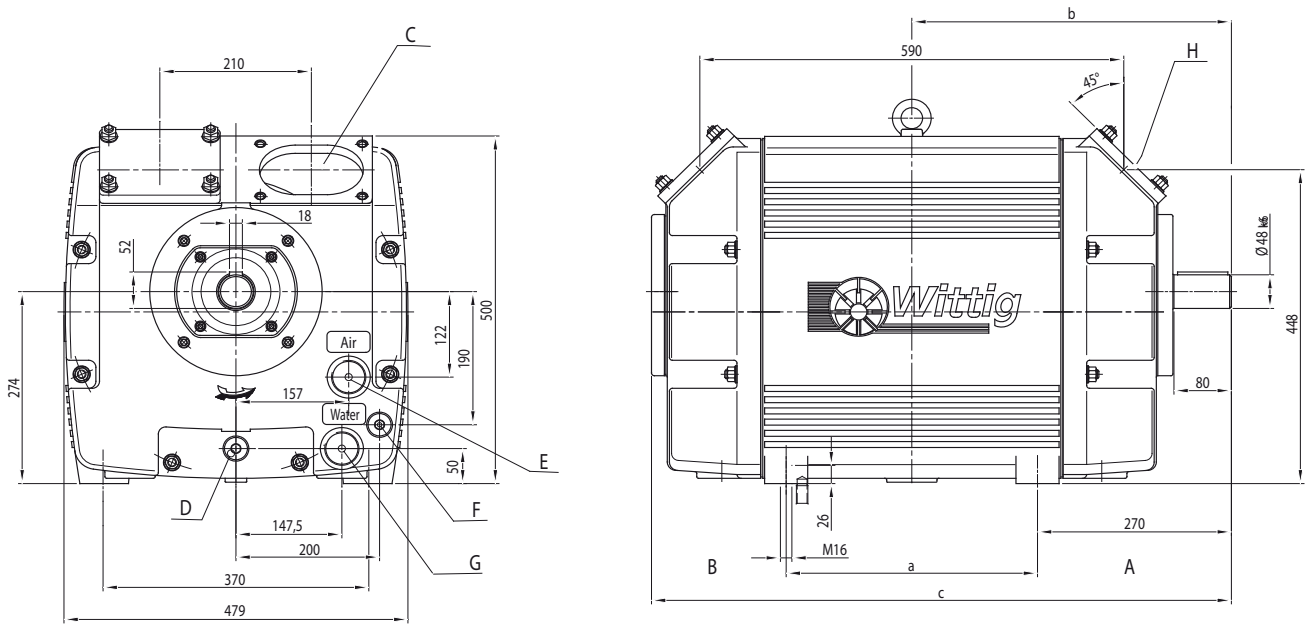
Liquid ring pump		Aqualine 1100	Aqualine 1600	Aqualine 2100	Aqualine 2700
Rated operating vacuum (absolute)	mbar	400	400	400	400
Maximum gauge pressure in compressor operation ¹⁾	barg	1.5	1.5	1.5	0.5
At 400 mbar (absolute) intake pressure					
volume flow rate	m ³ /h	900	1,300	1,700	2,075
final gauge pressure	barg	0.0	0.0	0.0	0.0
power consumption on shaft	kW	32	46	60.5	74
At 1,000 mbar (absolute) intake pressure					
volume flow rate	m ³ /h	840	1,270	1,660	2,100
final gauge pressure	barg	0.5	0.5	0.5	0.5
power consumption on shaft	kW	33	50	65	84
Possible max. intermitant vacuum (absolute) approx. ²⁾	mbar	130	130	130	130
Rated speed ³⁾	1/min	1,500	1,500	1,500	1,500
Mass moment of inertia, incl. liquid ring	kgm ²	0.7	1.0	1.3	1.6
Sound pressure at 7 m distance at 400 mbar (absolute)	dB(A)	66	68	70	72
Weight of the basic machine	kg	150	165	180	195
 All data relate to water at 20°C inlet temperature as the operating fluid and intake temperature of 20°C. Operating fluids other than water or water-glycol mixture require prior consultation with the manufacturer. The data and illustrations reflect the current state. The right of modifications is reserved.					

1) Secure by providing a safety valve.

2) Dependant on water temperature.

3) The permitted speed range from 1,100 to 1,500 rpm must be observed.

1.2 Dimensions



- A A-Side
- B B-Side
- C Connecting flanges with connecting variations (see figure 1.2)
- D Drain for the liquid ring fluid G 3/4"
- E Connection for an additional ventilation Z

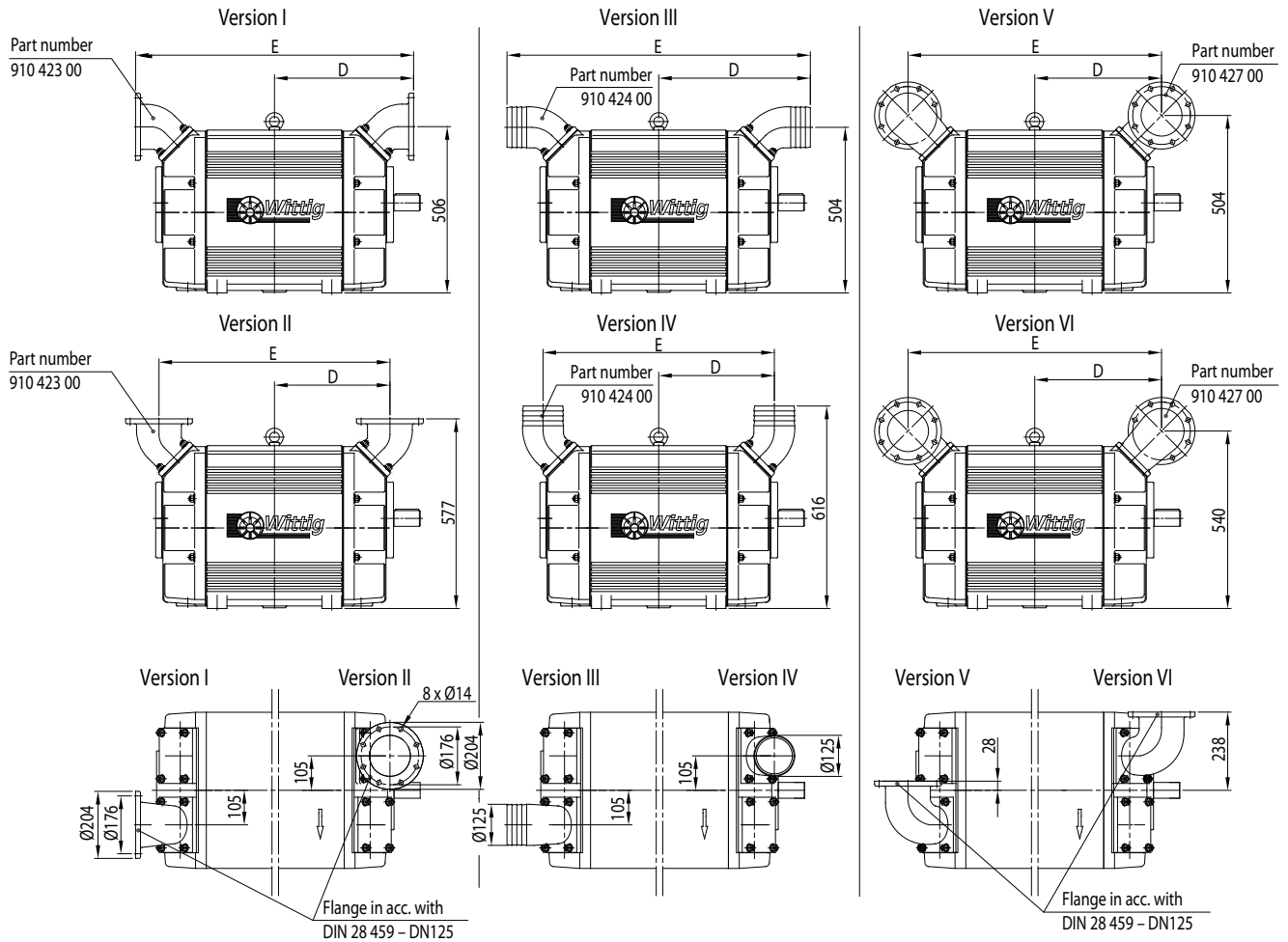
- F Drain for an additional ventilation G 3/4"
- G Connection for the liquid ring fluid G 1 1/2";
Operating water inflow duct – drain
- H Covered on A-side and B-Side

	a	b	c	Machine serial no.		Connection for additional ventilation Z ^{1) 2) 3)}	Ø Cell venting line I/D	Connection for liquid ring fluid	Ø Operating water line	Weight
	[mm]	[mm]	[mm]	cw rotation	ccw rotation					
Aqualine 1100	170	355	630	910 389/..	910 381/..	Optional G 1" or G 1 1/2"	28	G 1 1/2"	R 1 1/2"	150
Aqualine 1600	260	400	720	910 399/..	910 382/..					165
Aqualine 2100	350	445	810	910 409/..	910 383/..					180
Aqualine 2700	450	495	910	910 439/..	910 440/..	G 1 1/2"	52			195

- 1) One-side cell venting Z only for connection to the machine numbers in this table.
- 2) Second venting lines on opposite side required for machine serial nos. 910 390/.., 910 400/.. et 910 410/.. for housing pipe socket Z = G 1 1/4" and OD = 28 mm.
- 3) If conditions at the installation site require a second cell venting line, the minimum diameter in the table above also applies.

