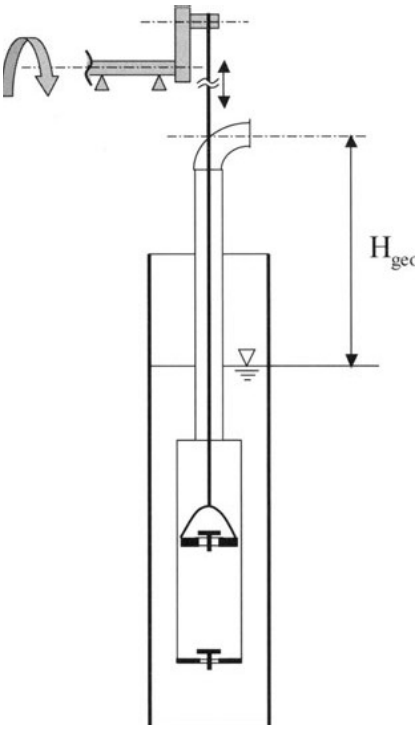
Pump

Introduction to the piston pump

The piston pump for the operation of the KUKATE 34K at is a single-acting reciprocating pump. The pump is placed in the drilled well below the water level. The pump is therefore a submersible pump. The water does not have to be sucked in, as the pump is located below the water level.



Construction

The figure shows the basic design of a reciprocating pump. The pump is embedded in the drilled well and the piston is located below the water level in the well. The piston is connected to the crank mechanism of the rotor by a linkage which runs in the mast and riser pipe. The pressure valve is located in the piston. The piston is sealed to the cylinder wall by gaskets. At the lower end of the cylinder is another valve (foot valve) which, when closed, closes the opening between the well and the cylinder chamber.

Function

Above the piston is water, which exerts a pressure on the surface of the piston and valve. As a result, the valve is closed so that the water above the piston is lifted by the stroke movement of the piston. The water is forced out of the outlet via the riser.

Meanwhile, water flows into the cylinder chamber through the open foot valve. At top dead center (TDC), which represents the top reversal point of the piston, the downward movement of the piston begins. With the valve open, the valve piston is moved by the water in the cylinder. The foot valve is closed during this process. The water in the cylinder flows through the piston valve into the upper cylinder chamber.

When the piston reaches bottom dead center (BDC), the direction of piston movement reverses and the stroke movement starts again. Due to the pressure exerted on the piston by the water mass above it, seals between the piston and the cylinder wall often become damaged. On the KUKATE 34K, the piston and piston linkage can be easily removed. The seals are made of leather and can be easily made and replaced by the customer.
Tubular piston pumps have an external seal, which is designed as a stuffing box. The advantage of our reciprocating pump KUKATE34K is that we can achieve flow rates from 10m depth of 1liter per second at approx. 6m/s wind speed even at low speeds.

Only at high heads do the leakage losses of the pump due to defective seals and delayed valve closure become noticeable. This is also shown in the figure, which illustrates the basic pump characteristic curve of a piston pump. As a result of increased leakage losses at high heads (H), the pump curve shows a slight curvature in the direction of lower flow rates (Q).

One disadvantage of the reciprocating pump is that all the pumping work is done when the piston rises. This leads to out-of-round running and to large dynamic forces during the upward movement of the piston. With the KUKATE34, the force required at piston rise is reduced by pretensioned springs or rubber bands which are clamped between the mast structure and the piston rod, and at the same time smooth running of the pump is achieved. The springs or rubber bands are tensioned when the piston goes down and thus support the pumping process when the piston goes up.

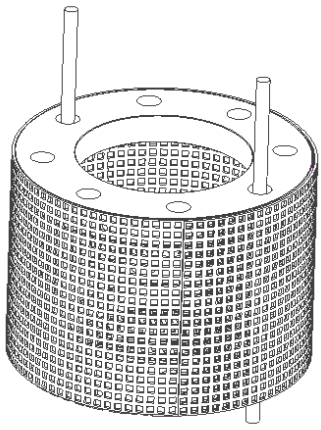
Pipe system

The tube system of the KUKATE34K also serves as a cylinder for the piston of the reciprocating pump. It is composed of several pipe sections. These are connected with flanged joints. Therefore, transporting the pipe system, which is 10.7 meters long in total, is easy. Installation in the drilled well is simple with the wind turbine in place. The pipe system is constructed from PVC-U pipes and fittings. The material has very good mechanical properties and is therefore suitable for use in groundwater production.

In addition, the processing of the pipe parts is very simple due to the adhesive technology. PVC adhesive is used as the adhesive. This dissolve the surfaces of the parts to be joined and creates a firm bond between the parts through the outgassing of the solvent. This process is also known as swelling welding. The bonded joint then has the same properties as the original material.
The individual areas of the pipe system are described below.

Strainer

The suction strainer represents the inlet opening for the well water into the pump. It serves to keep coarse impurities away from the pump. The suction openings are covered with screens. The total free cross-sectional area of the screen openings is at least four times the cross-sectional area of the suction pipe. This keeps the suction resistance low even in the event of partial blockage.
The suction strainer can be improvised:

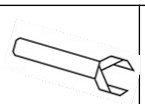
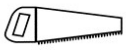


The strainer must have the following design features:

- It is attached to the bottom of the pump pipe.
- Its diameter must be smaller than that of the well pipe.
- Its material must be corrosion-resistant and mechanically stable.
- The suction strainer must not noticeably obstruct the water flowing into the pump cylinder.

Figure 1 – Complete strainer

Tools

				
	8;10	WS 13; 16	Metal	Metal

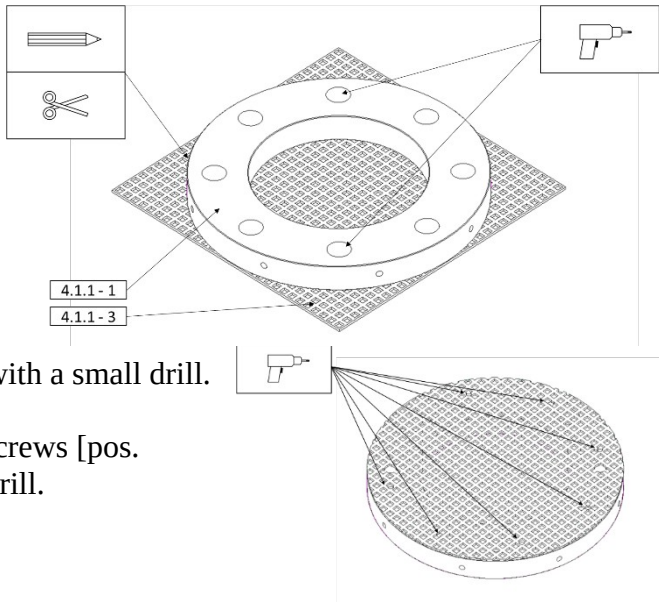
Material

Pos	Raw material	Name	Standard	Dimensions	Qty	Material
4.1.1 - 1		loose-type flange	DIN 8062		2	PVC
- 2	**R - 2**	floor grid	EN AW 5754	160x750x2mm	1	Aluminium
- 3	**R - 2**	floor grid	EN AW 5754	220x220x2mm	1	Aluminium
- 4		threaded rod	DIN 976	M10x560 mm	2	
- 5		hex nut	DIN EN ISO 4032	M10-A2-8.8	8	
- 6		washer	DIN EN ISO 7091	10-A2	8	
- 7		hex nut with torque part	DIN EN ISO 7040	M10-A2-8.8	4	
- 8		flat-head screw	DIN EN ISO 7049	St5,5x13-A2	24	

