DTU

Ram Pump Programme

DTU S2 PUMP

TECHNICAL
14
RELEASE

DTU TECHNICAL RELEASE NO.14 : THE DTU S2 PUMP

INTRODUCTION

This Technical Note is in four parts.

The first part (1 page) is a 'Stop Press' UPDATE containing amendments (dated November 1998) to the original which was written in 1995.

The second part (4 pages) is a summary of the pump's design and performance, suitable for copying, laminating and posting in the pump house.

The third part (20 pages numbered 1-20) is a detailed description of how to use the drawings to make an S2 pump. It should be read in conjunction with the amendments mentioned above.

The fourth part is a set of 16 drawings, of which Nos. 11a, 13, 14 and 14a have been added as amendments and offer alternatives to earlier drawings.

The 'Status' of this pump is that several dozen have been made, mostly in Africa, but that none has been run continuously for years on end. The pump is not a 'very-long-life' design although, in normal applications and incorporating the amendments in the UPDATE, continuous use should require only occasional replacement of worn parts. The Drawings deliberately do not precisely define the materials to be used, because the design is supposed to be somewhat adaptable to what is available. If all the metal parts are of mild steel, corrosion will cause some problems - especially affecting nuts and bolts and the impulse valve stem. If possible these parts should be made of stainless steel.

It is not the intention of the Development Technology Unit to undertake further development of this pump. However the Unit's Director would be happy to receive any comments from the field about its performance or any suggestions for further 'UPDATES'.

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TR14 UPDATE - November 1998

Since this Technical Release was written in 1995, based mainly on field experience in Zimbabwe and Zaire, the DTU has obtained further experience with this S2 model of ram pump. The following modifications derive in particular from observations during extended testing in Staffordshire, England during Summer 1998. The modifications are expressed as variants on the production procedure of the (original) pages that follow. Extra drawings have been added (Dwgs. 11A, 13, 14 and 14A).

1) [*Problem of steel washer cutting into delivery valve rubber disc*]
Refer to page 14 - Making the S2 pump delivery valve.

Fit a rubber washer, made from the same material as the valve disc and of the same diameter as the steel washer, between the steel washer and delivery valve disc.

2) [*Wear and tilting wobble of impulse valve stem*]

Refer to page 12 - Making the S2 pump impulse valve - and to old Drgs Nos.9, 11a & 12 and new Drawing No.11a.

Fit a second (upper) stage to the impulse valve guide. This requires that a longer valve stem and longer guide bolts are made/used than those shown in drawing number 12. The plain section of the valve stem is 50 mm longer (i.e. 100 mm overall length), the bolt shank is 50 mm longer (i.e. 130 mm long).

If a *new* two stage guide is to be used then the assembly should be welded together *before* the holes are drilled. However if the second stage of the guide is fitted *as an addition to/modification of* an existing impulse valve, then (to ensure correct location and operation of the valve itself) any welding should only be undertaken *after* the impulse valve is fully assembled and bolted to the pump body, as detailed on pages 17 to 18.

3) [*Problem of delivery valve gasket blowing out midway between the clamping bolts*]

Refer to old Drawing No.3 & new Drawing No.13

New gasket size, internal diameter = 95 mm, outside diameter = 165 mm. Using the internal diameter of the gasket shown in Dwg.13, which is a little smaller than that of the flange in Drg. 3, ensures that it protrudes slightly inside the flange. This wider gasket is primarily required between the air vessel and delivery valve plate, but can also be used between delivery plate and pump body and in the impulse valve.

4) [*Problem of rusting bolts*]

Thoroughly grease all bolts prior to assembly and use nuts or washer/nut combinations that extend to the end of the bolt threads, leaving almost no thread exposed. Of course if stainless steel bolts and nuts are available and affordable, they should be used in preference to plain steel.

5) [*Problems in aligning pump with drive pipe*]

If possible, the drive pipe, pump and cradle should be assembled in situ within the shuttering for the concrete base *prior* to any concrete being poured

6) [*Problems with marking out delivery valve plate for drilling*]

Refer to old Dwg. Nos. 5, 6 & 7 and new Drgs. Nos. 14 & 14a.

An alternative layout of holes in the delivery valve plate is to have them in parallel staggered rows as shown in Drawing number 14. The delivery valve rubber disc now flexes as a butterfly's wings and has to be retained by a bar or rod held in position by two bolts (rather than the original single central bolt) - see Drawing 14A. Slightly inferior pump output may be experienced (due to more back-leakage before the delivery valve recloses) but this layout is easier to mark out and make, so there is less chance of having too thin a wall between adjacent holes. As before, care should be taken to not so tighten the bar-retaining bolts that the valve rubber disc no longer lies flat on the valve plate. The nuts on these bolts should if possible be self-locking or held on with a locking compound such as 'Locktight'. The alternative of using a second locknut on each bolt is not so good.

7) [*Problems with silting up of intake pool*]

Ram pumps driven by water drawn from immediately below springs, or from large reservoirs, have little problem with silting. Pumps drawing water from behind small dams (e.g. 400mm high) on streams may experience major silt problems, with the 'pool' silting up by as much as 300mm after a single storm. Drawing all drive water through silt will almost certainly overload the silt-settling capacity of the drive tank. There is no easy way of automatically keeping such a pool silt-free and such locations are therefore not suitable for ram pumps unless someone is on site to apply frequent manual desilting procedures to both pool and drive tank.

DTU S2

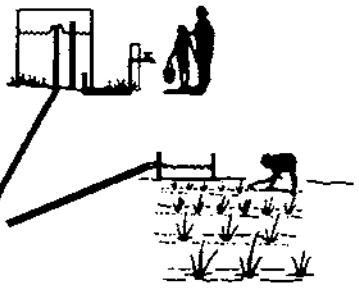
hydraulic ram pump

The name "S2" stands for a Steel pump with a drive pipe up to 2" in diameter.
The S2 replaces the DTU M8 pump

The DTU S2 hydraulic ram pump is a steel machine, using a 1.5" or 2" diameter galvanised drive pipe, that can lift water up to a height of 100 meters. It was designed for village water supply but may also be used for irrigation, and is being used successfully in many African countries. The pump has been designed to be made in small workshops with welding equipment and a pillar drill. A lathe can be useful but is not essential.

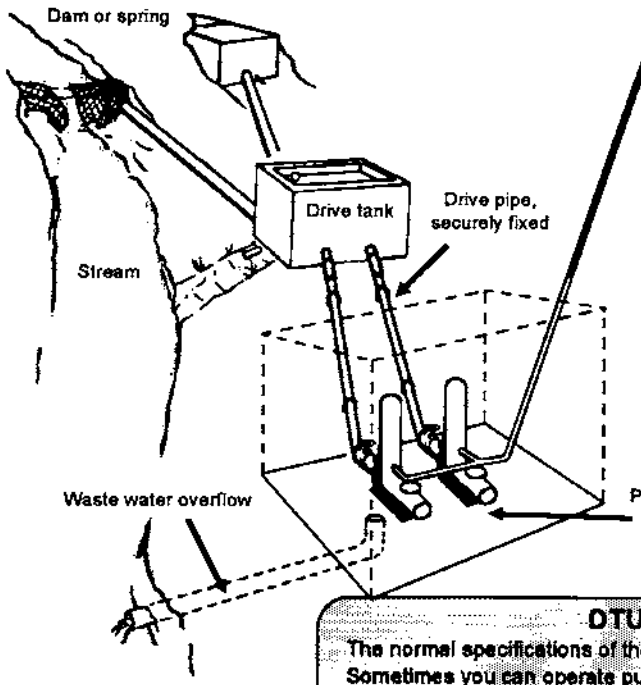
A ram pump is powered by falling water. Water from a stream or spring is diverted and dropped through a drive pipe into the pump. The power of the falling water is used to pump some of the water where it is wanted. The amount of power in the falling water limits how high you can pump, and how much water you can pump. Generally, the more water you drop and the further you let it fall, the more power there will be.

In areas where the water source flow varies greatly during the year, more than one pump can be installed, all sharing the same delivery pipe as shown in the drawing below.



Distribution system, for domestic or irrigation use. A tank is always recommended.

Delivery pipe, rising all the way along its length (no ups and downs). The pipe should be buried where possible and protected if it has to be above ground.



Use 25mm diameter plastic pressure pipe for the delivery pipe if there is one pump in the system, and one size larger if there are two.

The DTU S2 can be locally made Is easy to maintain and cheap to run!

DTU S2 ram pump specifications

The normal specifications of the DTU S2 ram pump are given here.
Sometimes you can operate pumps outside these limits, but they may not work well.

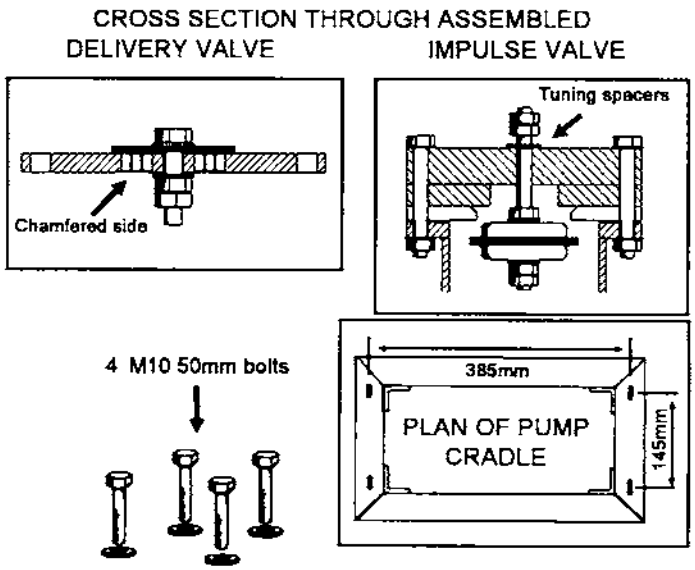
drive head range	—	2 to 15 meters
drive flow range	—	40 to 120 liters a minute
drive pipe material	—	Galvanised iron
drive pipe diameter	—	1.5" for flows from 40 to 80 liters a minute
drive pipe diameter	—	2" for flows from 60 to 120 liters a minue
delivery head range	—	up to 100 meters
typical delivery range	—	1 to 25 liters a minute
delivery pipe diameter	—	25mm

DTU S2 PUMP: USER INSTRUCTIONS

AN EXPLODED VIEW OF THE DTU S2 PUMP

PARTS LIST

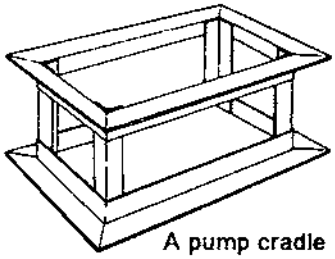
- Air vessel
- Pump body
- Delivery valve plate
- Impulse valve plate
- Rubber gasket (x 3)
- Delivery valve rubber (diameter 64, 68 or 80mm, and 3mm thick)
- Impulse valve rubber (diameter 76mm and 6mm thick)
- Snifter valve rubber (diameter 60mm and 1.5 to 2mm thick)
- Rubber washer (x 2)
- Impulse valve stem (length 140mm)
- Impulse valve stop bar
- Impulse valve plug
- Impulse valve weight
- 12 x 50mm M10 bolts
- 2 x 80mm M10 bolts
- 33 x M10 washers (standard size)
- 2 x M10 washers (35mm diameter)
- 21 x M10 nuts



To put the pump together you will need two open ended 17mm spanners.

Installation notes

The DTU S2 pump should be installed in a properly designed system. To prevent vibration causing breakages, it should be firmly bolted to a steel frame (called a pump cradle) that is half buried in a concrete base. The cradle is usually made from 40 x 40mm angle iron and will vary in size depending on the number of pumps installed. Hole locations for just one pump are shown on the previous page.
All pipes in the system should be supported firmly, and buried where possible. The drive and delivery tanks should be constructed on good foundations by experienced tradesmen. Pipe joints to the drive tank should allow the pipes to move slightly without damaging the tank walls or leaking badly.