Fig. 1.1 Dimensions of Aqualine 1100 to 2700

1.2.1 Connection versions



	Version I		Version II		Version III		Version IV		Version V		Version VI	
	D	E	D	E	D	E	D	E	D	E	D	E
Aqualine 1100	335	670	263	526	373	746	263	526	297	594	297	594
Aqualine 1600	380	760	308	616	418	836	308	616	342	684	342	684
Aqualine 2100	425	850	353	706	463	926	353	706	387	774	387	774
Aqualine 2700	475	950	403	806	513	1026	403	806	437	874	437	874

Fig. 1.2 Connection sizes for Aqualine 1100 to 2700 versions (in mm)

1.3 Operating fluid

The operating fluid is water or water-glycol mixture. Operating fluids other than water or water-glycol mixture require prior consultation with the manufacturer.

1.4 Drive

From the vehicle engine:

- by auxiliary drive and propeller shaft
- by Vee belt, whereby the Vee belt pulley is installed

on the free shaft end

- by hydraulic drive

From other engine, electric or hydraulic motor:

- by flexible coupling
- by Vee belt, whereby the Vee belt pulley is installed on the free shaft end
- For more details, see Installation section.

2. Safety instructions and hazard alerts

2.1 Use for intended purpose

The intended purpose of the liquid ring pump is to convey and compress filtered air. The entrainment of small amounts of water in the air is possible. Any use other than or beyond that described above is contrary to the intended purpose.

Following the operating data and the specified maintenance are also part of the use for the intended purpose.



Liquid ring pumps of the aqualine series comply with the requirements of directive 94/9/EC (ATEX) and belong to equipment group II, category 2, temperature class T4 (135°C maximum surface temperature), zone 1,2 (gas atmosphere).

Changes and repairs must only be made with the manufacturer's written permission. Units of the Aqualine series are designed for integration in a higher-level machine. The new risks created by the integration must be assessed by the manufacturer of the new machine.

2.2 Acceptance and monitoring

The liquid ring pump as a unit is not subject to any acceptance or monitoring requirements.

Any special provisions in effect at the site of the liquid ring pump must be observed by the operator.

2.3 Hazard alerts and symbols



This hazard alert symbol indicates important safety messages in this booklet. Carefully read the message that follows and act as required. Make certain that the safety instructions are known to all who need to know them!



"CAUTION" indicates provisions and regulations preventing damage to the machine.



Symbol for potentially explosive atmosphere. Here the symbol draws attention to provisions or information which must be observed if the machine is to be used in a potentially explosive atmosphere.



This symbol indicates information of particular importance to the operator of the machine.



This symbol indicates that no unauthorized persons must enter this area.



Risk of burning!
This symbol indicates a hot surface.



This symbol indicates that you must wear ear protectors.



This alert symbol indicates that environmental protection requirements must be observed.

2.4 Safe working



The liquid ring pump has been designed and built to good engineering practice and the accepted rules of safety. However, hazardous situations may still arise in using the machine with the possibility of personal injury or death of the operator or other persons and damage of the machine or other objects.



Air is the only conveyed medium.

- Use the liquid ring pump only in good working condition and for the intended purpose. Be alert to possible hazards. Defects impairing safety must be repaired without delay.
- Modifications, additions and alterations of the liquid ring pump that are likely to impair its safety are forbidden unless agreed with the manufacturer.
- The machine must only be used with delivery and intake lines connected.
- All warnings on the liquid ring pump must be legible and observed at all times.
- Work on electrical equipment must be carried out by a trained electrician applying the rules of the trade.
- All persons carrying out work on the liquid ring pump must have read these Operating Instructions, especially the chapter on safety, before starting work. It may be too late to refer to these Instructions when work has already started!
- Operation and maintenance of the machine must only be carried out when the machine is not running.

Safety instructions and hazard alerts

- Secure the drive against starting before beginning to work on the machine.
- When work is carried out on the system, the latter must not be under pressure or vacuum.
On the vehicle: Close the stop slide valve. Bleed or vent the pressure line between the system and the stop slide valve.
Relieve elevated pressure manually at the safety valve. Observe the pressure gauge reading.
- Remove the drive guard only when the machine is not running.
- Remove the safety guard only when the machine and the pressure line have cooled down.
- Before starting the machine, make certain that all guards are installed and in place.



Environmental protection requires that all emerging fluids, e.g., cooling water, cooling oil or lubricant residue, are collected and disposed of as prescribed.

3. Transport

Symbols on the packaging:



Top



Fragile



Keep dry

3.1 Transport

Avoid any use of force and load / unload the packages with care.



Attach lifting equipment only at the firmly installed eye bolts (see figure 3.1).

Remove transport safeguards, where provided.

3.2 Storage

Store the machine in a dry and heated room until installation. Remove the covers on and pressure openings only at the time of actual installation.

3.3 Scope of delivery

The contents of the consignment are described in the delivery note. Check for short delivery and transit damage without delay. Claims for damage in transit and short delivery can only be accepted if made in writing without delay.

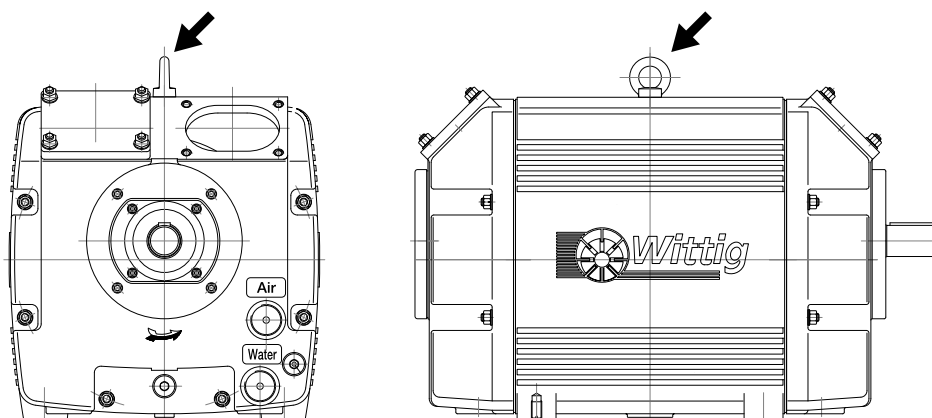
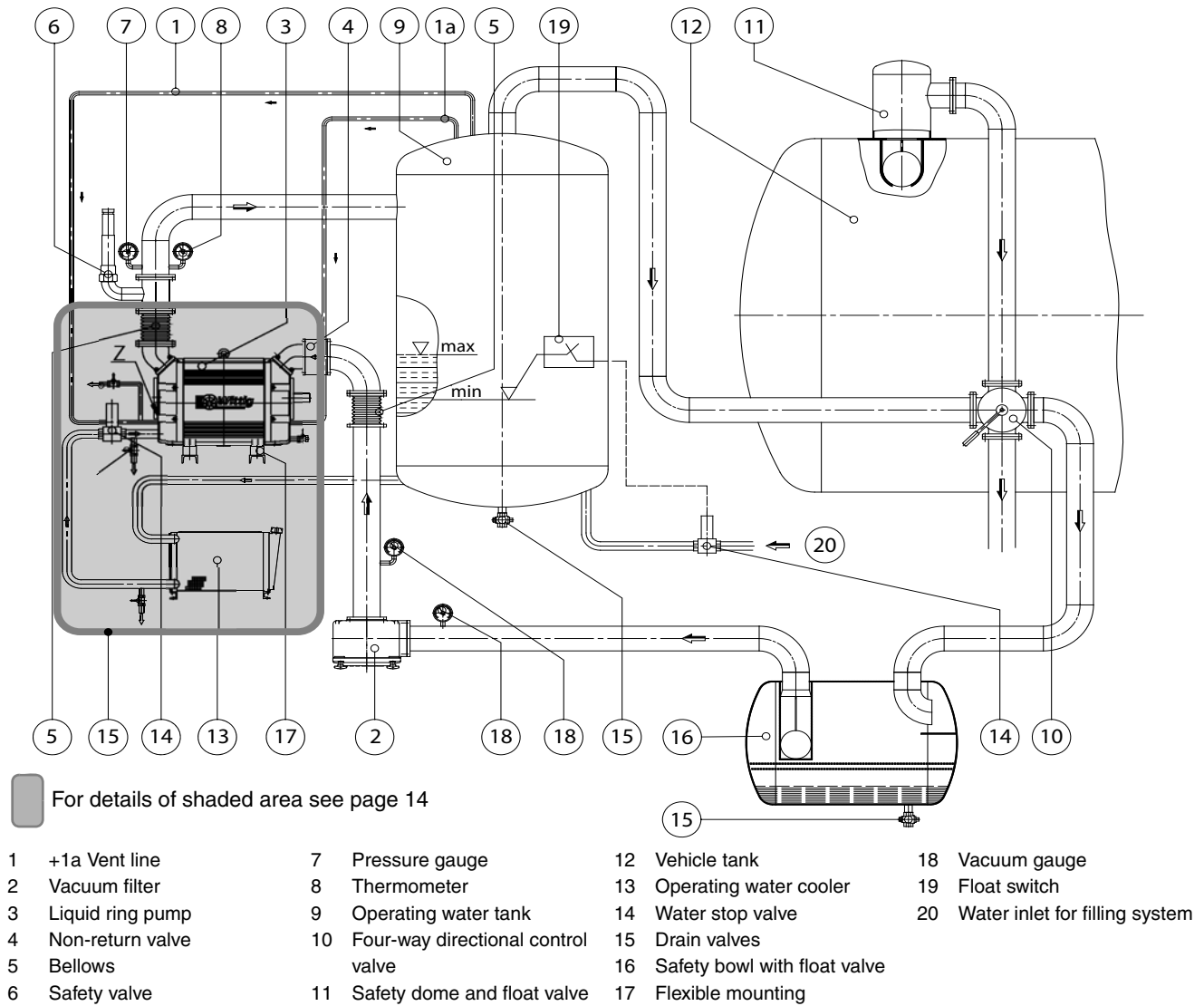