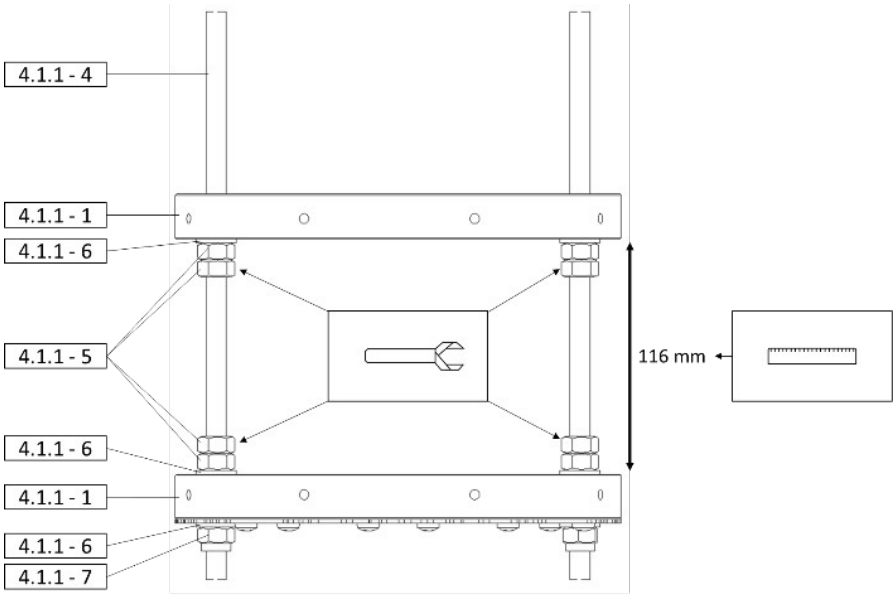
Table 1 – Bill of material 4.1.1 strainer

Construction

1. **Cut lattice plate to fit and screw together**
   To begin with, the bottom grid [4.1.1-3] is cut out of [R-2]. The flange can be used as a template for this. The flange is placed on the grid and the outline is traced. Now the disk is cut out of the grid.
   The two holes for the threaded rods can be drilled in the grille. It is important that the selected holes are aligned.
   The grille is placed on the flange and fastened with 6 screws [pos. 4.1.1-8]. The holes should be pre-drilled with a small drill.



The grille is placed on the flange and fastened with 6 screws [pos. 4.1.1-8]. The holes should be pre-drilled with a small drill.

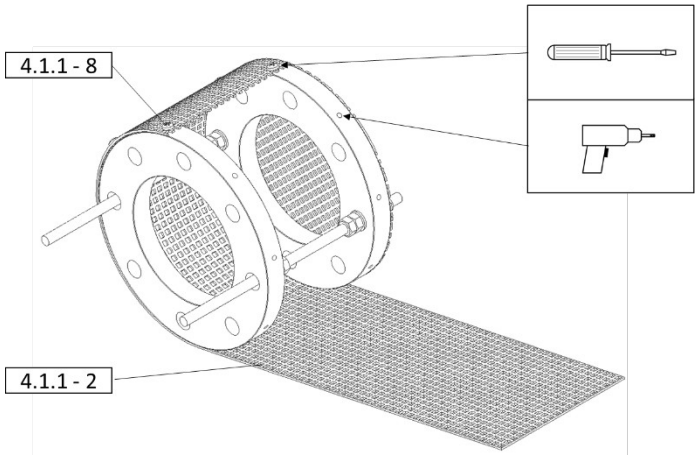


2. **Assembly of the mesh basket**

Next, the two flanges must be assembled. To do this, the threaded rods are fastened to the lower flange. As the illustration shows, four nuts must be used per threaded rod. This ensures that the nuts secure each other and cannot come loose.

3. **Mount the sieve frame on the perimeter of the suction strainer**

The sieve frame, fixed with the threaded rods, is placed on the bottom grid [4.1.1-2]. Both ends of the sieve are screwed to the two flanges with flat-head screws [4.1.1-8].
Now the sieve frame can be rotated over the work surface with the grating plate resting against the outer surface of the flanges. Every 90 mm, the bent mesh plate is fixed in the flanges with a screw [4.1.1-8].



Foot valve

The foot valve is located directly above the strainer and consists of a valve plate, a flexible rubber plate and a valve plate, as shown in Figure 2. The parts are connected to each other by three screw connections. The foot valve is used for the flow of the pumped liquid from the suction area into the cylinder, in which the piston performs its up and down movement. During this movement, the flexible rubber plate must close when the piston goes down, so that the water cannot flow back into the suction strainer outside the piston. When the piston moves upward, the rubber bands and releases the flow area through the foot valve plate. The water flows into the free cylinder area below the piston.

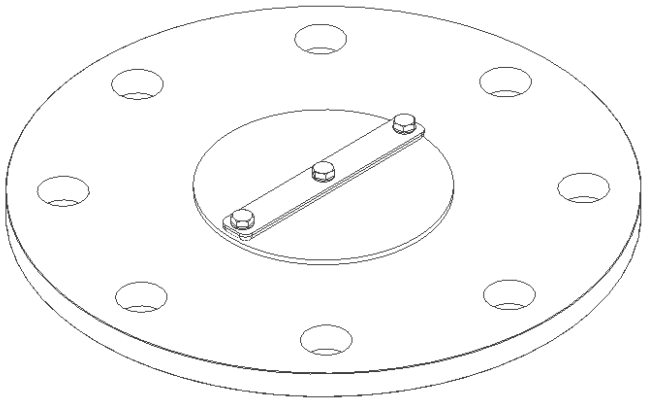
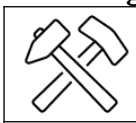
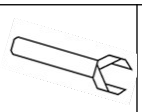
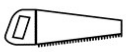


Figure 2 – Complete foot valve

Werkzeug

					
	4;5;10	WS 8	Metal	Metal	Chisel

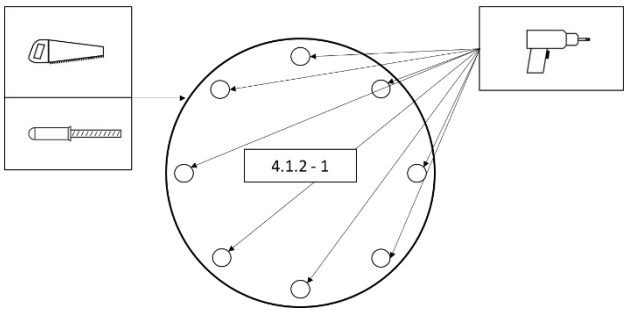
Material

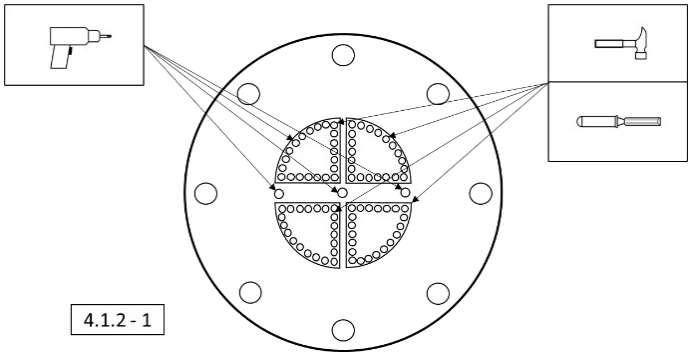
Pos	Raw material	Name	Standard	Dimensions	Qty	Material
4.1.2 - 1	**R - 1**	Piston crown	DIN EN 573-1	220x220x10mm	1	Aluminium
- 2	**R - 3**	Sheet	DIN EN 573-1	90x14x4mm	1	Aluminium
- 3	**R - 4**	Plate		80x80x2mm	1	Rubber
- 4		Hexagon head screw	DIN EN ISO 4017	M5x35-8.8	3	
- 5		Washer	DIN EN ISO 7092	5	6	
- 6		Hexagon nut with torque part	DIN EN ISO 7040	M5-8.8	5	