A pump cradle

Starting and stopping the ram pump

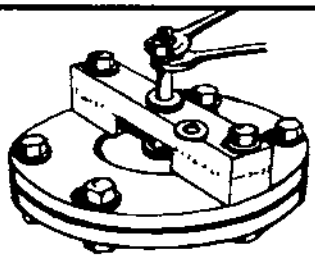
Although ram pumps often start very easily, they can be awkward the first time they are run.
To start the pump:

1. Make sure that any valve fitted on the delivery pipe is open and then open the drive pipe valve. Water will flow out of the open impulse valve until it suddenly shuts. If it reopens automatically, the pump should continue to run on its own. If it does not, you must prime the delivery system as described in Step 2 alongside.
2. Push down on the top of the impulse valve stem with your foot to reopen it (wear strong boots). Again, water will flow out of the open impulse valve until it suddenly shuts, then push down immediately to re-open the valve. Keep helping the valve to re- open until it will do so by itself.

To stop the pump, hold the impulse valve stem up to close it or shut the valve at the bottom of the drive pipe.

Tuning for best performance

The DTU S2 can be tuned to adjust performance. This is done by changing the up and down movement of the impulse valve, which is usually set to around 15mm. Tuning is usually done to achieve either the maximum delivery flow or the most efficient use of the drive water available.



Maximum delivery
When there is plenty of drive water available, the pump can be tuned to deliver as much water as possible. To do this, remove all washers from the impulse valve stem so that the valve has as much up and down movement as possible (about 20mm).
WARNING: - this also puts the pump parts under greater stress and makes them wear more quickly.

Low drive flow
If the pump uses more water than is available it will soon stop. If this happens it must be tuned to use less. The impulse valve should be tuned down to use 90-95% of the water available from the source. To tune the pump down, add washers onto the impulse valve stem so that the valve has less up and down movement. The shorter the stroke, the smaller the amount of drive flow needed, and the less water is delivered. The minimum stroke length is around 10mm.

Routine maintenance

While the pump is running normally, a visit should be made once a week to check that bolts are tight and that there are no leaks. Once a month an inspection of the whole system should be carried out. It is also recommended that a log book is kept to record the checks and repairs that have been made.

Monthly maintenance check list (without stopping the pump):

1. Inspect all the joints to check for leaks.
2. Check if there is sufficient air in the air vessel. This can be done by listening carefully to the pump. If there is insufficient air in the air vessel, the pump will be much louder than usual. This means that the snifter valve is probably blocked and will need to be cleared. If a bleed screw is fitted, when opening it, air or a small amount of water followed by a rush of air means the air level is OK. If only water emerges, then again the snifter valve will have to be checked for blockage.
3. Clean any filters installed in the system.
4. Remove excess silt or debree from tanks or from behind the intake dam or weir if necessary.
5. Walk along all pipes looking for damage. Also, inspect the tanks for leaks, particularly at pipe joints.

Pump repair

If the pump stops or it delivers less water than usual, it may require adjustment or repair.

Look at the pump and if there is no obvious fault start it again if you can. Watch the pump and listen for irregular pumping or unusual noises. A worn impulse valve, for example, is usually obvious because water squirts through when the valve is closed. Some parts of your ram pump may need occasional replacement. the frequency of this will depend on how hard the pump is working and on the cleanliness of the drive water.

Tools you will need:

2 x 17mm ring/open end spanners to disassemble and assemble the pump
2 x Adjustable wrenches - to loosen a union joint on the delivery pipe (if fitted)

Taking the pump apart

Depending on the fault it may be necessary to disassemble the impulse valve and/or the air vessel. Before attempting to take apart the pump:

1. Make sure that the drive pipe valve is closed and the impulse valve is open. This will allow you to work on the impulse valve ONLY.
2. Depressurise the air vessel.

WARNING - Before attempting to remove the air vessel, always release the pressure in it slowly. An ideal system will have a gate valve or one-way valve and a union fitted between the air vessel and the bottom of the delivery pipe and the optional bleed screw fitted to the air vessel. With the pump stopped, close the gate valve in the delivery pipe to stop it draining back. If a one-way valve is fitted it will close automatically. Then loosen the bleed screw to release the pressure in the air vessel. If none of the above are fitted, the only other way to release the pressure in the air vessel is to loosen each of the air vessel flange bolts one turn at a time until the water and air escapes through the join at the flange. You will certainly get wet this way.

Checks

1. Check the delivery valve rubber for wear and blockage of the valve holes. Check that the lock nuts on the valve bolt are tight.
2. Check that the snifter valve is in good condition.
3. Remove the impulse valve and check the impulse valve rubber and the rubber washers for wear. Check that the nuts on the valve stem are tight and check for excessive wear of the stem. Replace parts if necessary.
4. Check the pump body is firmly bolted down, then reassemble the pump, ensuring that all bolts are greased.

Putting the pump back together

Assembly of the pump is shown in the exploded view drawing, but the following important points need to be kept in mind:

1. Assembling the delivery valve
   Put together the delivery valve plate, the rubber and the bolt. Make sure the side of the plate with the chamfered holes is on the opposite side to the rubber, and that the rubber is on top.
   Screw on the first nut until it is finger tight and then undo it by one turn. Care must be taken not to overtighten the bolt and nuts as this will affect the performance of the valve. Next, screw on the other nut and tighten it up against the first. Use the spanners to tighten them firmly together. This will lock them together, and also allow a small up-and-down movement of the bolt and rubber.
2. Assembling the snifter valve
   Put the 'shaped' bolt and washer together, feed the bolt through the valve rubber, then push this through the pump body. Make sure that the shaped curve of the bolt head and washer align with the curvature of the body.
   Screw on the first nut until it is only finger tight. If the nut is on too tight the rubber will curl away from the pump body and will need to be slackened off slightly. Then screw on the second nut and tighten the two nuts firmly together using the spanners. Then check that the rubber has not distorted. If it has, slacken the nuts half a turn and tighten the outer one again.
3. Assembling the air vessel/delivery valve/rubber gaskets
   Align the delivery valve, air vessel, pump body and rubber gasket mounting holes and feed through the bolts. Make sure the delivery valve is the correct way up (the valve rubber facing upwards) and then tighten the nuts by hand. Use the spanners to tighten each nut and bolt a little at a time, working around the flange. This will draw the assembly together evenly.
4. Assembling the impulse valve
   The first parts to assemble are the valve stem, discs and rubbers. Screw on a nut to the longer threaded end of the stem up to the end of the thread. Push a steel washer on up to the nut, then add a rubber washer. Follow this with the valve plug disc, with the chamfered side towards the nut. Slide the valve rubber up against this, then the weight disk with the chamfered side facing away from the rubber. Follow this with another rubber washer and a steel washer. Screw a nut up them until it is finger tight. Thread on another nut and use the spanners to tighten the nuts together. This part of the assembly is sometimes known as the valve plug.
   Hold the impulse valve plate and the valve plug together, with the chamfered side of the plate opposite to the side against which the valve rubber presses. Slide the stop bar onto the top of the stem and thread a nut loosely on the stem.
   Align the valve assembly, pump body and rubber gasket and feed through the flange bolts. The two longer bolts feed through the cross-bar as well.
   Thread on the six nuts by hand, then use the spanners to tighten the four shorter bolts that hold down the valve plate. Again care must be taken to ensure that these nuts are tightened evenly. The next step is to make sure the closed valve plug is centred in the valve plate hole before tightening down the two remaining nuts that secure the stop bar. To check the alignment, open and close the valve manually turning the valve plug to make sure it does not catch on the hole in the valve plate.

Now you only need to set the stroke length of the valve for the pump to be ready for use.

Spare parts to keep on the site

- impulse, delivery and snifter valve rubbers
- an impulse valve stem
- a few spare M10 nuts, bolts and washers

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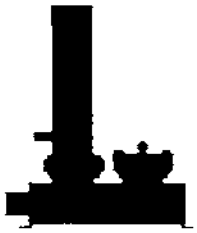
Making a DTU S2 ram pump



When you have decided to make a pump, the first thing you must do is make photocopies of the DTU S2 ram pump design drawings in Technical Release number 14b. The copies can be used in the workshop and it will not matter if they get dirty or are damaged. Some of the drawings can also be used as templates.

It will be useful to have the copies of the design drawings beside you as you work through this Technical Release. The pump's normal operating ranges are on the first drawing.

The manufacture process is presented under the following headings.

- **The parts of the pump**
  This introduces the main parts of the DTU S2 pump.

- **Tools required**
  The DTU S2 pump was designed to be made in small workshops with limited tools. This section describes the tools recommended. We have assumed that you are a workshop technician who already knows how to use the tools.

- **Guides and Templates**
  Simple guides and templates are useful, so we have included descriptions of guides and templates, and suggest ways of making them.

- **Materials needed to make a DTU S2 ram pump**
  A "shopping list" of the materials that you will need is given on page 6. This can be photocopied and taken with you when you buy materials.

- **A step by step guide to manufacture**
  The process of manufacture is described in detail under this heading. It begins with making the pump body and air vessel, and goes on to cover the valves and the pump cradle.

- **Assembly and testing**
  Putting the valves together properly is very important, so the process of assembly is described. The description includes some suggested ways of checking that they work properly.

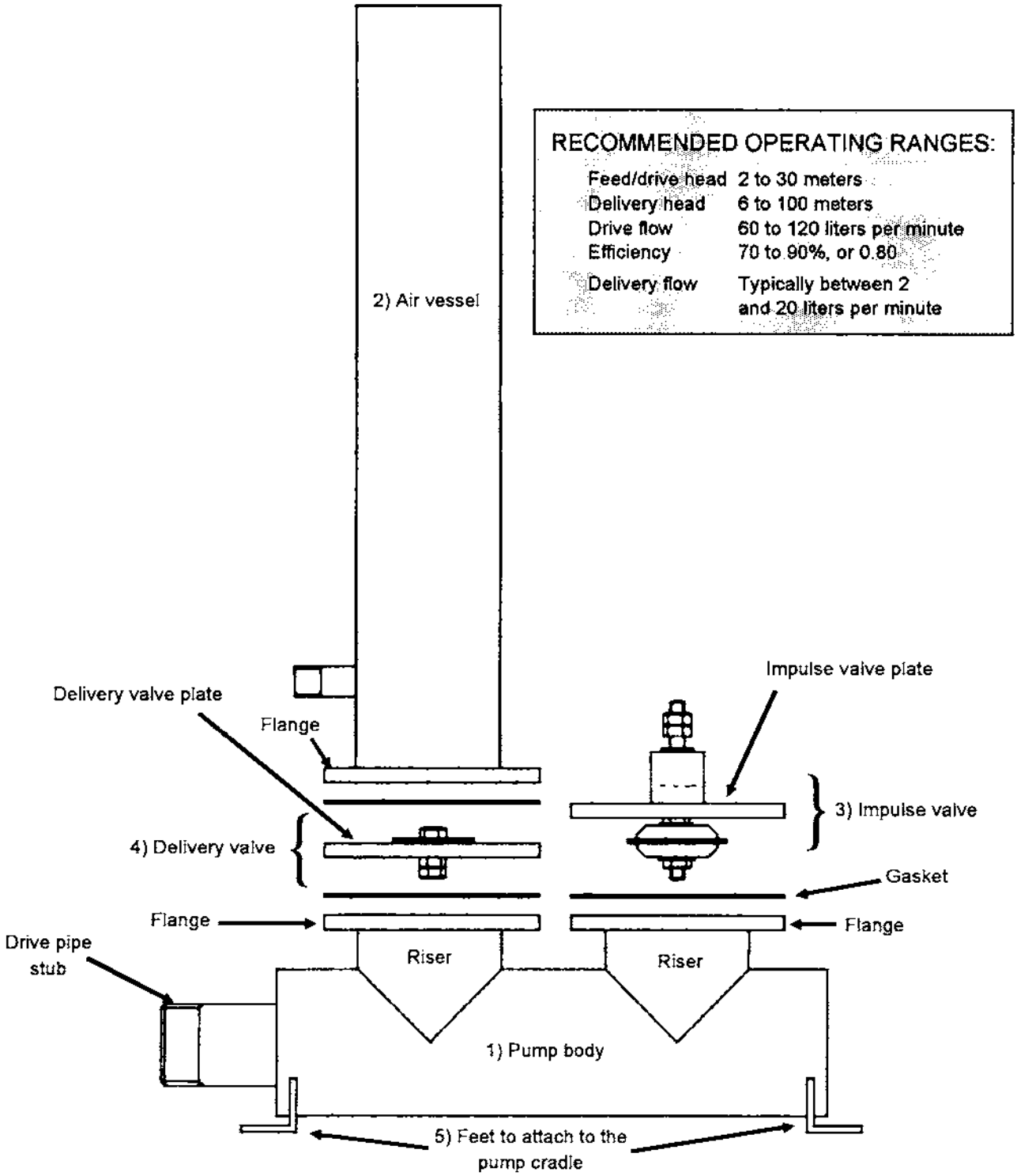
- **Spare parts**
  This explains which spare parts to supply with a pump. It points out which parts you should expect to wear out or fail.