Fig. 3.1 Lifting eye bolt

4. Installation

Figures 4.1 and 4.2 show a typical Aqualine liquid ring pump system completely installed. Other arrangement versions are also possible.

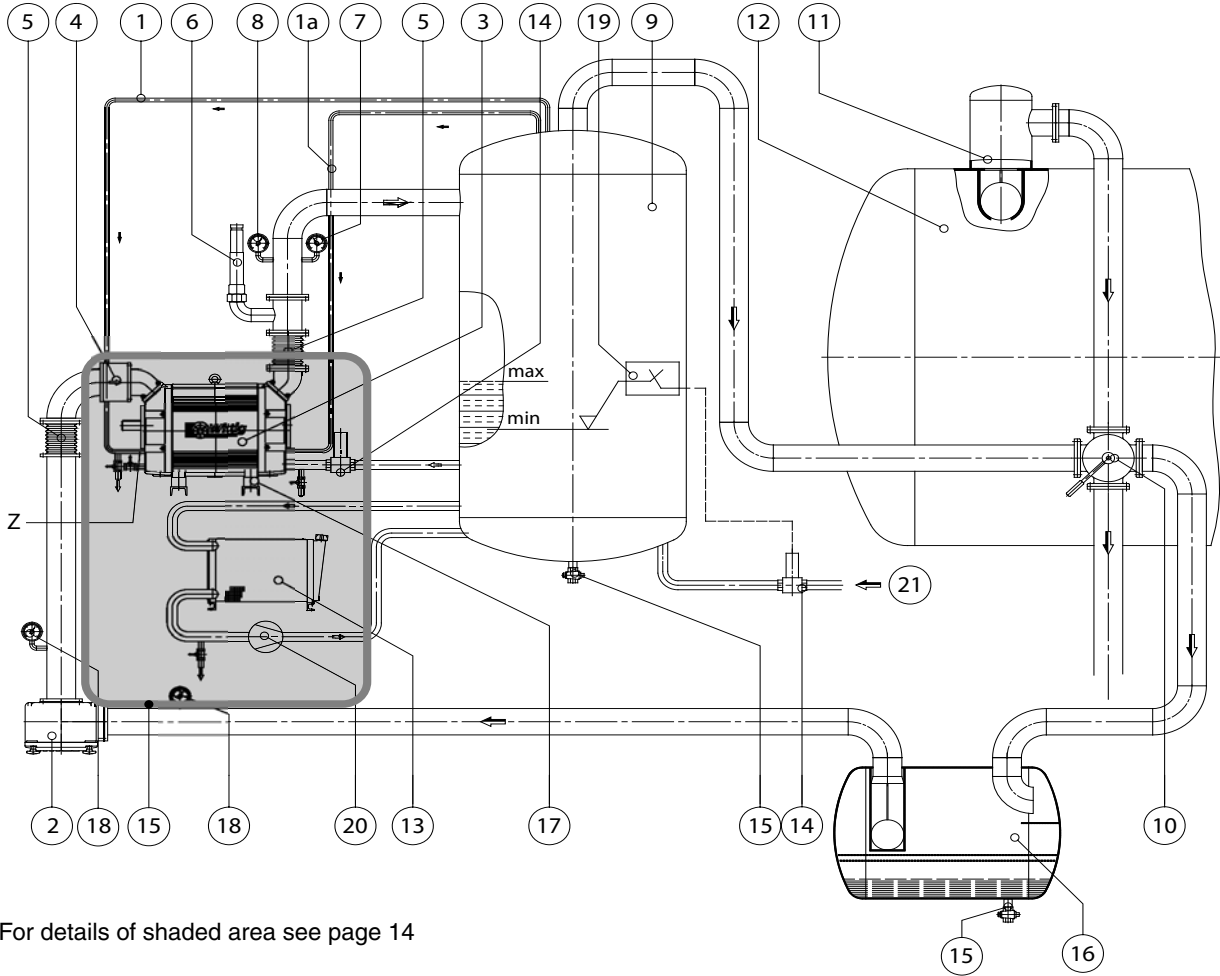
4.1 System setup with cooler in main flow



* For dimensions of the vent line, see table page 6

Fig. 4.1 Components of a system with liquid ring pump – Cooler in main flow

4.2 System setup with cooler in side flow



For details of shaded area see page 14

- | | | | |
|--------------------|---------------------------------------|---------------------------------|-----------------------------------|
| 1 +1a Vent line | 7 Pressure gauge | 12 Vehicle tank | 18 Vacuum gauge |
| 2 Vacuum filter | 8 Thermometer | 13 Operating water cooler | 19 Float switch |
| 3 Liquid ring pump | 9 Operating water tank | 14 Water stop valve | 20 Pump |
| 4 Non-return valve | 10 Four-way directional control valve | 15 Drain valves | 21 Water inlet for filling system |
| 5 Bellows | 11 Safety dome and float valve | 16 Safety bowl with float valve | |
| 6 Safety valve | 17 Flexible mounting | | |

* For dimensions of the vent line, see table page 6

Fig. 4.2 Components of a system with liquid ring pump – Cooler in side flow

Notes

- Installation and start-up must only be undertaken by trained persons. Damage due to improper handling is not included in the guarantee terms.
- The machine is delivered in fully assembled condition. It must not have suffered damage in transit.
- Please make certain that the rotor shaft can be rotated by hand. If this is not the case, inform our service staff.
- Lift the machine using only the securely installed eye bolts.



For use in a potentially explosive atmosphere, all parts of the equipment must satisfy the requirements for the zone in which they are used.

Note that it may be necessary to provide equipotential bonding between the equipment and the truck. The safe operation of the vacuum pump in a potentially explosive atmosphere requires that all safety instructions in our operating instructions and complementary instructions are strictly observed.