Table 2 – Bill of material 4.1.2 foot valve

Construction

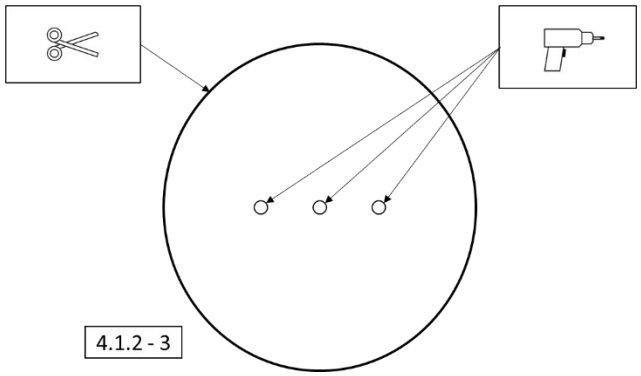
1. **Sawing / drilling the aluminium plate**
   At the beginning, the aluminium plate is also [4.1.2-1] sawn into a disc with the diameter of 220mm. After that, the disk is filed with a file. The 8 holes are drilled with an 18mm drill bit.



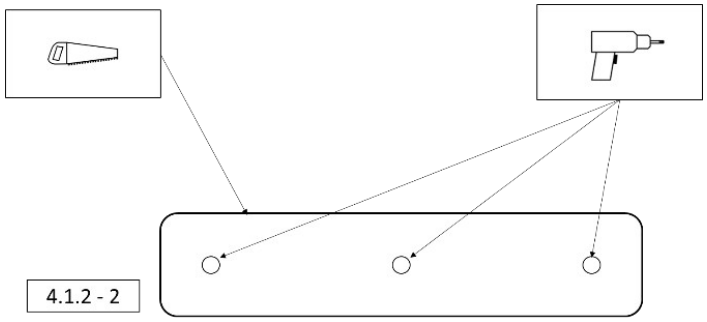


2. The inner four recesses are drawn first. Then it is recommended to drill several holes close to each other with a 4mm - 6mm drill bit. Make sure that the holes do not touch the drawn line. Then, using a flat chisel and a hammer, punch out the ridges between the holes and file the four inner contours. Finally, the 3 holes are drilled. You can also saw out the four recesses with a jigsaw.

3. **Prepare rubber plate**
   The rubber on the right is cut to a diameter of 90mm and the 3 holes are drilled with a 5mm drill. It is useful to use the plate [4.1.2-1] as a template.



---

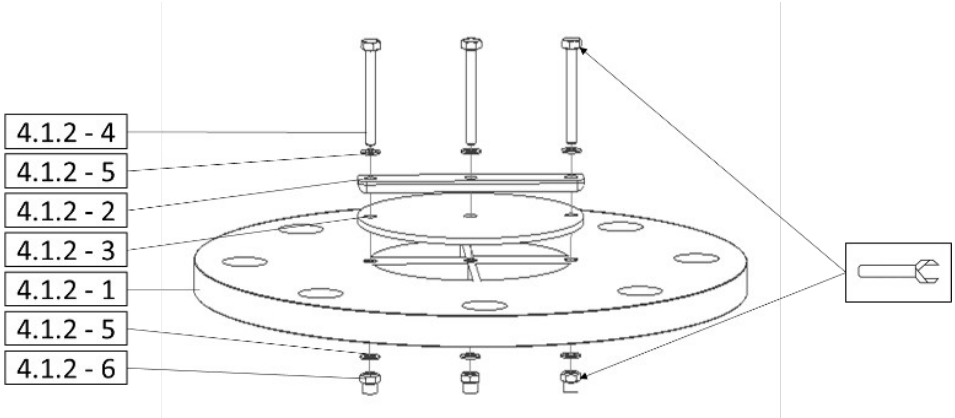
4. 

The aluminum bar is the last component of the foot valve to be manufactured. It is sawn, filed and then provided with 3 holes. It is also advisable to use the aluminum plate [4.1.2-1] as a template. This has the advantage that the holes of all three components are aligned.

<u>It is important to provide the lower two edges of the aluminum sheet with a radius of at least 3mm. Then the valve plate will not bend over a sharp edge during each pump stroke.</u>

---

5. **Assembly**
   Finally, the foot valve is assembled.
   For this purpose, the piston head [4.1.2-1], the rubber plate [4.1.2-3] and the aluminum plate [4.1.2-2] are placed on top of each other and fastened with the screws [4.1.2-4], washers [4.1.2-5] and nuts



[4.1.2-6].

Outlet

The outlet area consists exclusively of PVC-U pipes and fittings, which are glued together. In the lower area of the outlet, a flange forms the connection to the pipeline. This is screwed to the upper flange of the pipeline via a sealing ring. The upper fixed flange is glued to a 0.7m long pipe, which is provided with a cross piece at the upper end.
At the upper end of the crosspiece, a short pipe forms the connecting element between the fixed flange and the crosspiece. A cross-sectional constriction is glued to one of the two sides of the crosspiece, which, together with the connected pipe bend and a hose nozzle, narrows the line to a diameter of d = 25mm.
By means of a hose clamp, a hose di = 40mm can be attached to the outlet of the pump. The outlet is located at a height of h = 0.6m above the floor, so that a bucket can be placed under it without any problems. The other side of the cross piece offers the possibility of a further outlet. In the illustration, this is closed with a sealing cap.

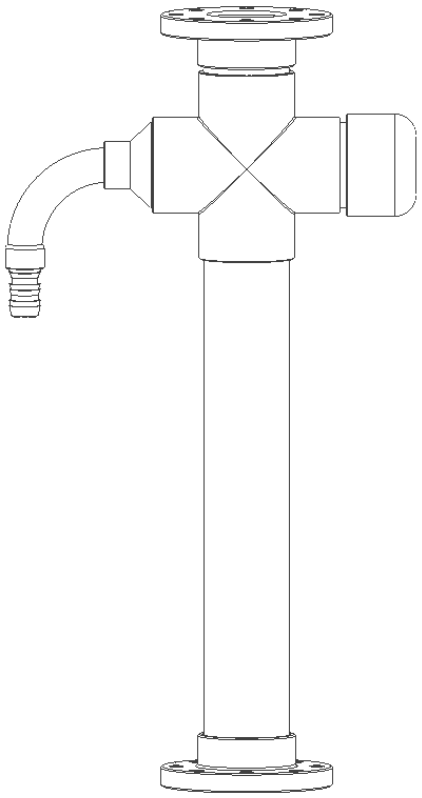


Figure 3 – Complete outlet

<u>Before bonding, the surfaces must be degreased and cleaned. (spirit, gasoline)</u>
<u>Bonding must be done quickly and without stopping. The bonding can no longer be removed.</u>

Alternatively, the cross piece can also be replaced by a T-piece if only one outlet is required.

The entire pipe system of the KUKATE34K can also be designed with other pipes if the standardized PVC pipe system selected by us is not available. The inner surface of the pipes must be very smooth in the area of the piston stroke. There the pipe surface forms the cylinder wall of the pump.