- **Optional addition**
  The addition of a "bleed" screw in the air vessel can make it easier to find out what is wrong with a pump when it does not perform properly. It can also make the pump easier to maintain. The "bleed" screw is described under this heading.

The parts of the pump

The picture here shows the main parts of a DTU S2 ram pump. There are five, apart from the risers and flanges. The pump's recommended operating ranges are given in the box.

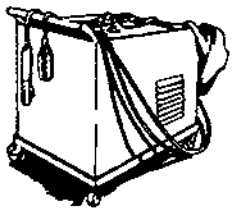
1 The pump body
2 The air vessel
3 The impulse valve
4 The delivery valve
5 Feet to attach the pump to the cradle.



Tools required

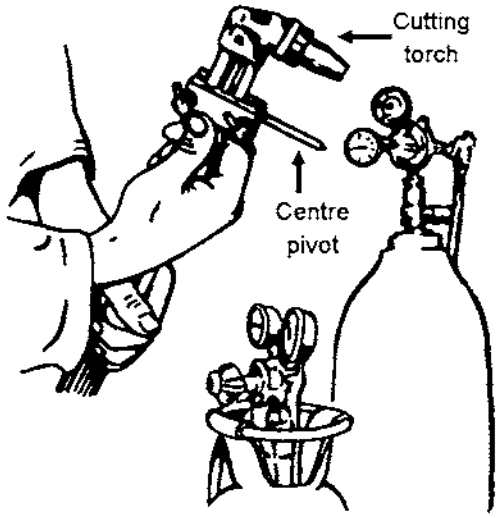
DTU S2 ram pumps can be made in a workshop with welding facilities, a drill, a hacksaw and files. It is hard work making them with as few tools as this. It is also hard to make the pumps to a high enough standard. Cutting and filing the parts by hand will take a very long time and it may not be possible to make the parts accurately. Do not plan to make more than one pump unless you have access to some other power tools.

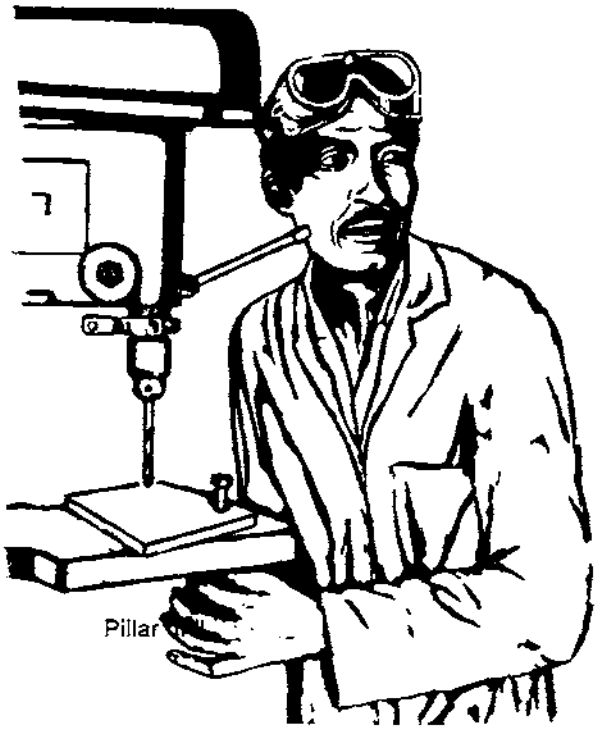
Most small workshops do not have a lathe, but many do have a gas cutting torch. Many also have a bench-grinder and a hand-held angle grinder. The step-by-step manufacturing guide that follows assumes that the pump is being made using a gas cutting torch, an arc-welder, a pillar-drill and grinding machines. Some parts of this guide will be useful to people who are making the pumps using other tools. A lathe can be useful for making parts of the impulse valve when one is available.

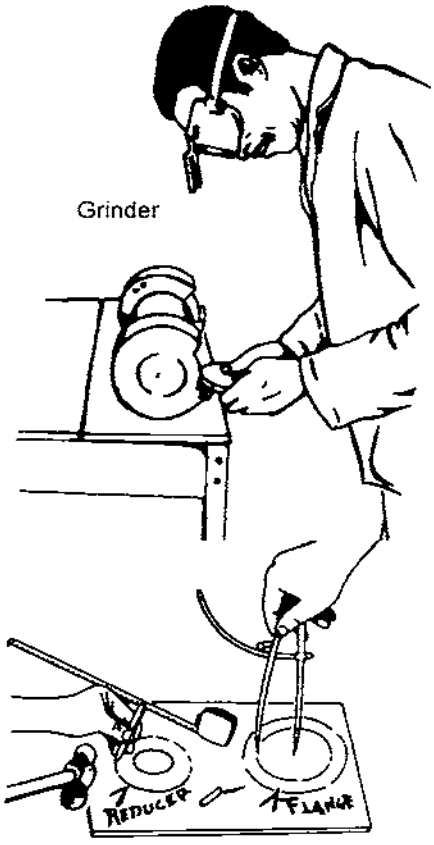


Arc welder

To cut circles accurately with a cutting torch, a centre pivot can be bought or made. The one shown here was made in the workshop where it is used.







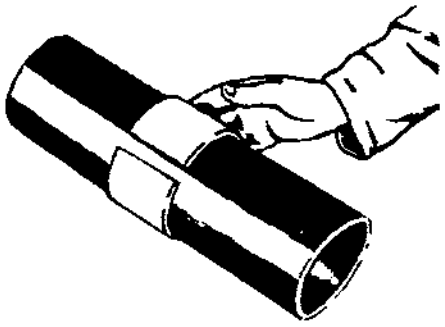
You will also need chalk, a scriber, a measuring tape, dividers, a centre punch, files, a 10mm hole punch, an M10 tap and die, drill bits, two 17mm spanners, goggles, gloves, PTFE tape, a setsquare, a feeler-gauge and a hammer.

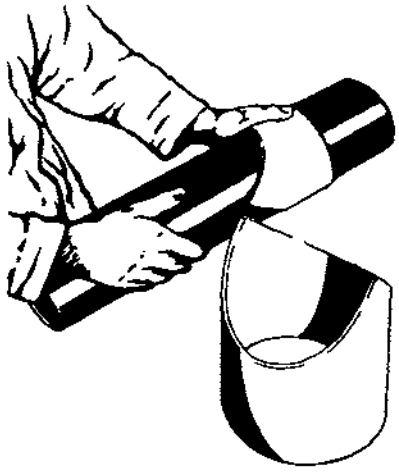
Guides and templates

When you are planning to make a number of pumps, it is worth making a few guides or templates or guides to help when marking up, cutting and drilling.

Guides for marking out the pump body

Use a short piece of PVC pipe of the same size as the pipe to be marked. Cut the PVC pipe along its length and push it over the steel pipe. Hold it in place and use it as a guide to score a line around the pipe.





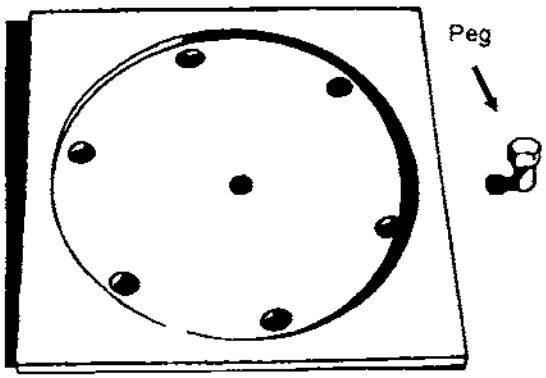
A "V" notch template like the one shown on the left can be made using thin plate (1mm) or PVC pipe. This is a guide for marking up the notches cut into the pump body and for the risers that fit into the notches.

When you have scored the line in the right place you can make it easier to see by rubbing chalk over it. Scored lines can be very hard to see through the protective goggles used when cutting. Use a centre punch to mark dots along the scored line. Use the punch about every 5mm.

It is very important to mark up clearly. If you do not, you may not cut a straight line with the torch and so you may have to start again.

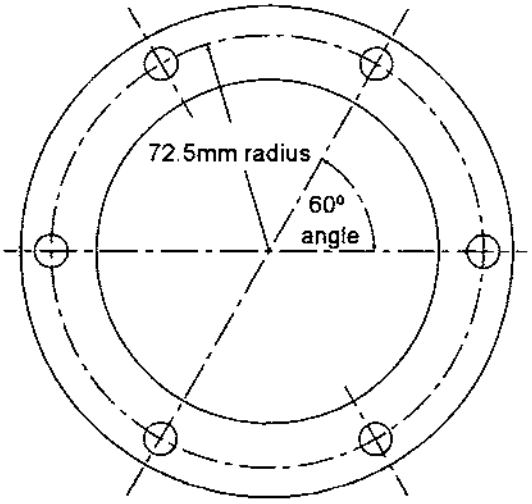
Flange and valve plate template

Design drawings number 3, 5, 6, 7, and 10 can be copied and used as templates. If you want to make a lot of pumps it is probably worth making a a steel template for the flanges. If you do not have access to a lathe, consider having the template made for you in another workshop.

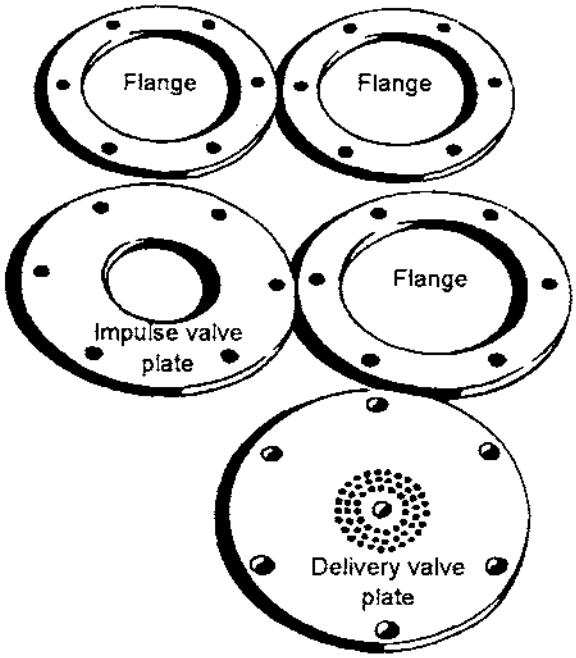


The template can be recessed with a lathe so that the flange drops into it when it is the right size. The example shown is recessed and has a ring of large holes around the outside. The example shown also provides a pattern for the bolt holes on the flanges and both valve plates.