Details of figure 4.1

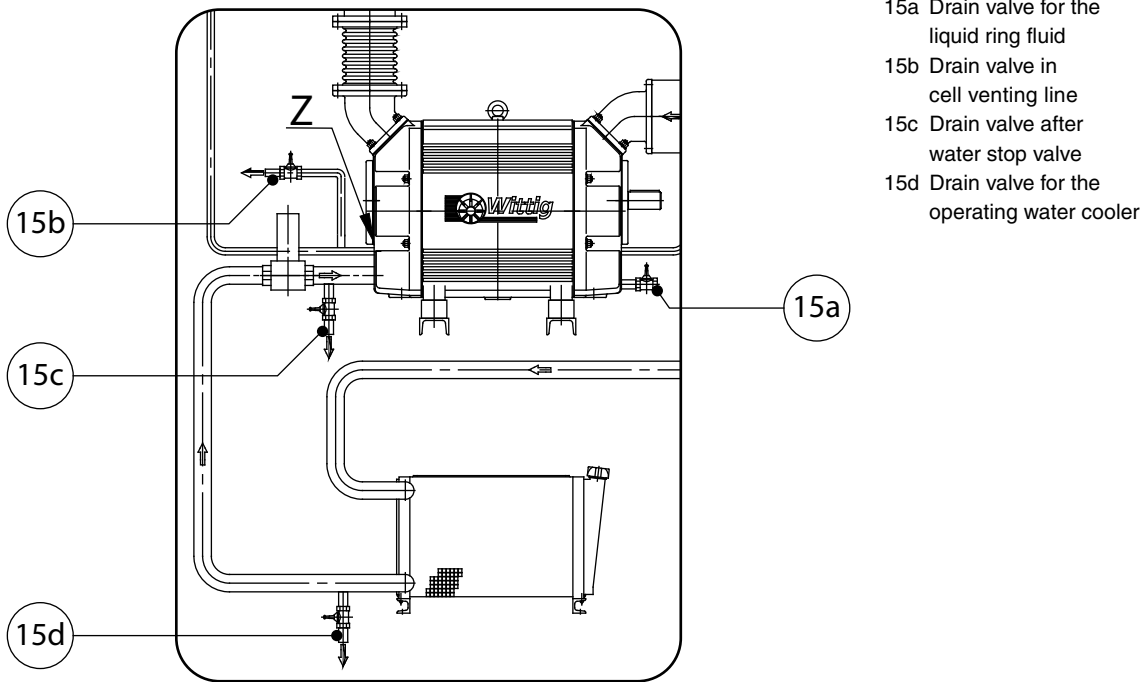


Fig. 4.3 Components of a system with liquid ring pump – Cooler in main flow (detail)

Details of figure 4.2

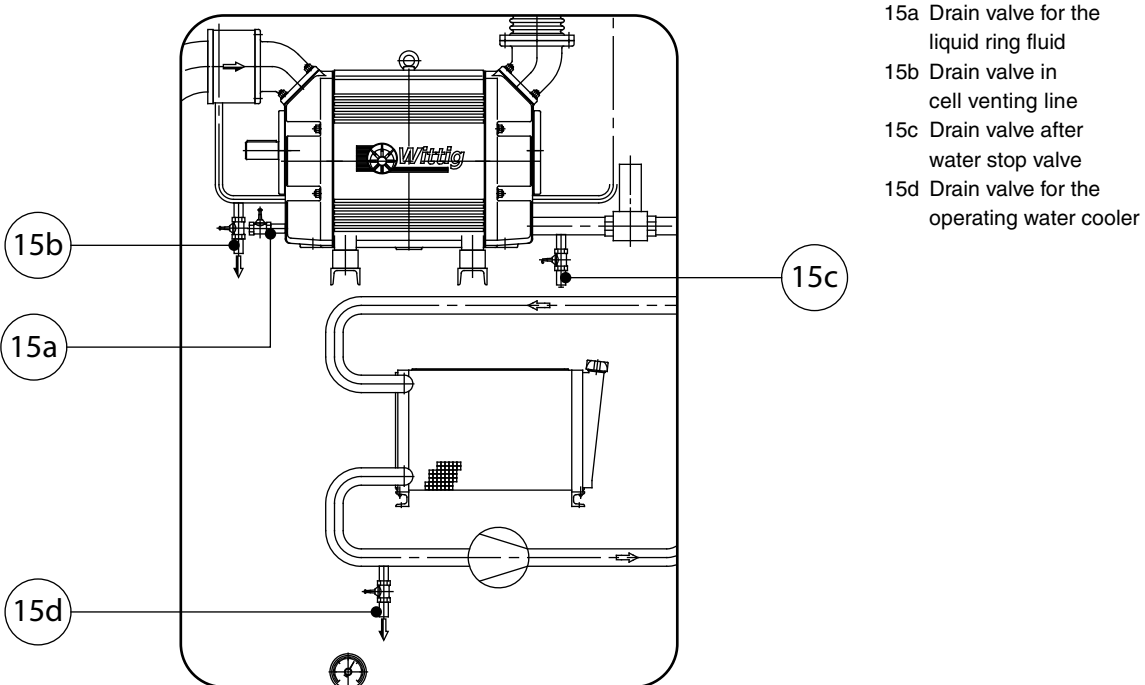


Fig. 4.4 Components of a system with liquid ring pump – Cooler in side flow (detail)

4.3 Point of installation and fastening

The point of installation on the vehicle must

- be easy to access,
- be protected from dirt, the impact of stones and water splash.
- leave sufficient space for the connection of operating water, the suction and pressure lines and the operating water drain.

Fasten the machine at the 4 feet (M16 tapped holes). The machine can be fastened directly onto a suitable frame. The minimum depth of thread engagement is 23 mm.

Framework must be of sufficient strength to support machine in operation and while vehicle is driven.

The four fastening points (machine foot supports) must be in exact alignment.

For dimensions and weights, see chapter 1. "Technical data".



The machine must be adequately earthed. An equipotential earth bonding strap should be securely fastened between the machine body and a suitable point on the vehicle frame.

Ensure that the machine and all ancillaries are earthed in accordance with BS5958 Pt1: 1991;

'Control of undesirable Static Electricity'.

4.4 Connections and piping

For regular service of the liquid ring pump the suction, pressure lines, operating water supply, and water drain line must be connected to the machine

The various possibilities of the suction and pressure line connections are illustrated in figure 4.5 for machines of clockwise and counterclockwise rotation.

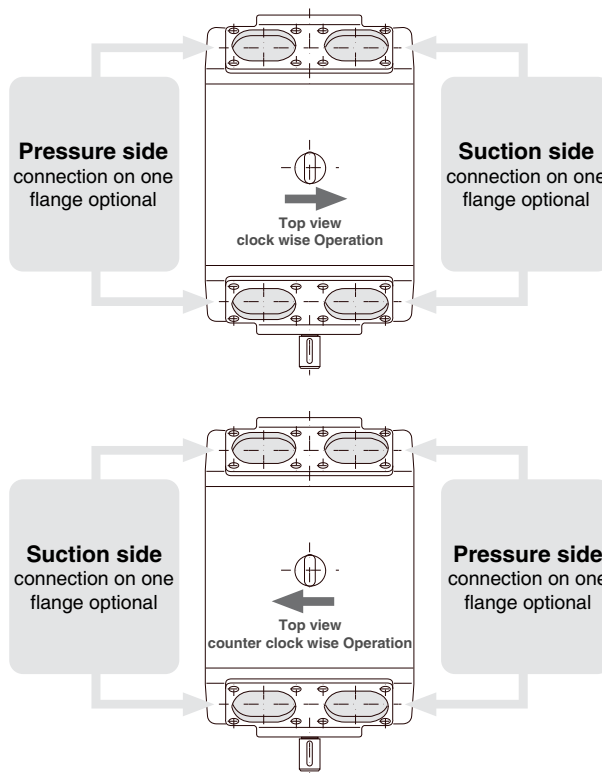


Fig. 4.5 Aqualine 1100 to 2700 connection versions

The suction and pressure line, respectively, can either be connected on the A side or B side. The same applies to the operating water supply, the drain line and the venting line.

As regards piping, the minimum pipe diameters in the table below are recommended.

Aqualine	1100	1600	2100	2700
Suction line	DN 125 (5")	DN 125 (5")	DN 125 (5")	DN 125 (5")
Pressure line	DN 125 (5")	DN 125 (5")	DN 125 (5")	DN 125 (5")

4.5 Protection against intake of dirt and residue

4.5.1 Suction line

The pipe must be corrosion-resistant inside. Clean the pipe inside before installing it. Remove all welding beads, scale and rust.



The suction line should be sufficiently large. The pipe diameter must at least meet the diameter specifications in chapter 4.4. Otherwise the machine will be overloaded!



Wrong design of the suction line causes forfeiture of all guarantee claims on Gardner Denver

4.5.2 Vacuum filter

Install the vacuum filter directly upstream the machine. The filter protects the machine from the ingress of impurities and attenuates the suction noise.