However, the piston diameter should not be smaller than 100mm. If it is 120mm, for example, you would have to reduce the stroke at the eccentric by approx. 40% (since the piston area is then 44% larger). Care must be taken to ensure that the rubber valve flaps do not flap on too large flow cross-sections in the cylinder base and piston (recesses or holes). They will then break down sooner.

Werkzeug

	Glue	Metal

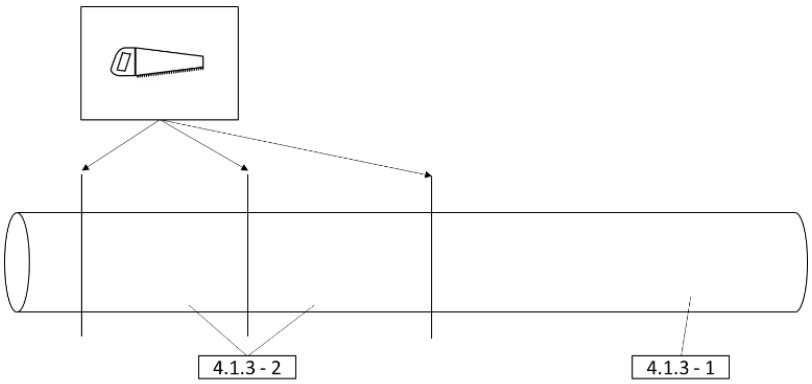
Material

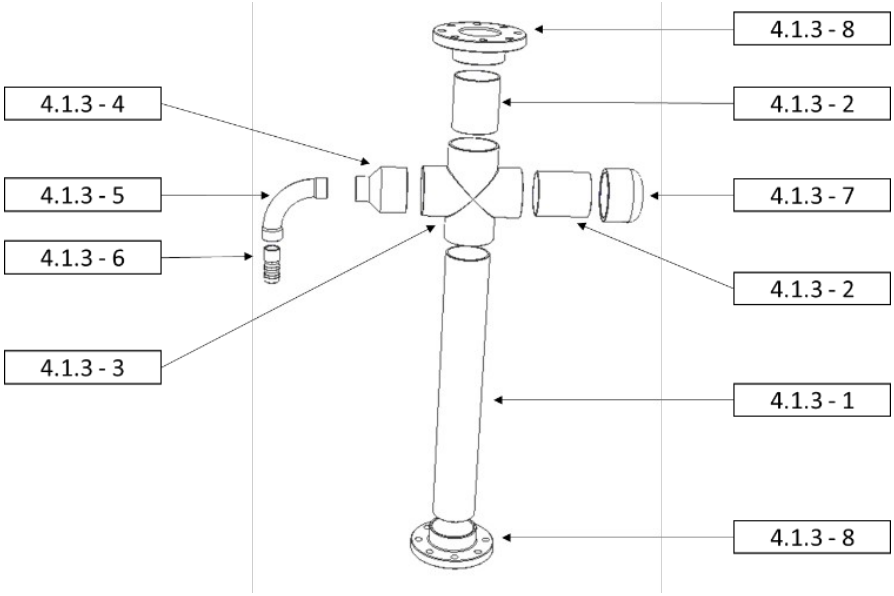
Pos	Raw material	Name	Standard	Dimensions	Qty	Material
4.1.3 - 1	**R - 5**	Pressure pipe DN 100	DIN 8062	730mm	1	PVC-U
- 2	**R - 5**	Pressure pipe DN 100	DIN 8062	130mm	2	PVC-U
- 3		Crosspiece DN 100	DIN 8062		1	PVC-U
- 4		Narrowing DN 40	DIN 8062		1	PVC-U
- 5		Round arch DN 40	DIN 8062	90°	1	PVC-U
- 6		Hoze nozzle DN 40	DIN 8062		1	PVC-U
- 7		cover DN 100	DIN 8062		1	PVC-U
- 8		Fixed flange DN 100	DIN 8062		2	PVC-U

Table 3 – Bill of material 4.1.3 outlet

Contruction

1. **Sawing pipes and bonding them with flanges**
   At the beginning, the tube [R-5] is to be sawn into 3 parts. The two required pressure pipes [4.1.3-1] and [4.1.3-2] are created from this.





2. **Now the spout is assembled.**

- Then clean the surface.

- The adhesive surfaces should be roughened with sandpaper beforehand.
- Then apply the glue and mount the frame.

Allow the entire assembly to rest for 24 hours.

Cover

The cover forms the upper termination of the pipe system and consists of a conventional PVC-U blind flange and a piece of wood, which are screwed together. The wooden block is sawn into two parts during production. This simplifies installation and maintenance. At the same time, it serves as a sliding bearing for the rod, which performs up and down movements in the center.

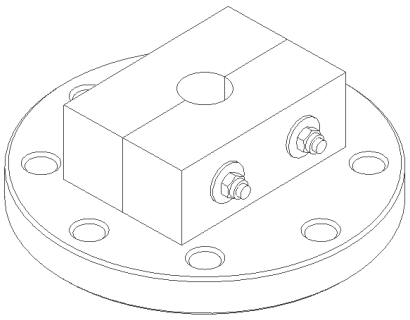
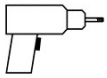
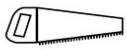
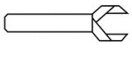


Figure 4 – Complete cover

Tools

				
	8	Metal wood	WS 13	

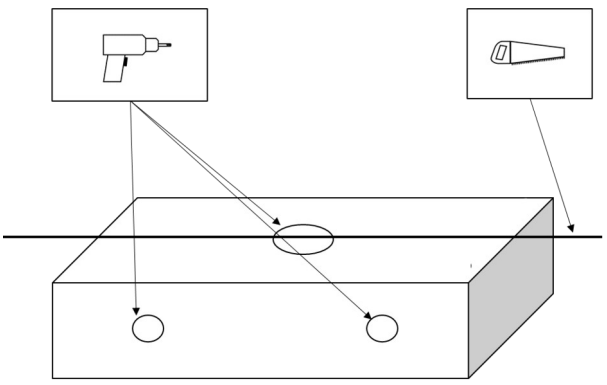
Material

Pos		Raw material	Name	Standard	Dimensions	Qty	Material
4.1.4	**-1**		Blind flange DN 100	DIN 8062		1	PVC-U
	-2		Hardwood block		45x130x40mm	2	wood
	-3		Wood screw	DIN EN ISO 7050	5,5x45mm	4	
	-4		Threaded rod	DIN 976 - A2	M8x120mm	2	
	-5		Fender washer	DIN 9021 - A2	M8x25	4	
	-6		Hexagon nut with torque part	DIN EN ISO 7040	M8-A2-8.8	12	

Table 4 – Bill of material 4.1.4 cover

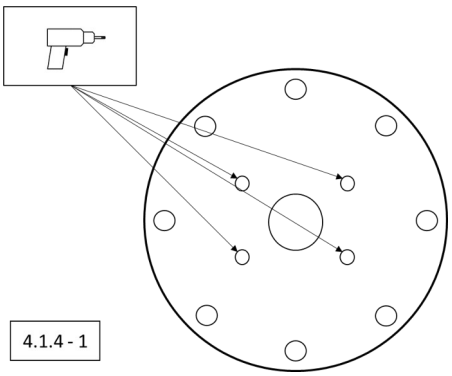
Contruction

1. **Drilling and sawing wood storage**
   To begin, saw the block of wood to dimensions. After that, the side holes are drilled with an 8mm drill. Then the wood block is sawn through in the middle. After that, the 30mm hole is drilled.
   Attention:
   This center 40mm sleeve bearing hole must closely surround the smooth piston rod as a fit.
   If the water is to be pumped into, for example, a 1.5m high reservoir, the bearing must be as tight as possible or you must extend the pipe section [4.1.3-1] according to the pumping height.