When the first hole in the outer ring has been drilled a "peg" made by cutting a bolt is put into the hole to prevent the disc turning inside the template.



A simple template like this can be made using thin plate



You must drill the flange holes equally spaced and at the correct radius. If you do not, the flanges may not bolt together, or may only bolt together one way around.

Some people simplify the making of flanges by stacking them and drilling them together. Although this will always mean that the holes line up, it can mean that only the holes that were underneath each other when they were drilled line up. When the pump is put together is it important that the holes align whatever way around the parts are turned. Either take great care marking up each flange and be sure that the centre-punch marks are perfectly positioned before drilling, or use a template.

Materials needed to make a DTU S2 ram pump

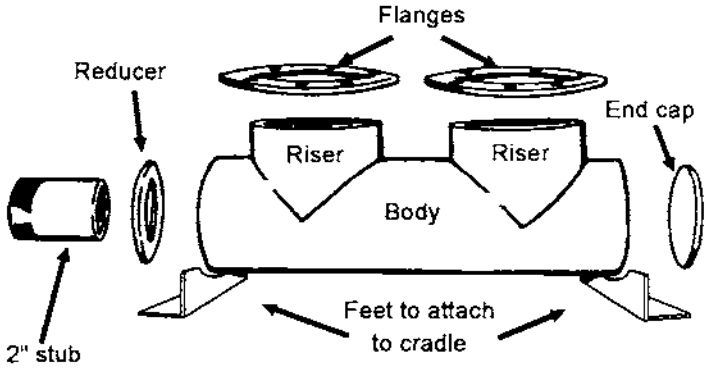
STEEL	Size	No. of	Length/area	Notes	✔
STEEL PIPE	4" (105mm internal diameter)	1	1350mm	The outside diameter of 4" pipe is 115mm. The wall thickness should be 5mm.	
STEEL PLATE	10 or 12mm	1	330 x 500mm	Do not use plate less than 10mm thick.	
STEEL BAR	25 x 25mm	1	165mm	If this is hard to find, make some by welding together a stack of thinner 25mm wide bars.	
STEEL BAR	25 x 15mm	1	165mm		
STAINLESS OR MILD STEEL ROD	10mm	1	280mm	If this is not available, mild steel reinforcing bar will do. This includes enough to make a spare impulse valve stem to supply with the pump.	
RUBBER	Size	No. of	Area	Notes	
GASKET RUBBER (inner tube)	Car or small truck	1	825 x 170mm	Make sure that it has not perished. This includes enough to make two spare flange gaskets to supply with the pump.	
IMPULSE VALVE RUBBER	6mm	1	152 x76mm	Offcuts of conveyor belt and shoe sole material have been used in the past . This includes enough to supply a spare of each with the pump.	
DELIVERY VALVE RUBBER	3mm	1	160 x 80mm		
NUTS & BOLTS	Size	No. of	Length	Notes	
BOLTS	M10	1	30mm	These must be stainless steel or galvanised. The 4 x 40mm bolts, nuts and washers to hold the pump to the cradle are included. Extra nuts and washers are needed for the valve stem and are included in the totals. The totals also include a few spares that you should supply with the pump.	
BOLTS	M10	10	40mm		
BOLTS	M10	8	50mm		
BOLTS	M10	3	80mm		
NUTS	M10	28			
WASHERS	M10	40			
CONSUMABLES				Notes	
WELDING RODS	The amount you use will vary according to your skills.			Select rods to give good penetration on the 5mm walls of steel pipe and on 10mm steel plate.	
GAS				For the cutting torch.	
PRIMER (PAINT)				Either have the parts of the pump galvanised or paint it. In most cases it is easiest to paint it	
ENAMEL PAINT					
THINNERS					

✎ Photocopy this table and tick off the materials as you get them so that you know you have everything you need before you start.

A step by step guide to manufacture

Before starting, decide which delivery valve template you will use. This will depend on the delivery head at the site where the pump is to be installed. If you do not know where the pump will be installed, use drawing number 5, which is the standard design.

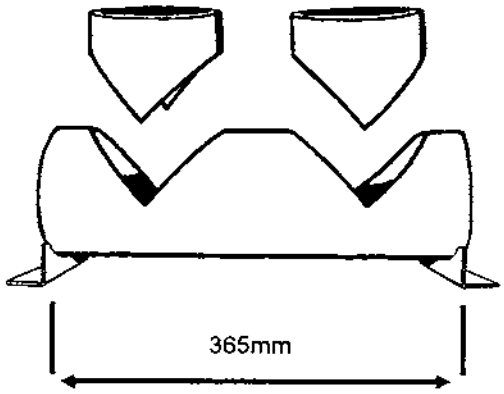
Cutting the pump parts



All the cutting for this pump can be done with a cutting torch. To save grinding and to minimise scrap, the metal cut from the centre of the flanges is used as the ends of the pump body. The ends are called the "Reducer" and the "End cap". The pump body is made from steel pipe with an internal diameter of 105mm (4" pipe). The length shown on the S2 design drawings is 365mm.

The discs of steel that fall out when the flanges are cut will fit inside the pump body, but are not big enough to cover the ends. So the ends are welded about 5mm inside the body. This should leave enough overlap to weld neatly to.

The feet are cut from 40 x 40mm angle iron. A curve that fits the pump body is cut out of one side of the angle iron.



The body is cut from a length of pipe by using the PVC pattern to score a line around the pipe. Mark it with chalk if it does not show up clearly, then go over the line with a centre punch to make sure it can be seen when cutting.

Skilled use of the cutting torch can result in the cut parts falling apart with clean edges. Even then, they will probably need to be tided up a little with a file or a grindwheel.

It is necessary to have a clean cutting nozzle on the torch, and to set the gas pressures appropriately.

If the pipe being used is galvanised, it can help to grind away the galvanise from the area to be cut. It is not worth using galvanised pipe for the pump body unless it is easy to get because a lot of the galvanised protection burns away by the time the pump is finished.

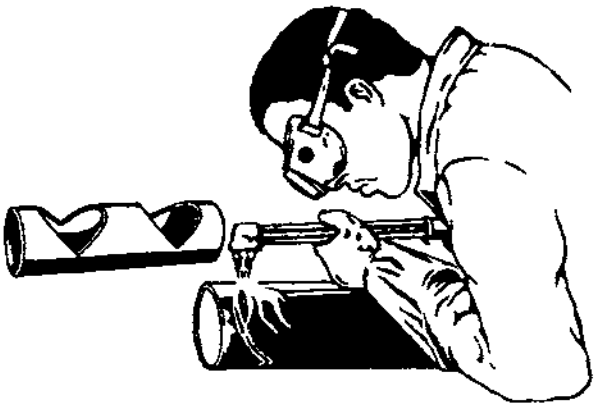
The fumes given off by burning Zinc galvanising are poisonous and should not be breathed.

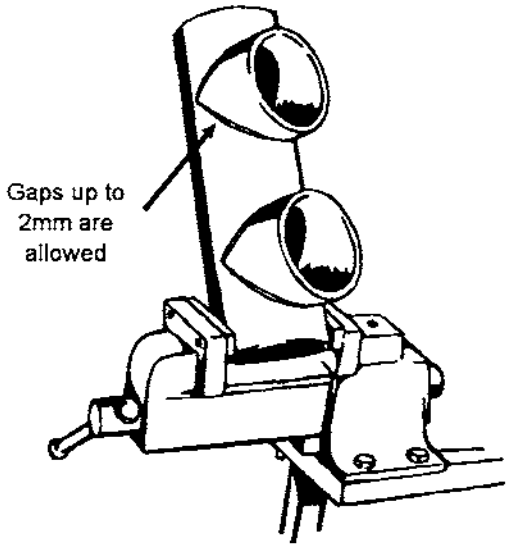
Cutting the S2 pump risers

The risers are made from the same pipe as the pump body. They are welded into "V" notches cut into the pump body. Both the risers and the notches can be marked up using the "V" notch pattern or template. At its shortest point, each riser should be no less than 30mm high. At its longest point it should be 87.5mm high.

Remember to go over the scored lines with a centre punch to make them easier to see.

Use an angle grinder or a bench-grinder to clean up the cuts so that the parts fit together properly. A gap of up to 2mm can be filled with weld.

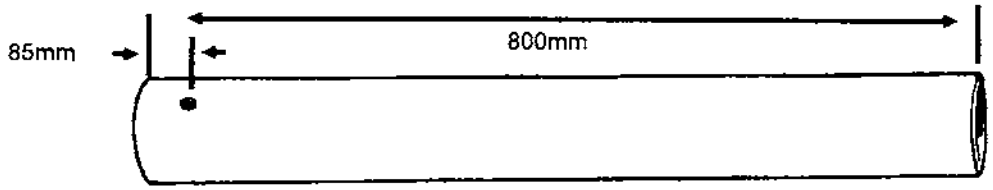




Place the risers in the pump body and grind them to fit. It can be useful to mark the risers and the notches, then grind each riser to fit a particular notch.

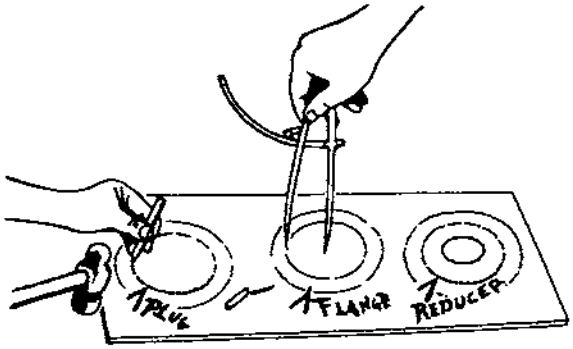
Cutting the S2 air vessel body

The air vessel body is cut from the same 105mm (4") pipe as the pump body. The length should be 800mm. This size will always be big enough, so do not change it. A ¾" hole should be cut (or drilled) with its centre 85mm from one end of the pipe. This is where the delivery pipe stub is attached.

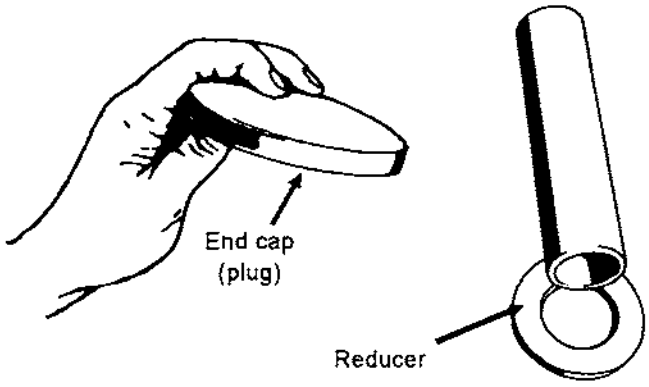


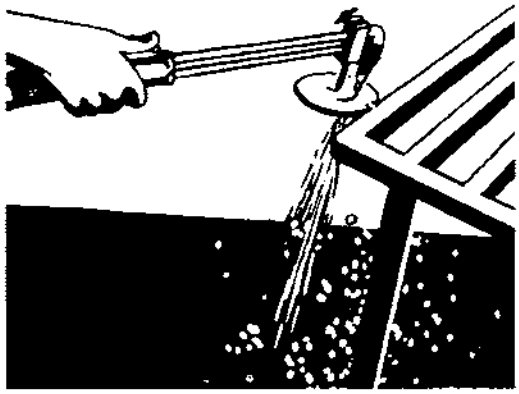
Cutting the S2 pump flanges and plates

The S2 pump body has two flanges and two pump body ends. The ends are called the "End cap" and the "Reducer". The "End cap" is the inner circle cut from a flange. The "Reducer" is the inner circle cut from a flange with another hole cut in the middle of it. The "Reducer" reduces the pipe size from the 4" pump body to the 2" drive pipe, so the inside hole is cut to take a stub of 2" pipe. The S2 air vessel has one flange and one end cap.