Observe the flow direction when installing the filter. The filter insert shall be removable from the filter for maintenance.

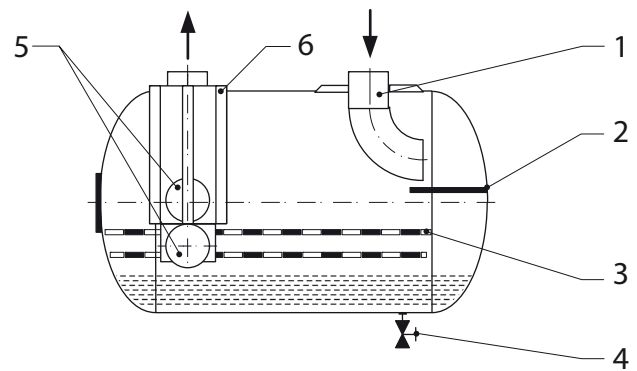
4.5.3 Safety dome

In addition to the float valve, a splash guard must be installed in the safety dome of the vehicle tank. The splash guard prevents liquid splash into the system.

4.5.4 Safety bowl

The safety bowl (at the lowest point of the suction line) must be so designed that

- entering air does not hit the liquid level directly,
- sufficient calming space is available,
- the filter element does not dip into the liquid (also filters with non-absorbing texture become saturated due to the capillary action of the liquid).
- A filter element in the safety bowl is not required if a vacuum filter type SFA-F is used.



- | | |
|---------------------------|----------------------|
| 1 Intake bend | 4 Drain cock |
| 2 Baffle plate | 5 Two floating balls |
| 3 Double perforated plate | 6 Four guide rods |

Fig. 4.6 Safety bowl

To inspect the function of the optimized gravity separator illustrated in figure 4.6 proceed as follows:

- When the amount of water to be separated is sucked in, that amount must remain in the bowl.

We will be glad to assist you in designing and inspecting your safety bowl.

4.6 Safety and monitoring instruments

The safe operation of the machine (i.e., the operation of the machine without risk) requires the following safety and monitoring equipment (also see figure 4.1 and figure 4.2).



All items of safety equipment must be inspected for proper function at regular intervals (see manufacturer's technical instructions).

It is forbidden to change, block or render safety guards ineffective in any way.

The operating safety of the system (i. e., the safe operation of the machine requires the following safety and monitoring instruments:

At the suction side:

- Vacuum gauge
- Vacuum filter
- Non-return valve
- Bellows

At the pressure side:

- Safety valve

- Thermometer
- Pressure gauge
- Bellows

Operating water supply line:

- Solenoid valve for opening or closing the operating water supply

Guard:

- Protection against rotating parts

Protection of the machine

- Speed monitor
- Install drain cocks for the operating fluid to ensure that the complete system can be drained of liquid.



Non-compliance causes forfeiture of all guarantee claims on Gardner Denver.

4.6.1 Vacuum gauge

To monitor the permitted operating vacuum as specified in chapter 1.1 "Machine data", a vacuum gauge is to be installed downstream the non-return valve at the suction side.

To measure the pressure loss in the filter, we also recommend the installation of a vacuum gauge upstream of the filter.

4.6.2 Vacuum filter

The vacuum filter protects the machine from coarse mechanical impurities. The vacuum filter must be installed in the suction line.

Note on installation the flow direction and required space for replacing the filter insert.

4.6.3 Non-return valve

The non-return valve prevents the entry of water from the pump to the intake line when the machine is not running.

Install the non-return valve in the suction line as near to the machine as possible. Observe the direction of flow through the valve.

4.6.4 Thermometer

To monitor the compression end temperature, install the thermometer in the pressure line directly down-

stream the pressure socket. For this, install a pipe coupling R 1/2". The immersion depth of the thermometers must be equivalent to one half the diameter of the pipe.

The indicating range of the thermometers must 0 to 100 °C.

4.6.5 Safety valve

A non-shutting off safety valve shall be installed downstream every compressor. The valve must be dimensioned and set so that the highest permitted operating pressure cannot be exceeded by more than 10%. The valve must be capable of blowing off the entire volume conveyed by the liquid ring pump. This valve must also be suitable for manual venting.



If the safety valve is handled or located improperly or tampered with, there is RISK OF EXPLOSION due to pressure and temperature rise!

The following points must be observed when installing the safety valve:

- Install the valve directly downstream the liquid ring pump, upstream of any other shutoff elements (especially shutoff valve),
- the component marking and seal must be visible.
- the setting must correspond to the maximum permitted operating pressure (see chapter 1.1 "Machine data"),
- the setting must be protected against tampering,
- the valve must not be blocked,
- the safety valve must not be used for control of the air volume in compression service.



Make a weekly check of the function of the safety valve by actuating the manual vent while the machine is running.

4.6.6 Pressure gauge

Provides pressure readings during normal machine service. Measuring range in accordance with the operating pressure. Install directly downstream the pressure connection.

4.6.7 Guard

The drive of the machine and the hot pressure lines must be protected by guards.

It must not be possible to touch rotating or reciprocating machine parts accidentally.

4.6.8 Bellows

To limit the connection forces in the suction and pressure line of the liquid ring pump, vacuum-tight and pressure-tight bellows must be installed.

At the same time, the bellows isolate solid-borne noise of the suction and pressure lines.

4.6.9 Speed monitor

Speed control of the liquid ring pump and a speed indicator in the operating area of the machine are recommended. For permitted speed range, see chapter 4.8 "Drive".

4.7 Operating fluid

For start-up, the liquid ring pump requires an amount of water sufficient to form the liquid ring.

Therefore, when installing the pump, make certain that the water tank is located so that when the operating water feed valve is open and the tank contains a minimum of water, the liquid ring pump fills with water up to the middle (also see Operating Instructions). If this is not ensured there may be problems in starting the pump (no conveyed medium flow).

If the water tank is located so that the liquid level is above the middle of the liquid ring pump, an automatic water stop valve must be installed in the operating water supply line. This valve must open when the pump starts and close when it is stopped to prevent inundation of the pump.

If the liquid ring pump is installed above the water level in the tank, a pump is required to ensure the operating water supply. The design of that pump must be such that the liquid ring pump is supplied with sufficient operating fluid. We will be glad to assist you in selecting the right pump.

Because liquid is removed from the working space and also because heat must be dissipated, the liquid ring pump requires a constant supply of operating fluid. For this, the covers of the machine have a G 1 1/4" connection (only one operating water supply connection is needed, i.e. either on the A side or B side).

If the piping has sufficiently low resistance (feeding line diameter R1 1/2" to R2", depending on pipeline length and layout) no recirculation pump may be needed for the operating water supply provided the arrangement of the liquid ring pump is such that the middle of the pump is at a lower level than the minimum liquid level in the storage tank.



A level control of the operating liquid must be provided if the machine is operating in a potentially explosive atmosphere.

4.7.1 Operating water back-cooling and storage tank

A circulation cooling system is required for back-cooling the operating water. The circulation cooling must be able to handle the following amounts of heat.

To reduce the loss of liquid by the exhaust air to a minimum and to ensure sufficient operating hours of the system, a combined operating water storage and separating tank is needed. For minimum sizes, refer to the table below.

Aqualine		1100	1600	2100	2700
Amount of heat to be dissipated at 1.5 bar _(g) at 0.5 bar _(g) at 400 mbar at 200 mbar	kW	50	65	78	
		25	32	39	50
		29	39	48	58
		33	48	57	67
Recommended pipe diameter operating water line		R1 1/2"	R1 1/2"	R1 1/2"	R1 1/2"
Recommended minimum tank size	ltr	250	350	450	600
Recommended water volume in the tank	ltr	150	225	300	400

The above minimum water storage figures relate to systems with water back-cooling.

Systems without water back-cooling require substantially larger storage tanks to ensure sufficient operating hours of the liquid ring pump without running the risk that the recommended limit temperature of 55 °C the operating water inflow is exceeded.

Suction dramatically reduces at higher temperatures.

4.7.2 Cell Ventilation

The cell ventilation is required to ensure the proper operation of the liquid ring pump at low intake pressure down to total residual pressure. The ventilation line is connected on the A-side and B-side housing covers (see figure 1.1 connection socket "Z").

Aqualine models 1100/1600/2100 need a ventilation line with a pipe internal diameter $\varnothing_i = 28$ mm. Aqualine model 2700 required pipe internal diameter $\varnothing_i = 52$ mm. The specified cross sections refer to about 2.5 meters line length. The ventilation line must be installed at an upward gradient and the connection is made on the "clean side" of the water separation vessel.