4.1.4 - 2

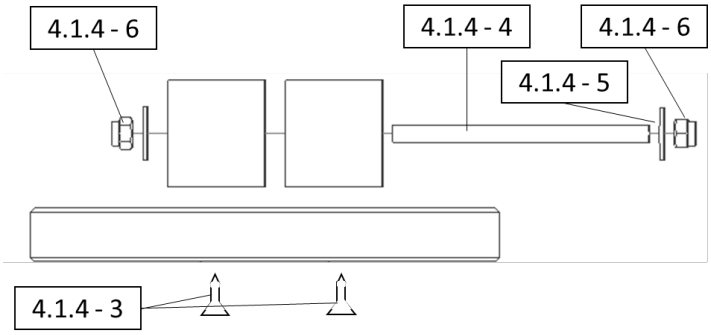
Here, instead of wood, you can choose, for example, PVC or another plastic block.

2. 

Drill screw holes

Now drill the Ø8mm holes in the blind flange as well. Make sure that the center hole of the wooden block is centered on the flange. The wooden block can be used as a template.

3. Finally, the two components are screwed together. The wood screws [4.1.4-3] are not visible from above.

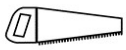
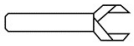


Pipe System

The piping of the KUKATE34K forms the riser pipe for the water and connects the inlet area (suction strainer) with the outlet area. It also serves as a cylinder for the piston. The pipeline with a total length of l= 9.52m consists of 3 segments which are connected by flange joints. This is necessary to enable transport to the installation site and assembly in the mast.
The individual pipe segments are connected by bolting the fixed flanges, which are glued to the pipes at the respective ends. In the process, the flange gasket is placed between the fixed flanges. **It must be ensured that the pipes cannot move at the joints so that the piston can be inserted and removed without any problems.**
For this reason, the PVC flange of pipe segment 1 is not pushed flush onto the pipe on one side but is glued in such a way that the pipe protrudes a little from the flange. On pipe segment 2, the flange is glued to the pipe on one of the two sides in such a way that the pipe ends inside the flange and has a distance to the flange surface. In this way, the protruding tube of segment 1 can be inserted into the flange of segment 2 and a crescent-shaped displacement of the tubes can be excluded. The same procedure must be followed for all other connections. The length of the segments is determined by the depth of the well. In these instructions, a water depth of 9.52 m was assumed, as this corresponds to the depth of the test installation. Accordingly, the length must be adjusted individually.

Figure 5 – Complete pipe system

Tools

			
	Kleber	Metall	SW 24

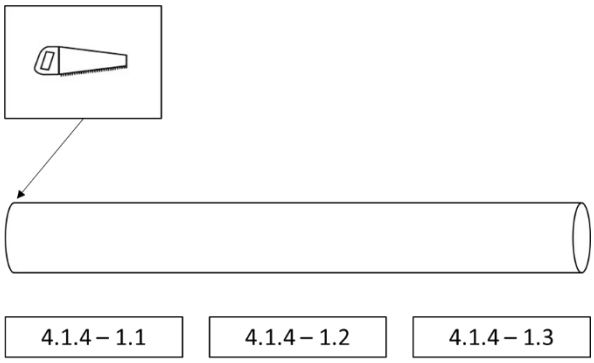
Material

Pos		Raw material	Name	Standard	Dimensions	Qty	Material
4.1.5	**-1**	**R - 5**	Pressure pipe DN 100	DIN 8062	3000mm	3	PVC-U
	-2		Fixed flange DN 100			6	PVC-U
	-3		Flange seal DN100		Ø110x4mm	3	Rubber
	-4		Hexagon head screw	DIN EN ISO 4017	M16x90-A2-8.8	32	
	-5		Hexagon nut with torque part	DIN EN ISO 7040	M16-A2-8.8	32	
	-6		washer	DIN EN ISO 7091	16	64	

Tabelle 5 - Stückliste 4.1.5 Rohrverbindung

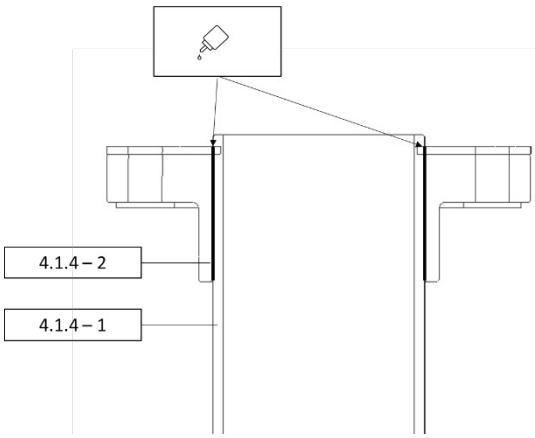
Construction

1. **Saw tubes**
   At the beginning, the 3 tubes [Pos. 4.1.5-5] are sawn to length. Depending on the water depth, this length must be adjusted individually. Make sure that the lowest pipe protrudes into the water.



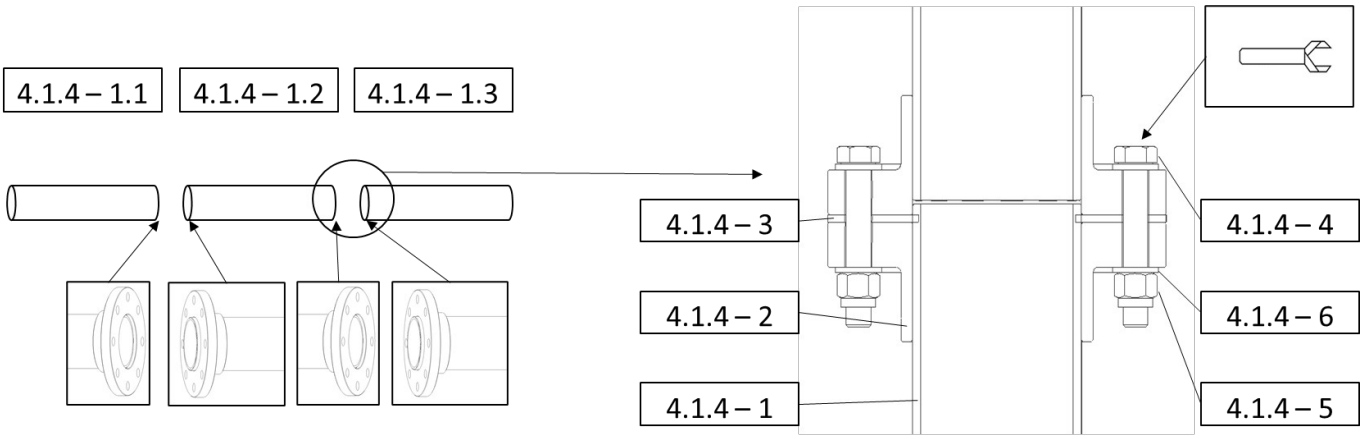
---

2. **Glue connection between the pipes staggered in length**
   Next, the flanges [Item 4.1.5-2] are glued to the pipes. The figure shows the places to be glued. Make sure that the pipe ends protrude 14mm on one side and the flange protrudes 16mm on the other side. This ensures that the tubes and the flange gaskets [Item 4.1.5-3] are aligned during subsequent assembly. Only then can the piston be pushed through the entire length of the pipe.
   At the end of the entire pipe, the flanges are glued flush with the end flanges.