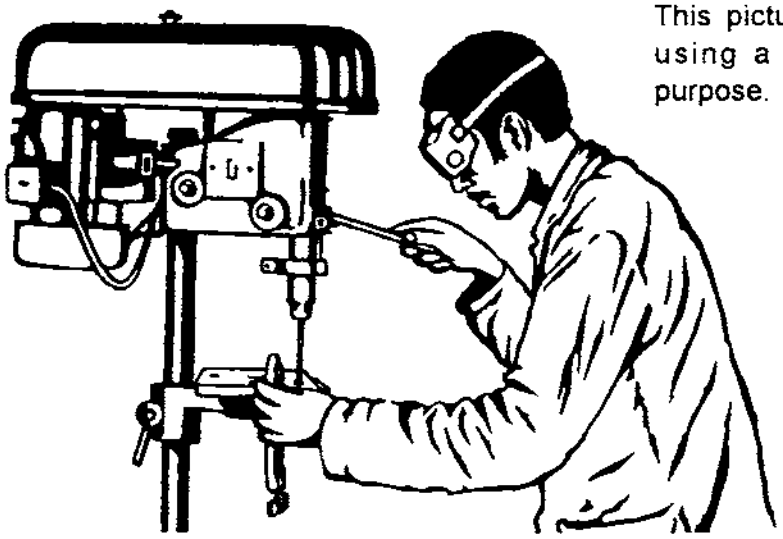
Mark up the flanges carefully, and cut the outer circle first. It can be useful to tack-weld the edge of the first circle to the workbench to make it easy to cut the second circle.





Drilling the flanges and valve plates

It is wise to make a template before drilling the flanges. Use a photocopy of design drawing number 3 as a template. Put it over the disc to be drilled, then use a centre punch to mark the hole centres through the paper template. To make the template last longer, glue it to thin cardboard before you use it.



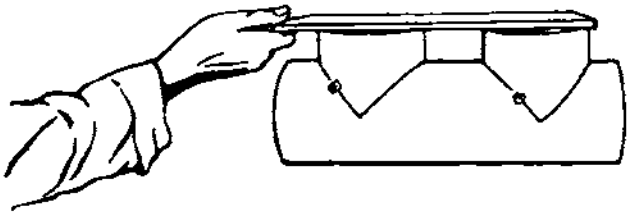
This picture shows a flange being drilled using a steel template made for the purpose.

Notice that the holes are drilled before the flanges are welded to the pump body.

Welding the S2 pump body

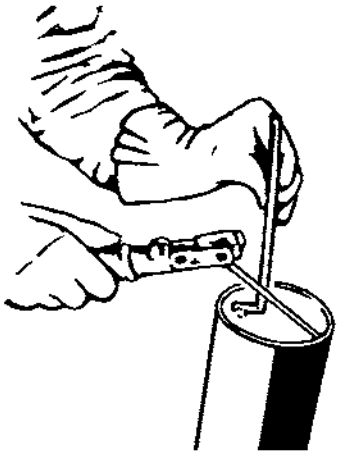
When the parts of the pump body and air vessel have all been cut they must be welded together. The following pictures show a suggested order in which to weld the parts. This order can be changed to suit the person doing the welding. It is important that the welder be skilled because the welds must be strong and not leak under pressure.

[1] Tack-weld the risers onto the body, making sure that their tops are level.

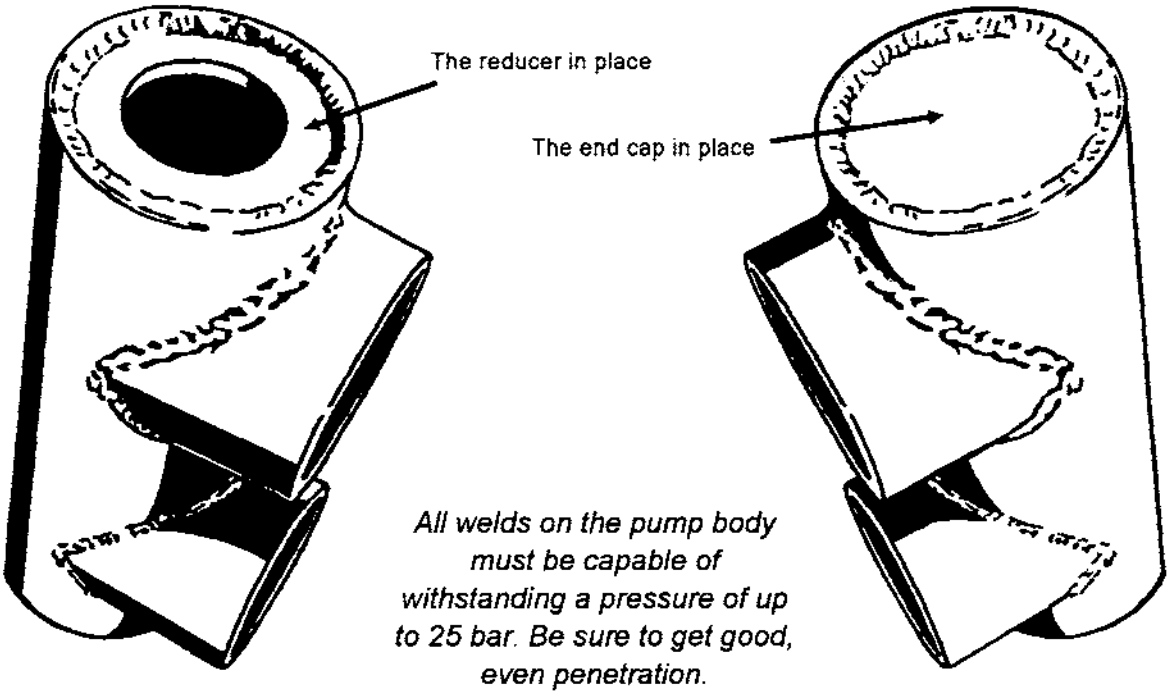


[2] Weld the risers all the way around on the outside of the body.

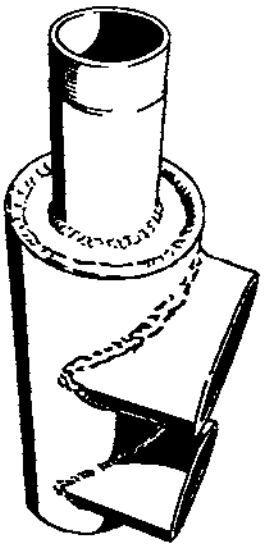
[3] Weld the end cap and the reducer 5mm inside the ends of the pump body.



If the ends are a loose fit, tack a rod to them and hold them in place while tack-welding them. Then weld all the way around.

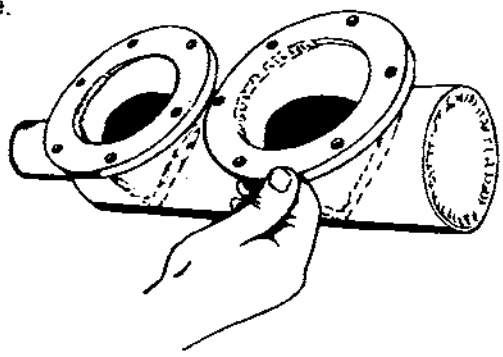


All welds on the pump body must be capable of withstanding a pressure of up to 25 bar. Be sure to get good, even penetration.



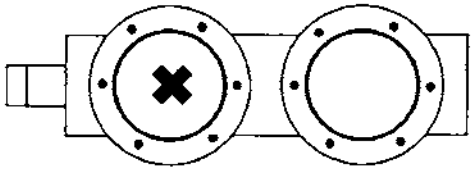
4 Weld the stub of the 2" drive pipe into the hole in the reducer. Cut a thread on one end of the stub before cutting it from a length of pipe.

5 Tack-weld the flanges onto the risers and make sure that the flanges are level, then weld all the way around.

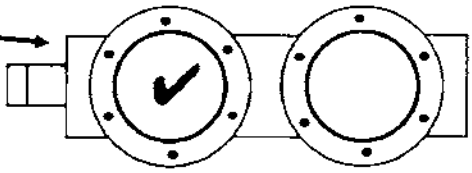


Make sure that the flange holes are not in line with the pump body.

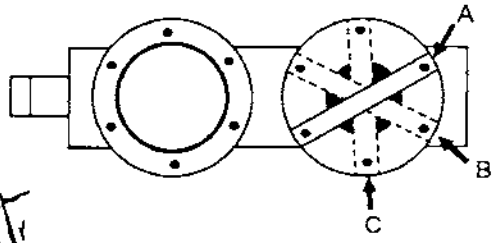
They should be offset like this.

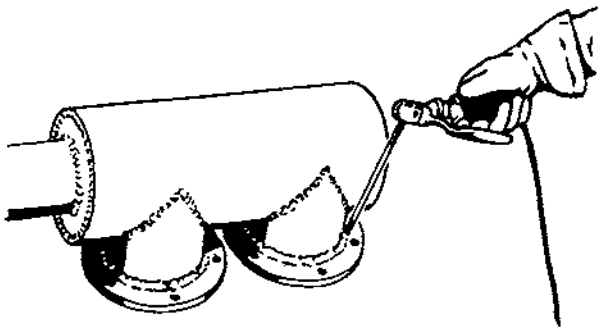


Flange hole alignment

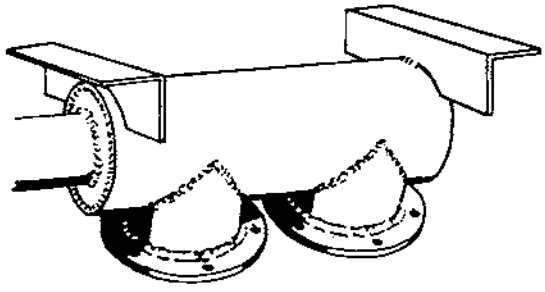


The impulse valve stop bar can later be bolted to the flange in any of the three possible positions, A, B, or C.





6 Turn the pump body over and weld around the flanges on the other side.



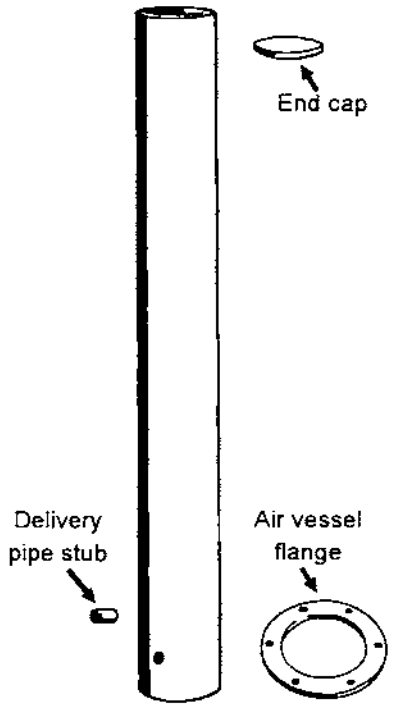
7 Tack-weld the angle iron feet to the bottom of the pump body, 5mm in from each end. Make sure that they are both level, then weld them on both sides.