Make sure the entrained air line is the correct size. Ensure sufficient fresh air can enter the work space of the liquid pump via the ventilation line. This is done by running the liquid pump with a closed intake line. If a loud noise is heard, the entrained air flow rate is insufficient. In this case a larger ventilation line must be installed.

If you want to drain all operating fluid from the liquid ring pump, open both water drains (see figure 1.1).

4.8 Drive



The direction of rotation must agree with the direction of the arrow on the liquid ring pump.

Permitted speed range: 1,100 to 1,500 rpm



Ensure the drive speed increasing or reducing ratios are observed (belt drive, auxiliary drive of vehicle, ...)

We recommend a speed monitor at the liquid ring pump with an indicator in the operating area.

Check the speed after installing the liquid ring pump and put up a note for the operator of the vehicle.

If the machine is powered by a combustion engine, the engine must have speed control which limits the speed to a permitted level if the power requirement drops.



The axial thrust of the drive must not be transferred to the rotor shaft.
Install the drive components on the rotor shaft using the available M16 thread.
Do not use a hammer or other impact device to install the drive components on the rotor shafts



A coupling guard must be fitted as appropriate.

4.8.1 Drive by hydraulic motor

The selection and installation of the hydraulic motor is the responsibility of the installation firms.

We can supply a matching flange and coupling.

After mounting the flange, the motor side coupling hub must not transfer axial thrust onto the liquid ring pump.

4.8.2 Drive by flexible coupling

If the pump is coupled directly to the drive (e.g. diesel engine) a torsionally flexible coupling that compensates most of the drive irregularities must be selected according to the specifications of the engine maker.



Align the coupling exactly as prescribed by the manufacturer.

4.8.3 Drive by propeller shaft

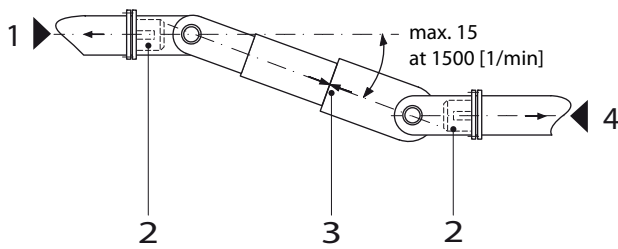
The propeller shaft drive must

- incorporate a splined shaft,
- be balanced,
- have smallest possible angles and be as short as possible.

The centre axes of the propeller shaft flanges must be parallel with each other.

Installation

The mounting flange of the propeller shaft must be installed on the drive shaft of the compressor.



- 1 To liquid ring pump
2 Keyed shaft
3 Marking on splined joint
4 From drive

Fig. 4.7 Mounting the propeller shaft

Bolt the propeller shaft to the mounting flange of the liquid ring pump shaft.

The resulting angle of bend must not exceed 15° at 1,500 rpm speed.



Ensure propshaft spline is correctly engaged. Observe marking.

4.8.4 Drive by Vee belt

If the engine speed must be raised or reduced, Vee belt drive is recommended. Observe the rated speeds in chapter 1.1 "Machine data".

The belt pulleys in the table below can directly be installed on the free shaft end.

Aqualine		1100	1600	2100	2700
Belt profile		XPB	XPB	XPB	XPB
Belt pulley minimum diameter D_w ¹⁾	mm	280	280	280	280
Max. gauge pressure with Vee belt drive	bar _ü	1.5	1.5	0.5	0.5
Number of belts in pressure service		4	5	5	5
Number of belts in vacuum service		4	4	5	5

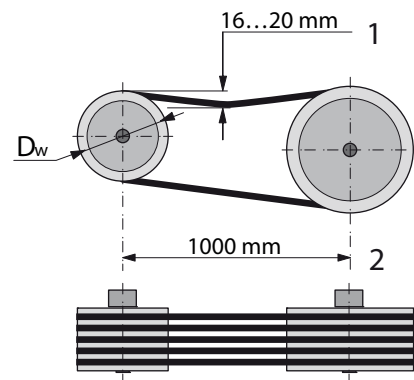
¹⁾ Consult the manufacturer if smaller pulleys are to be used.

Installation of the Vee belt drive

- The axis of the driving and driven machines should be parallel.
- The grooves of the belt pulleys must be inline.
- Vee belt lengths should be the same to ensure uniform belt tension.
- The Vee belt tension is correct when the installed and tensioned belt can be deflected by the pressure of the thumb by 16 to 20 mm for every 1000 mm axial distance.



Ensure the bending moment exerted by the belt drive on the shaft of the driving machine is within the limits recommended by the manufacturer.



- 1 Vee belt deflection (16 to 20 mm for every 1.000 mm distance)
 D_w Vee belt pulley diameter, min. 280 mm
2 Axial distance

Fig. 4.8 Correct Vee belt tensioning

Installing the Vee belt pulley with taper lock bush

- Clean and degrease all blank faces. Place the pulley and the bush one in the other. Bring holes in alignment with each other and install screws loosely.
- Push the pulley with the bush on the shaft, align and uniformly tighten the screws.

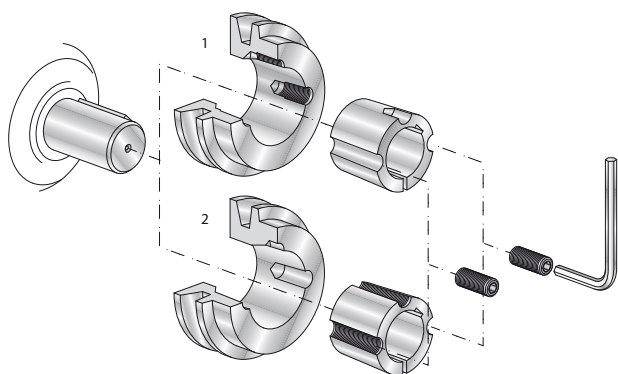


Fig. 4.9 Installing the Vee belt pulleys

Removal

1. Take out the screws, install one as a forcing screw in the half-thread hole in the bush and tighten. This slackens the taper lock bush.

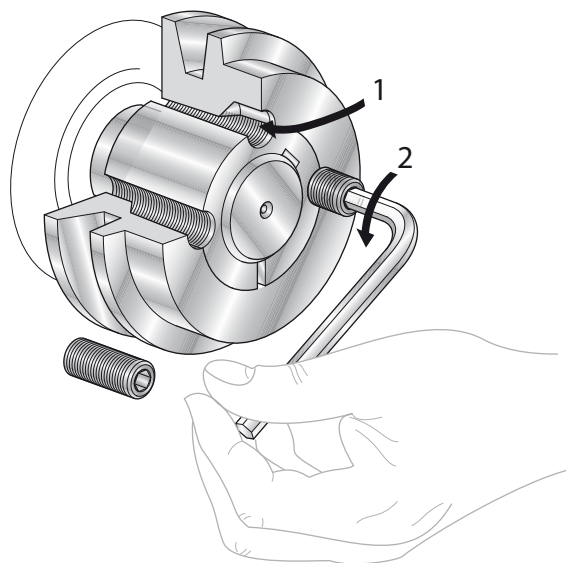


Fig. 4.10 Removing the Vee belt pulley

2. Remove the slack pulley assembly by hand; do not use a hammer as this may damage the machine.

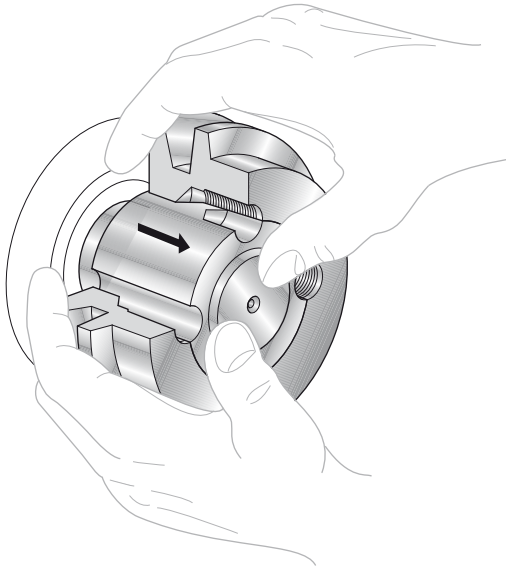


Fig. 4.11 Removing the Vee belt pulley

5. Start-up

5.1 Testing the system

The correct initial commissioning and start-up after extended standstill (more than 4 weeks) is essential for the optimum function of the liquid ring pump.

We recommend that you allow adequate time to commission the system. The liquid ring pump may be damaged if the correct procedure is not followed.



Damage as a result of incorrect commissioning is not covered by our warranty!