---

3. **Assembly on site**
   Finally, the pipe segments are assembled. It is recommended to assemble this only at the place of use.



Disc piston

The valve piston of the pump is a disc piston. It consists of two piston heads, between which the leather package is clamped as a seal to the pipe. The valve rests on the valve base of the piston and consists of a flexible rubber plate. This is attached to the piston via a valve plate. The piston heads consist of two aluminum plates of equal size. To prevent contact between the piston heads and the cylinder wall, they are smaller than the inside diameter of the PVC tube.

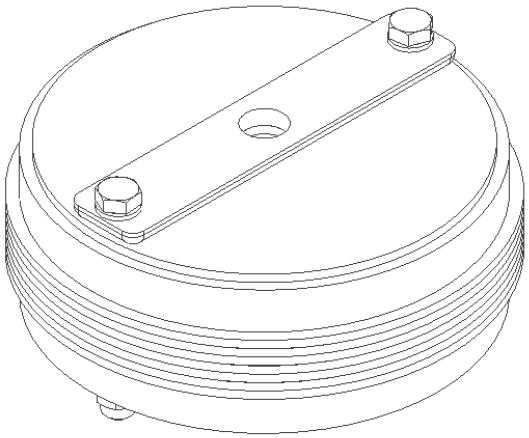
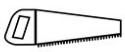
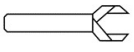
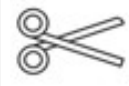


Figure 6 – Complete disc piston

In addition to the holes used for fastening, the upper piston head is provided with holes which form the flow cross-section through the valve head. The holes are arranged in such a way that the flow cross-section is as large as possible with simple manufacture, and at the same time there is a support surface for the rubber plate between the openings. Because of the great weight of the water column bearing down on the valve, the holes must not be made too large. Otherwise, the weight of the water would push the valve plate in through the openings.
The bottom of the piston is used to secure the leather pack, which is sandwiched between the two piston bottoms. This is provided with 2 large crescent-shaped openings so that as few losses as possible occur when the pumped medium flows through.
The leather pack is located between the piston crowns and serves as a seal between the piston and the cylinder wall. The leather pack consists of alternating leather discs and aluminum rings. The aluminum rings act as separating discs between the leather sealing rings and have a stabilizing effect.

Tools

					
	10;7;5	Metal	WS 8	Metal Leather	

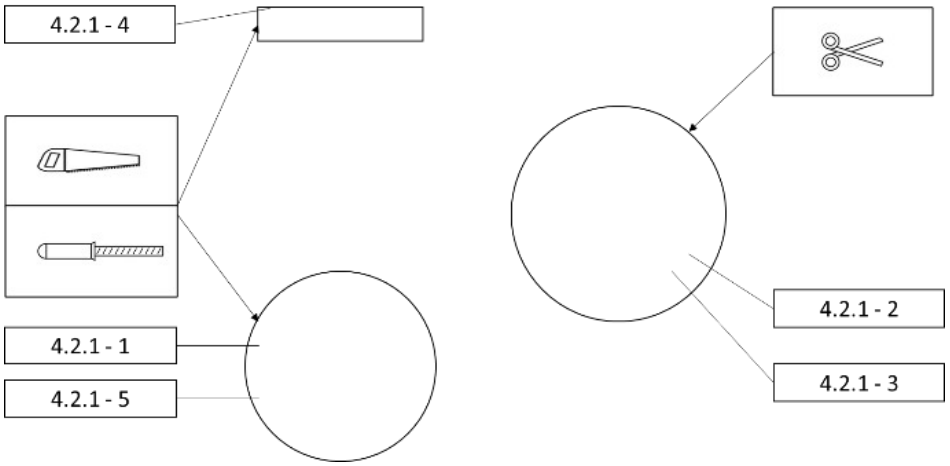
Material

Pos		Raw material	Name	Standard	Dimensions	Qty	Material
4.2	**-1**	**R - 1**	Plate	DIN EN 573-1	100x100x10mm	2	Aluminium
	-2	**R - 4**	Plate		90x90x2mm	1	Rubber
	-3	**R - 7**	Leather seal		102x102x2mm	4	Leather
	-4	**R - 3**	Sheet	DIN EN 573-1	90x13x4mm	1	Aluminium
	-5	**R - 11**	Sheet	DIN EN 573-1	100x100x2mm	3	Aluminium
	-6		Washer	DIN EN ISO 7092	5	4	
	-7		Hexagon head screw	DIN EN ISO 4017	M5x5-8.8	2	
	-8		Hexagon nut with torque part	DIN EN ISO 7040	M5-8.8	2	

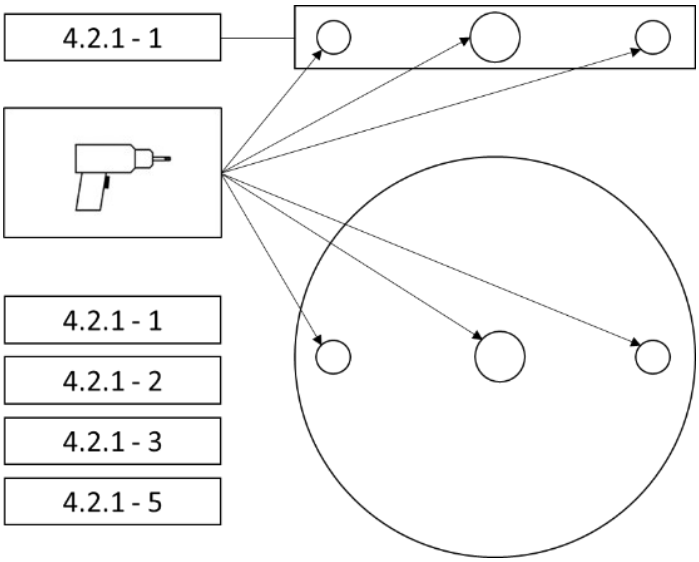
Table 6 – Bill of material 4.2 disc piston

Construction

1. **Make different slices**



To begin with, the components are cut to their outer diameter. First roughly saw out and then file to size. The bar is also first sawn and then filed to length. The leather and rubber components are cut out exactly in a circle.
If a lathe is available, you can rough saw out the discs first. Then clamp them tightly on a threaded rod M10 and then carefully turn them round.
(It is then helpful to initially drill the 10mm hole only 9.8mm tight or if too tight 9.9mm tight so that the discs can be centered and clamped tightly onto the threaded rod).