Welding the S2 pump air vessel

8 Weld the air vessel End cap in place, 5mm below the top of the air vessel.

9 Weld the air vessel flange in place, being sure to get it level. Weld it inside and outside.

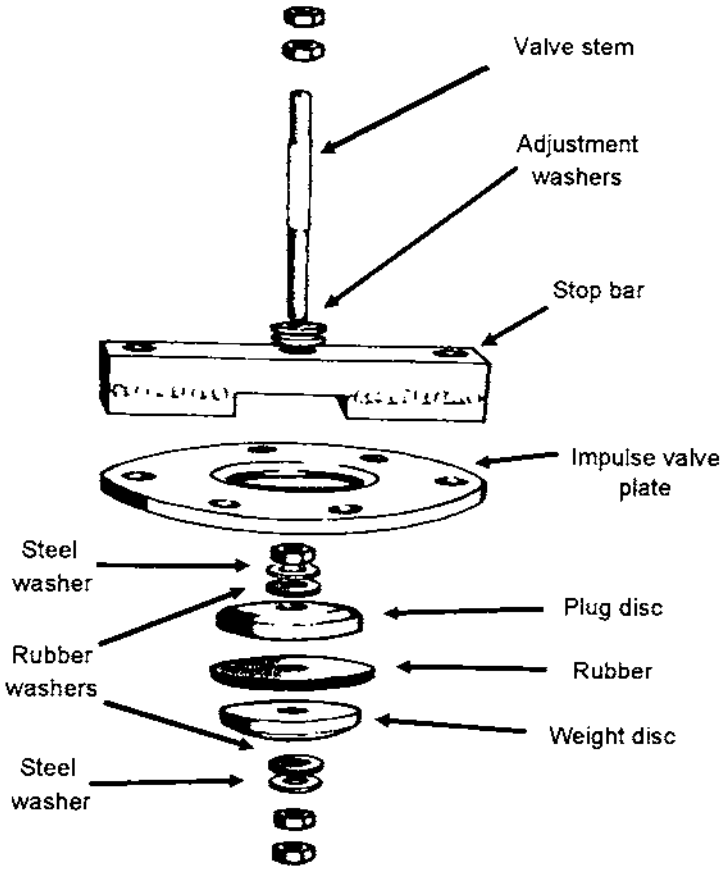
10 Weld the delivery pipe stub into the hole in the air vessel. Cut a thread onto the stub before you cut it from the end of a length of pipe.

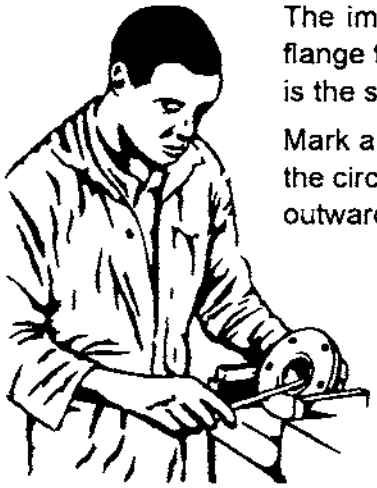


Making the S2 pump impulse valve

The valves are the most important parts of these pumps. They must be made accurately or the pump will not be as efficient as it should be and may be unreliable. If they are made carelessly, the pump may not work at all.

The valve stem rises and falls as the pump works. When it falls it pushes the plug down to allow water to flow through the central hole in the impulse valve plate. When it rises it pulls the plug up to almost block the hole, and the rubber makes a final seal.

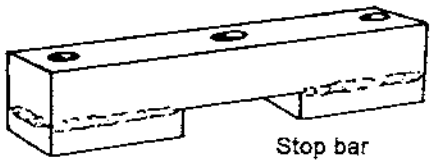




The impulse valve plate is a disc of 10 or 12mm steel plate. Use the flange template to drill holes around the outside. The outside of the disc is the same size as a flange (165mm diameter).

Mark a circle with a radius of 33mm from the centre of the disc and cut the circle out. Use a file to chamfer one side of that hole so that it slopes outward at 45°. The chamfer should be 5mm deep.

The stop bar is a 165mm length of 25mm square steel, with two 58.5mm lengths of 15 x 25mm bar welded to it. The bar is drilled to fit on top of the impulse valve plate.

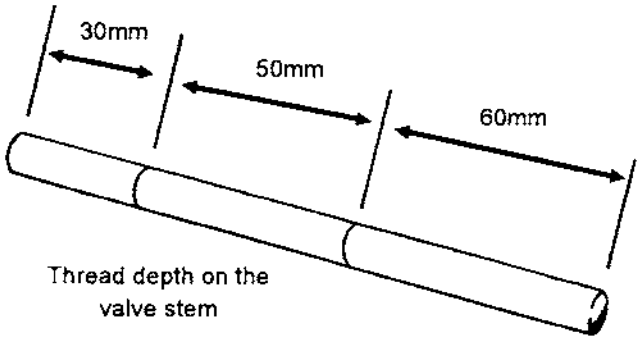


Stop bar

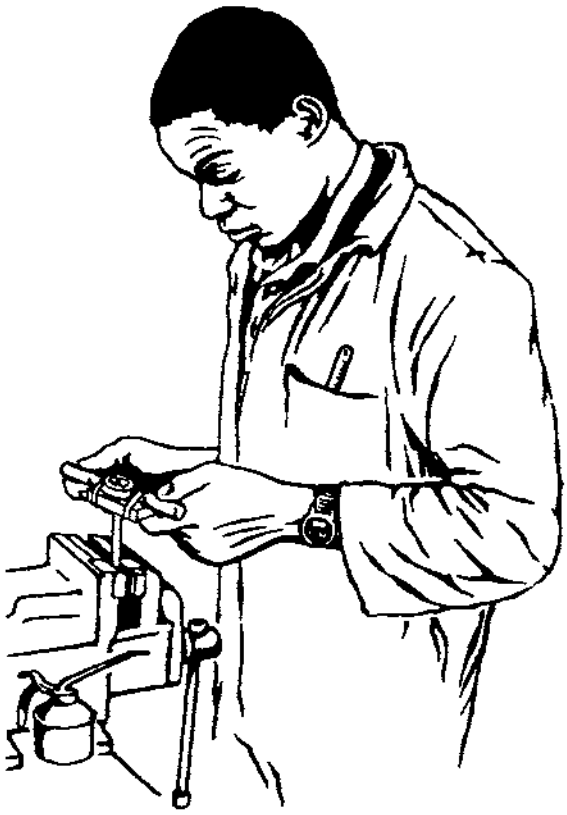
It is important that the holes are drilled upright through the bar, so use a pillar drill when you can.

> **Lathe alternative**
>
> *Drill the holes in the stop bar and cut the threads on the valve stem with a lathe when you can.*

People prefer their pumps to look good, so it is often worth grinding away any excess weld on the stop bar using a grindwheel. In the drawing alongside, a hand-held grinder is held in a vice to make a temporary bench-grinder. If you do this, make sure that the grinder is held firmly.



Thread depth on the valve stem



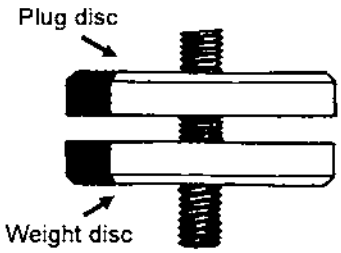
The valve stem is 140mm of 10mm stainless or mild steel bar. If plain bar is not available, reinforcing bar can be used, but it may not last as long. The bar must be straight. A slightly bent bar may break quickly when the pump is being used.

The stem must be threaded at each end. The depth of the thread is greater at the bottom than the top.

The impulse valve plug and weight discs are identical. When they are put onto the valve stem, the second is put on upside down.

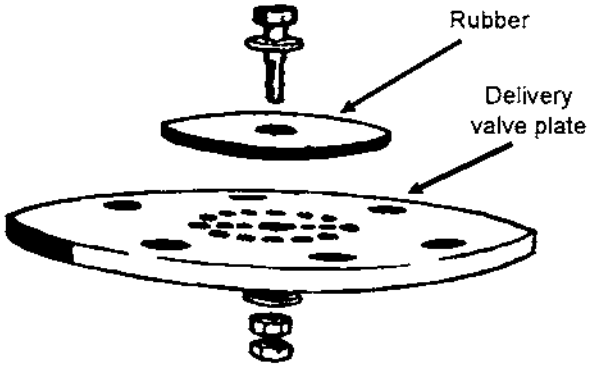
Cut two 60mm disks from the same 10 or 12mm steel plate that you used for the Impulse valve plate, then drill a hole of 11mm diameter in the centre of each. It is important that the holes are straight.

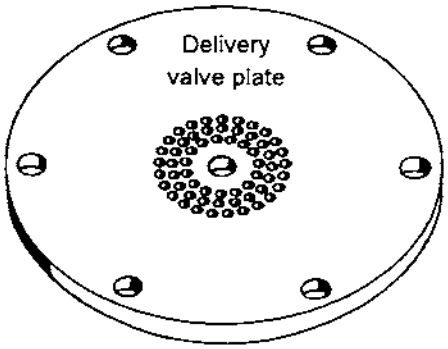
One edge of each valve disc must be chamfered with a 45° angle. The chamfer should only be 3mm deep, leaving 7mm of the edge straight.

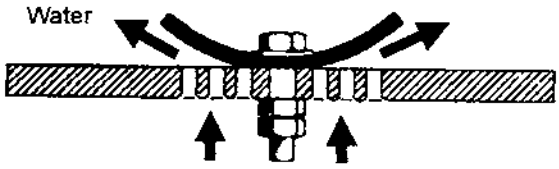


Making the S2 pump delivery valve

This is a simple flap valve. The delivery valve rubber is pushed up when the pump reaches delivery pressure, and flaps closed when the pressure drops. When the rubber is bent up, water flows through the small holes into the air vessel and into the delivery pipe.



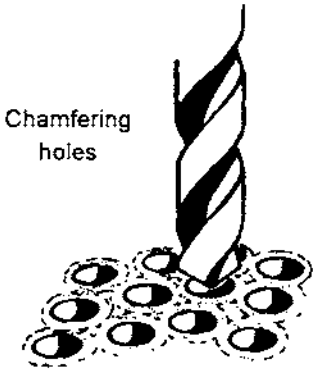




CROSS-SECTION THROUGH A DELIVERY VALVE WITH THE RUBBER OPEN

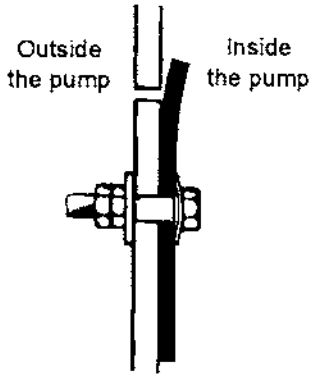
The delivery valve plate is cut from the same 10 or 12mm plate used for the flanges. You should have already chosen which of the design drawings numbers 5, 6 and 7 to use as a template. Punch through the template to mark out the holes. The central rings of holes allow water to pass through when the valve is open. To increase the flow through these holes, chamfer them using a larger drill bit (6 - 8mm) on one side of the valve plate.

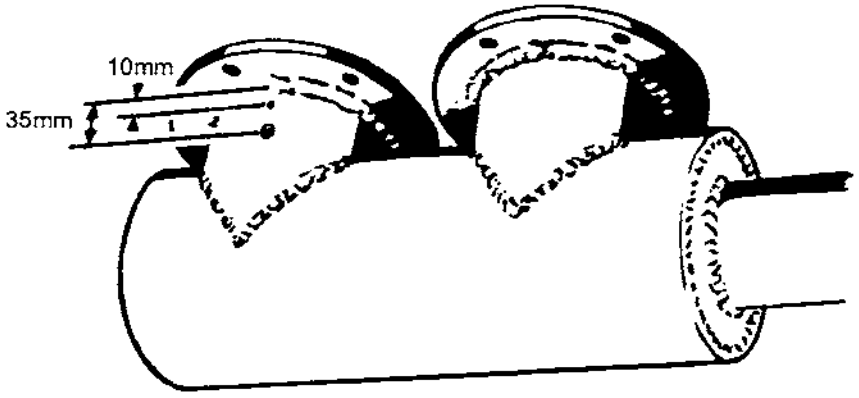
The chamfered side must be underneath when the valve is put together.