Before start-up

- Inspect the liquid ring pump (for damage in transit, incorrect installation),
- Inspect the drive guard and the safety guard on the pressure side for damage,
- Instruct the operators,
- Instruct others who need to know the operation and maintenance of the water ring pump,
- Make certain that the rotor shaft can be rotated by hand.

5.2 Operating liquid

Make certain of the following points to ensure that the liquid ring pump is supplied with operating liquid:

- Completely fill the operating water system, fill only up to the maximum mark in the combined operating water and separating vessel.
- Fill the liquid ring pump up to shaft centre, it may be necessary to observe a closed automatic water stop valve (also see chapter 6.2.4 "Operating the liquid ring pump").
- Check the function of the automatic water stop valve.
- Make sure that the pressure line is not blocked.



If sub-zero temperatures are likely, mix anti-freeze as specified by the manufacturer (usually 33%). Alternatively drain the operating water system completely if the machine is not used.

5.3 Stop slide and shut-off valves

- Inspect the installation direction of the non-return valve (see arrowed direction)
- Open all manual stop slide and shut-off valves.



Switch over the four-way directional control valve to extreme position, an intermediate position is not allowed. (If the valve is set to an intermediate position, the temperature of the operating water rises and more water is lost.)

5.4 Direction of rotation

When starting the system for the first time, briefly switch on the drive to check the rotation. Observe the arrowed direction on the machine housing.

5.5 Drive

Switch on the drive and check if pressure or vacuum are produced.

5.6 Check speed, vacuum and pressure

5.6.1 Speed

Permitted speed range: 1,100 to 1,500 min⁻¹

5.6.2 Vacuum and vacuum gauge

Permitted minimum suction pressure see nameplate

5.6.3 Pressure at pressure gauge

The maximum pressure indicated on the nameplate is permitted (also see chapter 1.1 "Machine data").

Make certain that the safety valve blows off.

6. Operation

6.1 Start-up

For normal setting the liquid ring pump (referred to as the "machine"), follow chapter 5. "Start-up".

6.2 Regular inspections

In pressure service

Check the operating gauge pressure at the pressure gauge (for permitted pressure, see machine nameplate)

In vacuum service

Check the operating vacuum at the vacuum gauge (for permitted vacuum, see machine nameplate)

Operating water inlet temperature

Recommended max. inlet temperature: 55 °C

pH

5 < pH < 8

Speed

Permitted speed range: 1,100 to 1,500 min⁻¹

Check the operating speed

6.2.1 Safety valve

Every compressor must be fitted with a safety valve in the pressure line that cannot be shut off. The valve should be set so that the highest permitted operating pressure cannot be exceeded by more than 10%.



The setting of the valve must be guarded against tampering.

The safety valve must not be blocked or manipulated.


Avoid blowing the full volume flow through the safety valve with the pressure line closed. This can produce harmful vibration.

On Initial installation and at weekly intervals check the function of the safety valve by actuating the manual vent while the machine is running.

6.2.2 Water stop valve

Check for proper function.

6.2.3 Inspection intervals

	See chapter	Every 10 – 20 min while running	Weekly	If necessary
Operating speed	6.2	X		
Operating pressure / operating vacuum	Nameplate	X		
Operating water feed temperature	6.2	X		
Actuate safety valve	6.2.1		X	
Water stop valve	6.2.2		X	
Replace contaminated operating water (e.g. pH, abrasive material)				X
Clean compressor and cooling unit			X	
Operating liquid level: Inspect the level of the operating liquid before every start and during operation of the pump. Bearings: Inspect the housing, housing covers and end covers for symptoms of overheating, abnormal noise or colour daily/regularly.				

6.2.4 Operating the liquid ring pump

The volumes of operating water required for proper operation of the liquid ring pump are given in the table below:

Aqualine	1100	1600	2100	2700
Operating water volume at 400 mbar in [litr/min]	50 – 70	60 – 80	70 – 90	80 – 90

Note that the actual operating water requirement varies widely as a function of the operating vacuum / operating pressure.

6.2.5 Operating water consumption and control

While passing through the liquid ring pump, the conveyed medium (air) comes into close contact with the operating medium (water). This causes the relative humidity of the conveyed medium to be, as a rule, 100% at the discharge side. Even if all water droplets were separated in the water storage tank or in a cyclone, the steam in the exhaust air will always cause a certain consumption of operating fluid.

The specific water discharge as a function of the operating pressure and the operating water temperature can be seen in Fig. 6.1.

It follows that for Aqualine 2100 at 400 mbar operating pressure and operating water temperature of 40 °C the water loss due to steam is

$$1,700 \text{ [m}^3\text{/h]} \times 0.016 \text{ [kg/m}^3\text{]} = 25.6 \text{ kg/h}$$

That is roughly 26 [litr/h]

In actual pump service, therefore, the following points should be noted:

- The loss of water due to steam can cause a rise in the concentration of pollutants in the operating water tank, which depends on the conveyed medium; this again can change the pH of the operating water.
- To avoid operating water pH outside the permitted range of $5 < \text{pH} < 8$, the pH should be checked regularly (daily or as dictated by experience) and the operating water changed in regular intervals. Litmus paper can be used for pH measurement.
- Water can condense in long exhaust lines, especially in cold weather. To prevent the outflow of condensed operating fluid from the exhaust system, the installation of an additional separator (cyclone) at the end of the exhaust line may be used.

If the water inlet temperature exceeds 55°C. Stop the machine immediately. Recirculate the water for half an hour or until the water temperature is below 55°C.



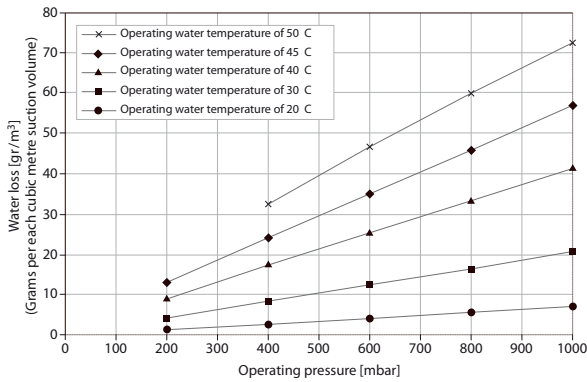


Fig. 6.1 Specific loss of water as a function of the operating water temperature and the operating pressure (Calculated for air at atmospheric pressure and 60% RH)

6.4 Extended period of non-use

Check the operating water, replace if necessary.

6.3 Possible faults by the operator

Faulty operation can cause failure of the machine.



The following must be avoided:

- Underspeeding and overspeeding (see chapter 6.2 or nameplate)
- Pressure above the permitted limit (see chapter 6.2 or nameplate)
- Blowing off the full volume flow through the safety valve when the pressure line is closed
- Vacuum below the permitted limit (see chapter 1.1 "Machine data" or nameplate)
- Poor cooling (lack of water, contaminated cooling unit)
- Poor water quality (e.g. pH, abrasive material, etc.)
- Blocked vacuum filter
- Water stop valve malfunction
- Wrong lubricating grease



Damage due to wrong operation causes forfeiture of all warranty claims on Gardner Denver.

6.5 Troubleshooting

The following table can be used for fault diagnosis.



All failures should be repaired without delay. The machine should not be started until the failure has been repaired. Repairs must only be carried out by qualified technical personnel.

Possible cause	Remedy
Poor pump output	
<ul style="list-style-type: none"> Vacuum filter soiled Suction line leaking Instrument leaking Underspeed Lack of operating water High operating water feed temperature 	<ul style="list-style-type: none"> Clean vacuum filter Locate and repair leak Replace leaking instrument Run at prescribed speed Top up operating water to maximum level Inspect the operating water cooling system
Abnormal noise ¹⁾	
<ul style="list-style-type: none"> Poor machine alignment Bearings worn Operating water grossly contaminated Incorrect speed Pressure has changed Vacuum has changed (higher vacuum needed) Vent line blocked Operating water temperature high Foreign object in the machine 	<ul style="list-style-type: none"> Re-align machine Replace bearings or have them repaired Change the operating water Keep within speed limit Keep within rated pressure Keep within rated vacuum / inspect, clean exhaust air system Inspect and/or clean vent line Inspect the operating water cooling system Remove foreign object immediately and flush the machine
Operating pressure or operating vacuum cannot be obtained	
<ul style="list-style-type: none"> Incorrect pressure gauge or vacuum gauge reading Vee belt slip Directional control valve at wrong position Operating water feed disturbed (not enough or no water) 	<ul style="list-style-type: none"> Replace pressure gauge / vacuum gauge Inspect Vee belt tension, re-tension if necessary Set directional control valve to correct position Ensure sufficient operating water supply
Operating water temperature high (above 55 °C)	
<ul style="list-style-type: none"> Not enough water in the operating system Cooling unit soiled 	<ul style="list-style-type: none"> Top up operating water & recirculate water until water temperature is less than 55°C. Clean cooling unit
Sludge or liquid has entered the machine	
<ul style="list-style-type: none"> Vehicle oversucking 	<ul style="list-style-type: none"> Clean the machine; check the operating water, change if necessary
High power consumption	
<ul style="list-style-type: none"> Overspeed Exceedingly high output pressure Pressure gauge reading wrong 	<ul style="list-style-type: none"> Keep within speed limit Keep within rated pressure, actuate/check safety valve Replace pressure gauge