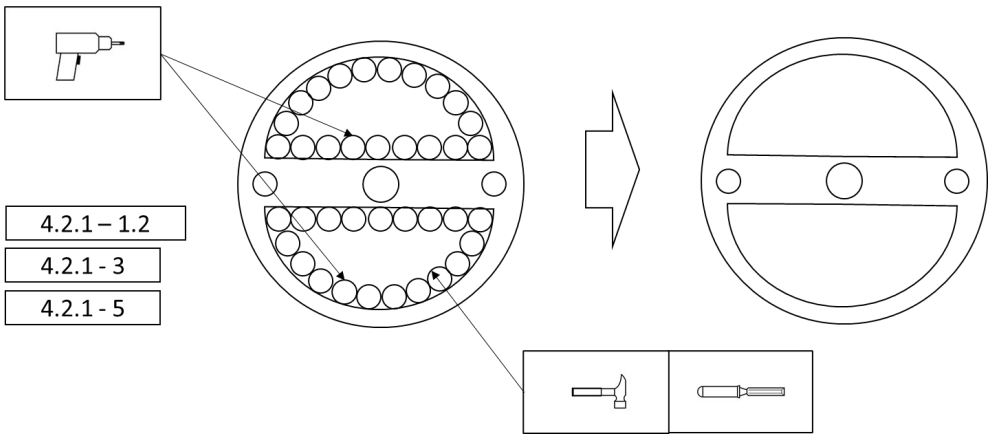


2. **Drill holes**

The holes in the piston crowns, which are used for fastening, must line up exactly. Small inaccuracies can cause the parts to rattle during operation. <u>For this reason, all components should be placed on top of each other and fixed when drilling the fastening holes and the holes should be drilled through both components at the same time.</u> <u>The center hole can also be drilled.</u>

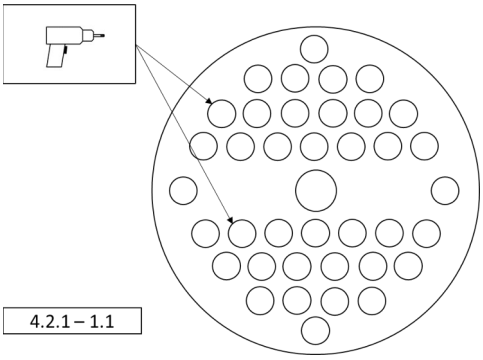
---

3. **Make recesses in the discs**



The next step is to make the recesses. To do this, holes are first drilled next to each other with a 5mm drill bit. After drilling, the holes are hammered out with a hammer and chisel and filed to size.

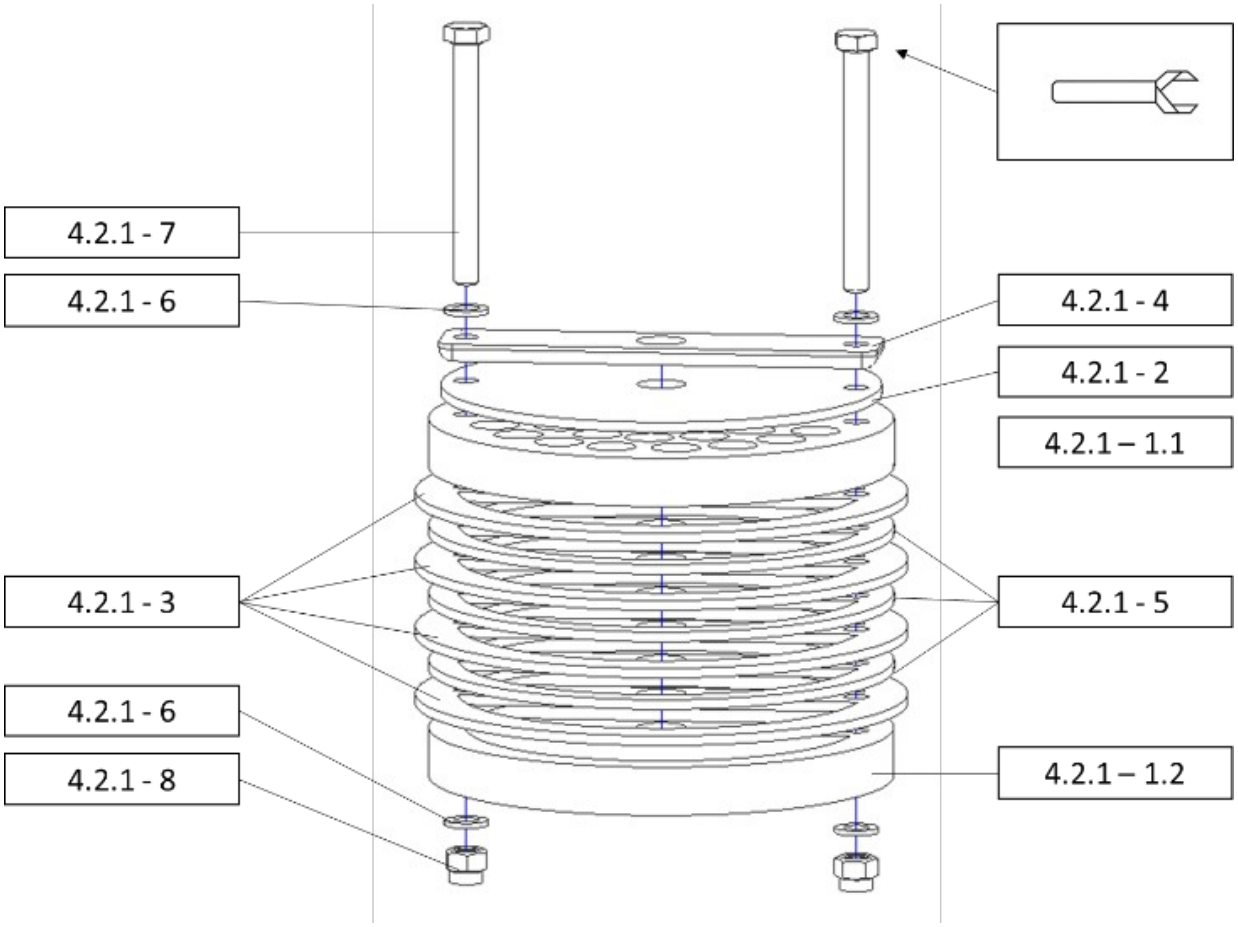
These openings can also be made with a jigsaw.



4. The upper aluminium plate is simply provided with holes (Ø7mm). The arrangement is less important, but a minimum distance of 1mm should be maintained between the holes.

---

5. Finally, all components must be screwed together.



Connecting rod

The piston linkage provides the connection between the piston and the drive unit and will have a total length of 21m when installed. The entire linkage is prepared in this assembly. The final assembly should only be carried out at the place of use, as this ensures easy transport.

In the event of piston downstroke, buckling may occur in the linkage due to the length as a result of the compressive stress. To avoid this, disc washers are fitted to the linkage inside the pipe system. The outer diameter of the discs is 95mm. The disc has large openings to allow the water to flow through. Normally, the discs do not rest against the pipe wall. However, if there is a bend in the downward movement of the piston, the discs will contact the pipe wall and the rod will be supported.

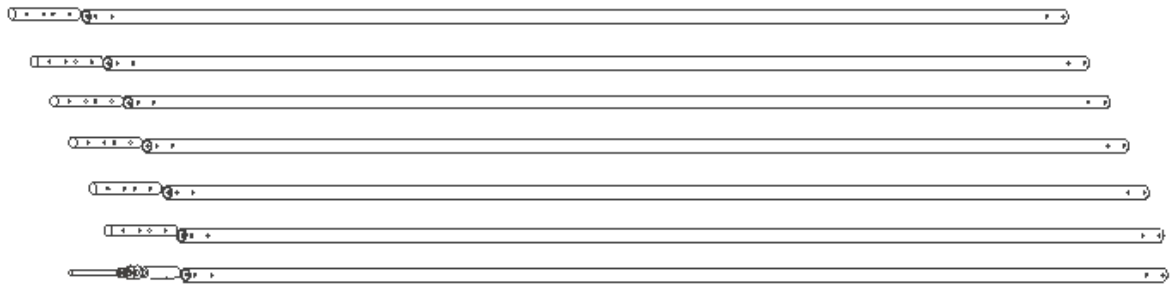
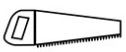
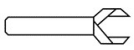