Making the S2 pump snifter valve

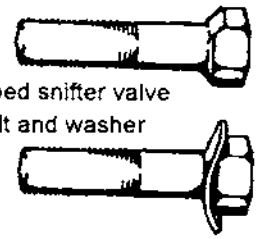
The snifter valve is a small flap valve in the riser furthest away from the drive pipe stub. When the pump is running, it allows a little air into the pump body. The air is pumped through the delivery valve with the water and keeps the level of air in the air vessel constant.





Drill a 1 or 2mm diameter hole in the riser 10mm below the bottom of the flange, (or 20mm below the top of the flange, which is the same thing). Drill a 10mm diameter hole 25mm below the first hole. The 1 or 2mm hole is the hole that air will come through.

The rubber flap inside the pump body must sit flat against the side of the riser. Because the riser is curved, you must file away parts of the bolt head and bend a washer as shown in the drawing. Then, when the bolt is tightened, the rubber flap will be able to sit flat. Be careful not to tighten the bolt enough to distort the rubber. Usually it is enough to tighten the nut with your fingers, then lock another against it using spanners.

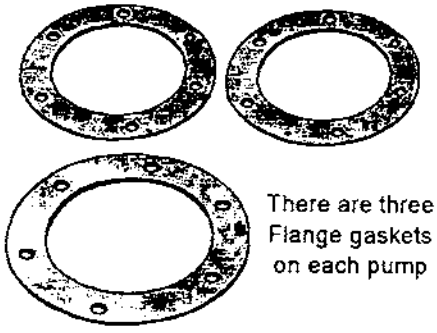

Shaped snifter valve bolt and washer

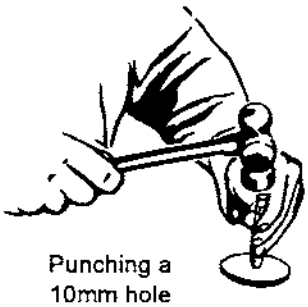
It is very important for the air in the air vessel to remain at a constant level, so it is essential that the snifter valve is fitted and working properly. If it does not work properly, the pump will be less efficient, and may even be damaged.

Rubber parts

You will need valve rubber and flange gasket rubber to complete an S2 pump.

Flange gaskets are usually made using old inner tube rubber. Make sure that it is not so old that it has started to perish, and try to select an area where it is more or less the same thickness. On some tubes, especially those made for big wheels, the rubber can be twice as thick in some places as others. Using the flange template as a guide, cut the big circles using a sharp knife. The bolt holes should be punched out using a 10mm hole punch. This leaves clean holes on which the threads of the bolts do not catch.


There are three Flange gaskets on each pump



Punching a 10mm hole

Delivery valve rubber

Impulse valve rubber

Inner tube rubber can also be used for the snifter valve rubber disc.

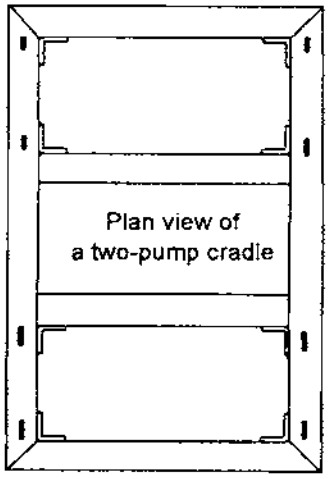
The large impulse valve rubber must be stiff but the delivery valve rubber has to bend easily. The impulse valve rubber should be about 6mm thick. Thicker rubber will probably be all right, but do not use thinner rubber. The delivery valve rubber should be about 3mm thick. Delivery valve rubber can also be used for the small impulse valve rubber washers above and below the impulse valve discs. We have used rubber made for shoe repairs and offcuts of conveyor belt when we cannot buy rubber sheet easily.

The pump cradle

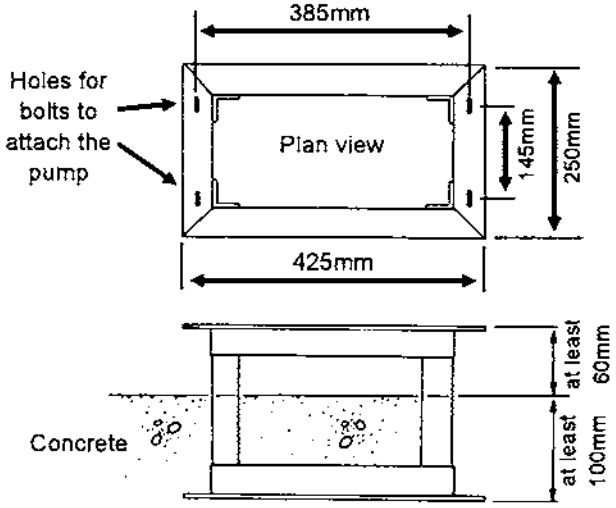
You should not make and sell a pump without including a pump cradle. If a ram pump is not securely fixed during use, it will break, and may break the connecting pipework too.

It is important that you use steel strong enough to hold the pump firmly, and that the cradle is buried in a strong concrete base. The pump tries to vibrate when operating and will soon shake itself loose from an insecure base.

Use 40mm angle-iron, about 5mm thick, to make the cradle. It can be extended to support two pumps when needed.



Plan view of a two-pump cradle



SECTION THROUGH A CRADLE INSTALLED ON A CONCRETE BASE

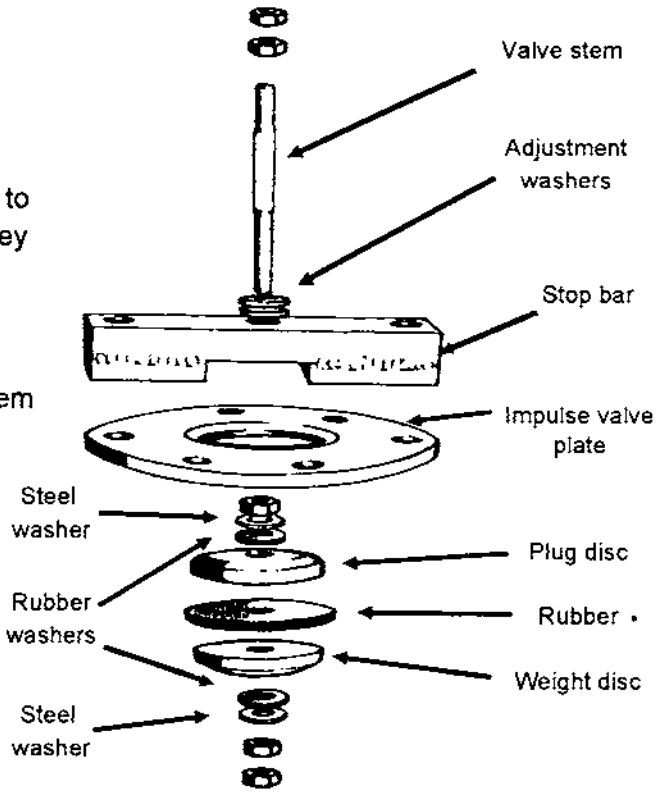
The pump is attached to the cradle by the angle iron feet that you have welded to the bottom of the body. Notice that the holes are slotted so that the pump can be moved from side to side slightly to allow for small mistakes in drive pipe alignment. The cradle must stand up from the concrete far enough to make it easy to reach the fixing nuts.

Assembly and testing

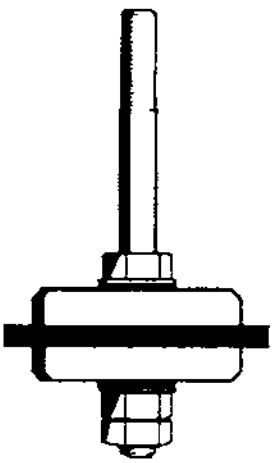
Putting the pump together properly is very important. The process of assembling the valves is described here, including some simple ways of testing them. Paint all the metal parts you have made before you assemble them for the final time. You may like to assemble them loosely before painting to check that everything is OK. To make the pump last longer, it should be painted inside and out with a metal primer, then a good enamel paint.

Assembling the impulse valve

The impulse valve design drawings, numbers 9, 19, 11 and 12, are also templates. Start by holding each part against the drawing of it on the template to check that the dimensions are right. If they are not right, either adjust them or make them again.



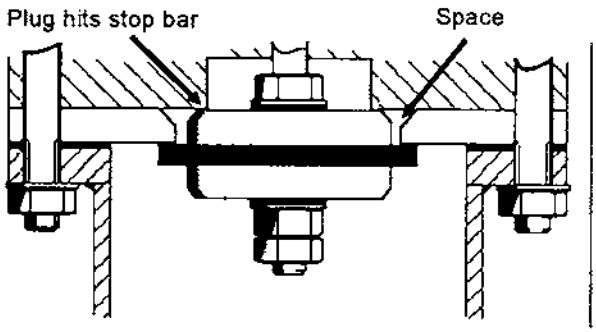
When the parts are all the right size, thread a nut onto the end of the valve stem that has a longer thread. This will be the bottom of the valve stem. Screw the nut to the end of the thread and use a spanner to lock it there. Then push a steel washer and a rubber washer up to the nut. Put the plug disk onto the stem, with the chamfered edge towards the nut and washers already there. Then push the impulse valve rubber over the stem up to the plug disc. Put the weight disc over the stem with the chamfered edge facing away from the valve rubber. Then push a rubber washer and a steel washer up to the weight disc. Thread on a nut up to the washer. Thread it on finger tight. If you use a spanner, do not tighten it so that it squashes the rubber washers. Hold the nut with a spanner and use another spanner to lock a second nut against it. The valve stem should look like the one in the drawing below.

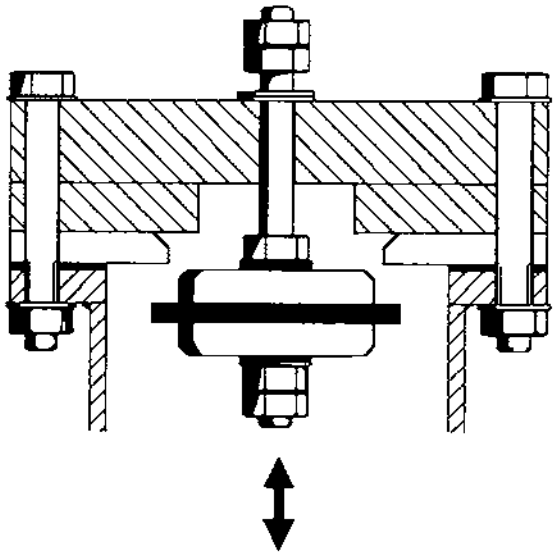


Push the stem up through the Impulse valve plate and through the stop bar. Drop two washers over it and thread on two nuts. Lock them lightly against each other. They should be adjusted when the pump is installed, so do not over-tighten them.

When the valve has been assembled, bolt it to the pump with a rubber gasket between the Impulse valve plate and the flange on the pump. The impulse valve goes on the riser furthest away from the drive pipe stub. Tighten all the bolts on the flange except the two holding the stop bar in place. Put nuts on these but leave them finger tight.

Check that the impulse valve can move freely up and down without the plug disc catching on the sides of the hole in the Impulse valve plate. If it does catch, push the stop bar away from the side that catches. The stop bar has a small amount of movement between the bar and the threads of the bolts holding it.

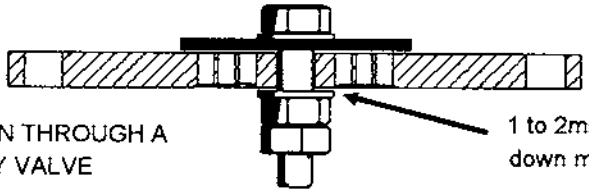




There should be a space all the way around between the side of the plug disc and the Impulse valve plate. If the pump has been made exactly to the measurements, the space will be 3mm. If it is less than 1mm, you should take the valve apart and check the parts against the templates. If the plug disc is too large you may be able to make it smaller. If the hole in it is not in the centre, you will probably have to make another. If the hole in the impulse valve plate is too small or not round, you may be able to file it out. Do not file it so that the hole is bigger than 66mm as shown in design drawing number 10. The plug disk must also hit the stop bar all the way around. Turn the plug disk to make sure that this is so.