Operation

Possible cause	Remedy
Safety valve blowing	
<ul style="list-style-type: none"> • Closed valves in pressure line • Pressure pipework blocked 	<ul style="list-style-type: none"> • Open valves • Remove blockage
Compressed air exits at shaft end and water leaks	
<ul style="list-style-type: none"> • Seal damaged 	<ul style="list-style-type: none"> • Replace shaft seal in end cover or have it repaired • Check Mechanical Seal & replace if necessary
Rubber smell (with Vee belt drive)	
<ul style="list-style-type: none"> • Vee belt slip due to lack of belt tension • High output pressure 	<ul style="list-style-type: none"> • Check belt tension, re-tension if necessary • Keep within rated pressure
Vee belts buckling	
<ul style="list-style-type: none"> • Lack of belt tension • Belt wear • Belt pulley out of alignment • Belt pulley wear 	<ul style="list-style-type: none"> • Check belt tension, retension if necessary • Install new Vee belts • Align pulley • Replace pulleys



1)The cause of abnormal noise in the machine can be a foreign object; remove the foreign object without delay.

If the problem persists, please call our Service department.

7. Maintenance

7.1 Warranty

Damage due to non-compliance with the installation and operating instructions are not covered by the warranty.

Please note that repairs to the liquid ring pump must be made by an authorized repair centre using original parts. Otherwise the warranty will be invalid.

7.2 Maintenance, maintenance schedule



When carrying out maintenance or inspection, observe the safety instructions (chapter 2. "Safety instructions and hazard alerts").

Machine failure due to poor or improper maintenance can result in high repair costs and machine down time. Regular maintenance is therefore necessary.

The operating, safety and service life of the machine are largely determined by the level of maintenance undertaken.

The table below contains time, type and maintenance work information for normal service of the liquid ring pump.

The specified maintenance intervals assume approximately 5 hours of pump service per day. If your service conditions are different, the maintenance intervals may be proportionally shorter or longer.

As operating conditions may vary, no forecast can be made as to how often the necessary wear inspections, maintenance and general inspections should be made. Decide on the most suitable arrangement in the light of your conditions.



Refit all guards properly after completion of any maintenance work.



Dispose of grease, cleaners and spent components, e.g., filter cartridges, as prescribed by the environment laws.

7.2.1 Water back-cooling with air

The flow of cooling air must not be obstructed.

- Remove dust and dirt from the cooler every week.
- Inspect the operating water level in the compensation tank and top up water if necessary.

7.2.2 Liquid ring pump

- Clean the machine every week.

7.2.3 Vacuum filter (GDD types)

Depending on the dust load, daily cleaning may be necessary; clean at least once every week.

The filter insert consists of either a stainless steel mesh or a fine filter cartridge.

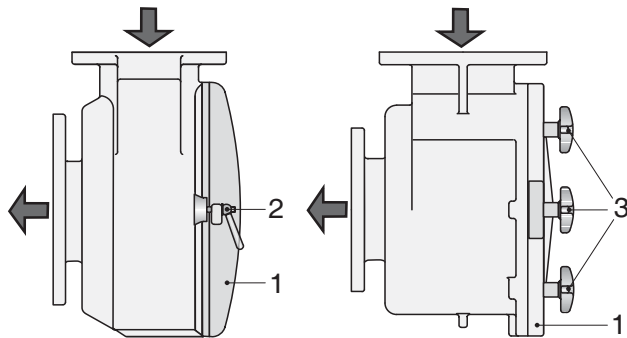
Maintenance points	Type of work	See chapter	Maintenance interval		
			1 week	1 month	3 months
Cooling unit/water cooler	clean	7.2.1	X		
Liquid ring pump	clean	7.2.2	X		
Vacuum filter	clean	7.2.3	X		
Safety valve	check	6.2.1	X		
Water stop valve	check	6.2.2	X		
Vee belts, Vee belt tension	inspect, re-tension	7.2.4	X		
Non-return valve	check	7.2.5			X

Opening the filter:



Warning!
Only open when the machine is stopped and de-pressurized.

Slacken or unscrew the tapered handle or star handles (7.1/2+3). With type SFA, turn the cover (7.1/1) about 15° counterclockwise out of straight pins. With type SFD, simply lift up the cover.



1 Cover
2 Tapered handle (type SFA)
3 Star handle (type SFD)

Fig. 7.1 Vacuum filters SFA and SFD

Cleaning the filter



Caution!
Filter cover is under moderate spring tension.

- Wash out the filter housing with a cold cleaner.
- If the filter insert is stainless steel mesh it can be washed out with cold cleaner.
- If the filter insert has a fine filter cartridge, it can be blown out with a steam jet directed from the inside to the outside. Inspect the fine filter cartridge for damage. Replace damaged filter insert.
- Inspect the round seal ring or seal for damage. Replace damaged seal.

Make certain that dirt or cleaning residue does not enter the pump when the filter housing is cleaned.

Assembling the filter

- Install the filter cartridge.
- Place the round seal ring/seal in the cover and filter cage (type SFD) (7.1/1). Install washers to the tapered handles or star handles (7.1/2+3).
- Push the cover (7.1/1) in the housing (with type SFA; turn cover clockwise into the straight pins (7.1/6)).

- Tighten the cover with tapered handles or star handles (7.1/2+3).

7.2.4 Vee belts and Vee belt tension



Remove the Vee belts and Vee belt/drive guards only when the machine is stopped and the vehicle engine is stopped.

Inspect the Vee belts and the Vee belt tension every week and re-tension or replace the belts if necessary, see installation section 4.

Always replace damaged Vee belts as a complete set of length matched belts.

7.2.5 Non-return valve

The non-return valve needs maintenance every 3 months.

We recommend a first inspection after 300 operating hours.

7.3 Lubrication

7.3.1 Antifriction bearings

The antifriction bearings of the liquid ring pump are pre-lubrication with enough grease for 5,000 operating hours.

The special lubricating grease ensures outstanding wear protection, excellent resistance to water and debris, good corrosion protection, good ageing resistance and an especially high resistance to tribocorrosion.

The grease is available from Gardner Denver in 400g cartridges (Part No. TW53105000).



Work on the antifriction bearings must only be carried out by trained personnel with knowledge of the equipment and the potential risks.

The lubrication of the anti-friction bearings must be replaced, at the latest, after 5,000 operating hours, or three years. Remove all old lubricant and clean the bearings before filling with new lubricant. Use only lubricant certified by the manufacturer (GDD Part No. TW53105000).

Remove the bearings and install new bearings (GDD Part No. TW41123100) at the latest after 15,000 operating hours.

7.3.2 Shaft seal

The Aqualine series is equipped with a mechanical seal. This seal is lubricated by the operating water & requires no regular maintenance.

8. Spare parts

8.1 Spare parts

Keeping a sufficient stock of major spares (maintenance and wearing parts) at the site of the machine is an important to ensure the constant availability of the liquid ring pump.

Please order spare parts from the Spare Parts List document no. T-ET-5000-2-EU-06-11.

Our warranty is only for original parts supplied by us.

Any installation or attachment of spare parts or extra units not supplied by us is not included in the Gardner Denver warranty. Please note that that specific manufacturing and delivery specifications may apply to parts made by us or OEM suppliers. All parts delivered by us are of latest engineering standard and satisfy latest mandatory regulations.

For ordering spare parts, please specify the data in the spare parts list...

Repairs and maintenance must only be carried out by qualified technical personnel.

Use only original parts from Gardner Denver.



Repairs and maintenance must only be carried out by qualified technical personnel.

Repairs must be carried out or parts exchanged only outside a potentially explosive atmosphere.

Use only original parts from Gardner Denver.

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The logo for Gardner Denver, featuring the word "Gardner" in a large, bold, black sans-serif font, with a thick red horizontal line underneath it. Below the line, the word "Denver" is written in a smaller, bold, black sans-serif font.

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