Figure 7 – Complete connecting rod

Tools

						
	8;2,6	Metal wood	WS 10	Metal		M6

Material

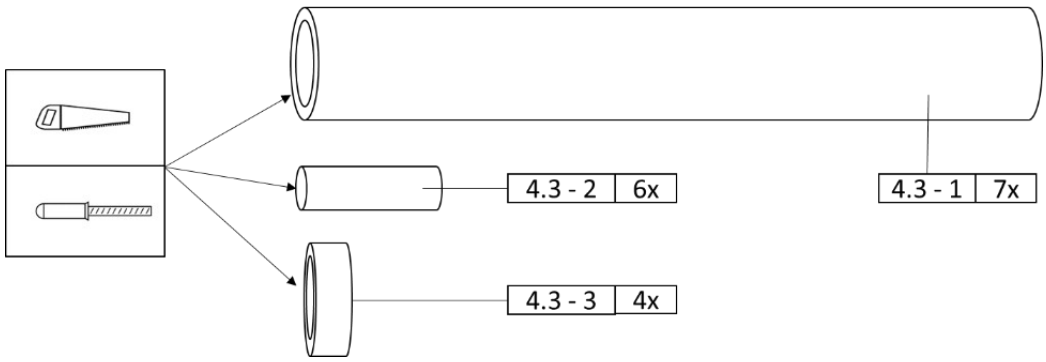
Pos		Raw material	Name	Standard	Dimensions	Qty	Material
4.3	**-1**	**R - 9**	Pipe	DIN EN 755-7	Ø30x3000mm	7	Aluminium
	-2	**R - 8**	Round profile	DIN EN 755-3	Ø24x200mm	7	Aluminium
	-3	**R - 10**	Pipe	DIN EN 755-7	Ø40x20mm	4	Aluminium
	-4	**R - 4**	Plate		35x35x2mm	1	Rubber
	-5	**R - 12**	Plate		95x95x10mm	2	Kunststoff
	-6		Fender washer	DIN 9021 - A2	M10	1	
	-7		Threaded rod	DIN 976 - A2	M10x140mm	1	
	-8		Hexagon head screw	DIN EN ISO 4014	M6x40-A2-8.8	21	
	-9		Hexagon head screw	DIN EN ISO 4014	M6x50-8.8	4	
	-10		Hexagon nut with torque part	DIN EN ISO 7040	M6-A2-8.8	25	
	-11		Hexagon nut with torque part	DIN EN ISO 7040	M10-8.8	1	

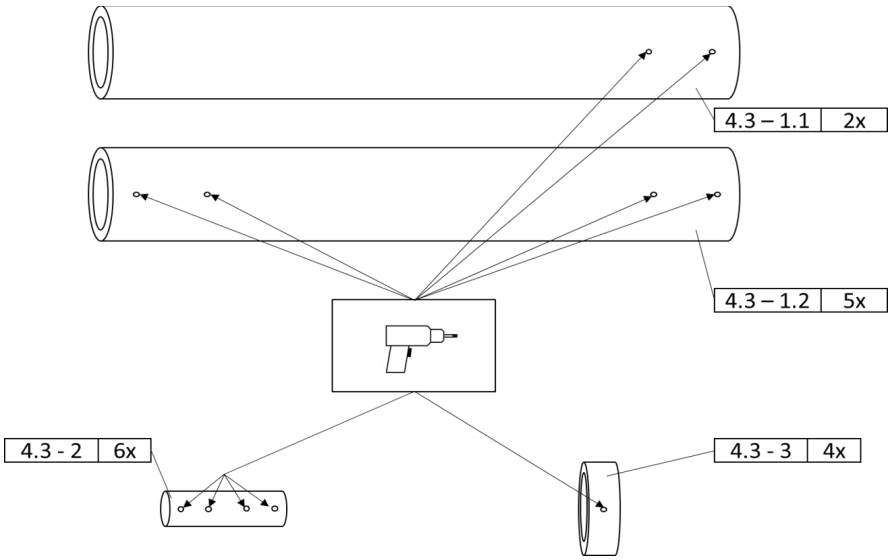
-12		Hexagon nut	DIN EN ISO 4032	M10-8.8	4
-13		Washer	DIN EN ISO 7092	10	2
-14		Threaded rod	DIN 976 - A2	M10x60mm	1
-15		Eye nut	DIN 582	M10	2
-16		rubberband			2

Table 7 – Bill of material 4.3 connecting rod

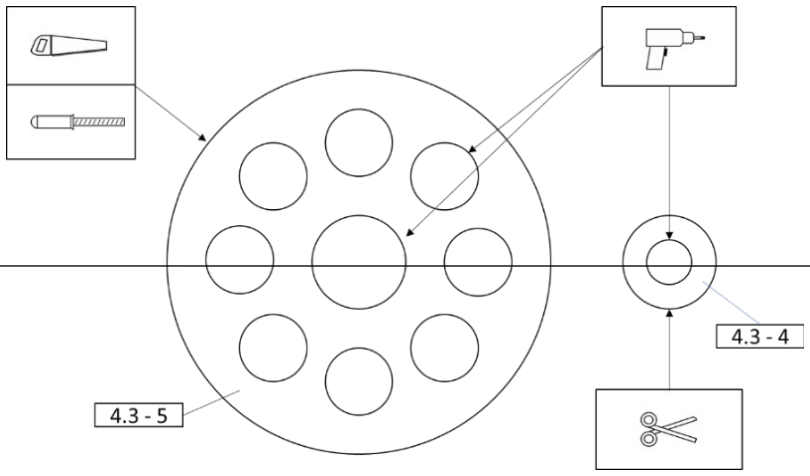
Construction

1. **Sawing and deburring**
   To begin, saw the pipes and rods to length.

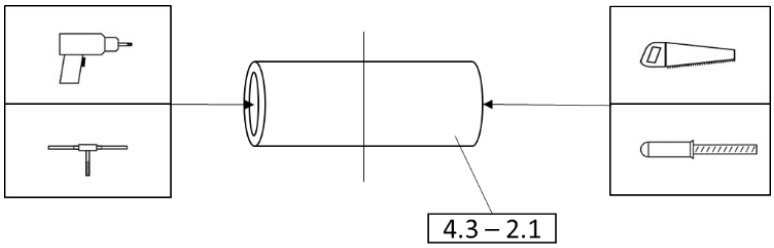




2. **Drilling**
   Next, the holes are drilled in the components shown. 4 holes are drilled in 5 of the 7 tubes [4.3-1.1] and 2 holes in the other two tubes [4.3-1.2]. These are connected to the drive shaft at the upper end and to the piston at the bottom.



3. **Fabricate plastic spacer**
   The plastic washer [4.3 - 5] is sawn out and filed to size.
   The rubber [4.3 - 4] can be cut out with scissors. The holes are then drilled.



4. **Manufacture coupling piece linkage-piston**
   First, the sleeve [4.3-2.1] is manufactured. It serves as a connecting element between the rod and the piston. First saw the sleeve to length. Then drill an 8.2 mm hole from one side up to half of the sleeve length. An M10 thread is then cut.

---

5. **Test assembly**
   One of the two end pipes [4.3-1] is now mounted with the coupling [4.3-2] and the threaded rod [4.3-7]. To do this, insert the sleeve into the tube so that it is flush and drill a 6mm hole (better: two holes crosswise 20mm apart - due to high hole reveal pressure). After the coupling has been provided with one (better 2!) screw [4.3-8] and nut [4.3-10], it can no longer slip out of the tube.
   Next, screw in the threaded rod, put the body washer [4.3-6] and the rubber [4.3-4] on it and secure it with 2 nuts [4.3-12].