Assembling the delivery valve

The delivery valve must be assembled so that the nuts are tight on the bolt, but the bolt has some up and down movement. This is shown on the drawing below. When the bolt head is pressed down against the washer and rubber on top of the delivery valve plate, there should be a gap on the underside of 1 to 2mm between the plate and the washer.

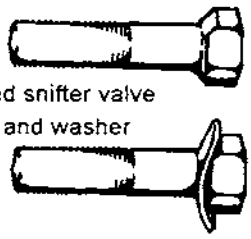


CROSS SECTION THROUGH A DELIVERY VALVE

To assemble the valve put a washer over a 40mm M10 bolt and push it through the delivery valve rubber. Make sure that the rubber moves freely on the bolt. It the hole in the centre was cut out with a hole punch, it should move freely up and down. If the rubber distorts when it is pushed over the bolt, you must make the hole in the middle bigger. This can sometimes be done with a round file or a stick with emery paper wrapped around it.

Check that there are no rough edges on the holes in the delivery valve plate then push the bolt through it. The chamfer on the delivery valve holes should be on the underside of the plate, away from the bolt head. Push on a washer and thread on a nut, leaving 1 to 2mm up and down movement in the bolt. Use a feeler-gauge if you have one, or do up the nut with your fingers until it starts to get tight, then unscrew it one full turn. Use spanners to lock a second nut against the first, then check that there is still enough up and down movement. It should be at least 1mm and not more than 2mm.

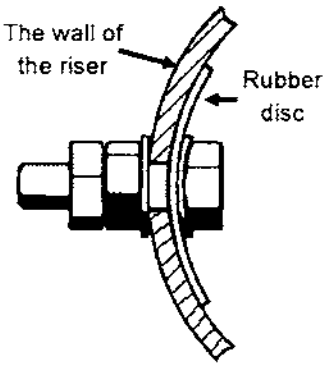
Assembling the snifter valve



Shaped snifter valve bolt and washer

The snifter valve rubber must sit flat against the inside curve of the riser below the delivery valve. To make this happen you must shape a nut and washer as shown on page 15.

Make sure that there are no rough edges on the inside of the two holes you have drilled through the riser on the pump body. Even a small burr can stop the valve working properly. Also make sure that the holes have not been blocked by paint.



CROSS SECTION of the snifter valve assembly from above

To assemble the valve, push the rubber over the bolt up against the shaped washer. Make sure that the rubber moves freely on the bolt. It the hole in the centre was cut out with a hole punch, it should move freely up and down. If the rubber distorts when it is pushed over the bolt, you must make the hole in the middle bigger. Then push the bolt through the riser on the pump body. Make sure that the rubber disc covers the small snifting hole in the riser. Be sure to use a disc of rubber rather than a smaller flap. If the disc turns it will still cover the snifting hole.

Push a washer over the thread outside the pump body and thread a nut onto it. Holding the head inside the pump, tighten the nut half a turn with spanner. Check that the rubber disc has not distorted. If it has, slacken the nut off until the rubber disc sits flat against the riser. When the disk sits flat and there is no play in the nut and bolt, use spanners to lock a second nut against the first.

Spare parts

It is important that you make the pump parts carefully to match the dimensions given on the design drawings. Then, if a part needs to be replaced, it can be made from the drawings and taken to the pump. If the parts are made carelessly, the pump may have to be brought to the workshop so that you can make a part that fits.

The DTU S2 ram pump costs much less than any commercial pump we have seen. It is made using materials and tools that are widely available. The disadvantage of this is that some parts will wear out or fail more quickly than they do on expensive pumps. The parts that have failed in the past are the rubber discs and the valve stem. You should make spares of these and supply them with the pump. A valve stem made from stainless steel usually lasts a lot longer than a stem made from mild steel. After the pump has been taken apart a few times it may also need a new flange gasket. The head or the thread on a bolt or nut may also get damaged, so the pump should be supplied with a few extra nuts, bolts and washers of the right size.

Provide these spares with each pump:

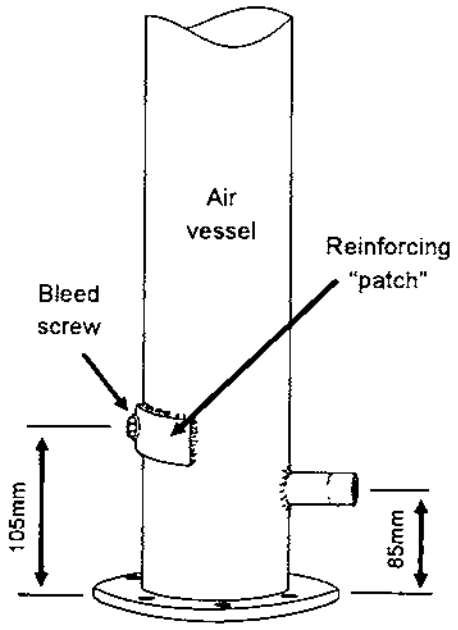
- a spare impulse valve stem;
- spare impulse and delivery valve rubbers;
- 2 spare flange gaskets.
- 1 spare 40mm M10 nut and bolt;
- 1 spare 80mm M10 nut and bolt;
- 2 spare 50mm M10 nuts and bolts;
- 4 spare M10 nuts and 6 spare washers.

If the impulse valve discs are not made carefully with their holes in the centre, the valve plug disk may not turn freely in the hole in the valve plate. It may not strike the stop bar on both sides all the time when the valve plug is turned through 360°. This may also happen if the hole in the middle of the stop bar is not drilled absolutely vertically through it. If you find these faults, you must make the parts again.

Optional addition

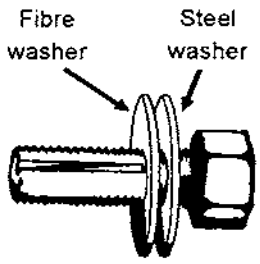
The addition of a "bleed" screw in the air vessel can make it easier to find out what is wrong with a pump when it does not perform properly. It can also make the pump easier to maintain.

Many commercially available pumps have a bleed screw on the air vessel. The screw is opened to check that there is enough air in the air vessel, and to let out the water when there is too much. It is also a useful way of letting the pressure out of the air vessel when you want to take it apart for maintenance.



The bleed screw should be position just above the delivery pipe stub on the other side of the air vessel.

The pressure in the air vessel can get very high, so the bleed screw and its thread must be made carefully to prevent it leaking. To make the thread longer and more secure, a "patch" cut from the same 4" pipe as the air vessel should be welded over the area first. Then you drill a hole through the patch and the wall of the air vessel. Cut a thread in the hole so that an M10 bolt will screw into it.



The thread on the bolt used should be 30mm long. Holding the head of the bolt in a vice, use a hacksaw to cut a shallow slot along the threads. Do not cut more than 1mm deeper than the bottom of the thread. When the hacksaw blade hits the bolt head, stop. The bolt should look like the one in the drawing alongside. You will need to use a steel and a fibre washer under the bolt head to make a good seal.

To bleed air or water from the air vessel, simply undo the bolt a few turns until air starts to hiss out, or water to spray out.

DRAWINGS

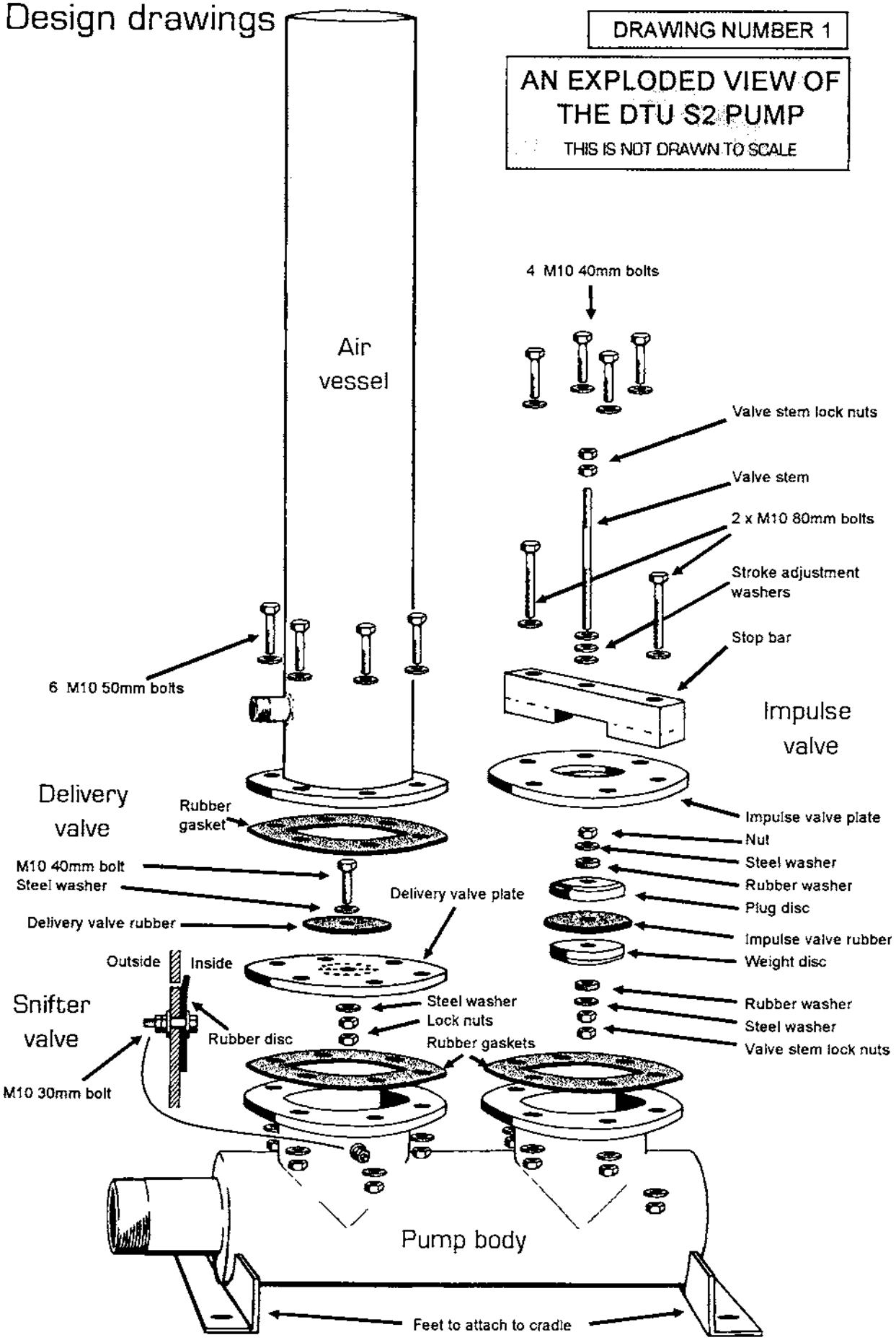
1	An Exploded View of the DTU S2 Pump
2	DTU S2 Pump Body
3	DTU S2 Pump Flange
4	DTU S2 Air Vessel
5,6,7	Delivery Plates 1, 2 & 3 *[Original]*
8	Snifter and Delivery Valve Assemblies
9	Impulse Valve Assembly
10	Impulse Valve Plate
11	Impulse Valve Stop Bar *[Original]*
11a	Two-Stage Impulse Valve Stop Bar / Guide *[Amendment]*
12	DTU S2 Impulse Valve Discs and Stem
13	DTU S2 Gasket *[Amendment]*
14	Plate for Alternative Delivery Valve *[Amendment]*
14a	(Alternative) Delivery Valve Rubber and Retaining Bar *[Amendment]*

DTU S2 pump
Design drawings

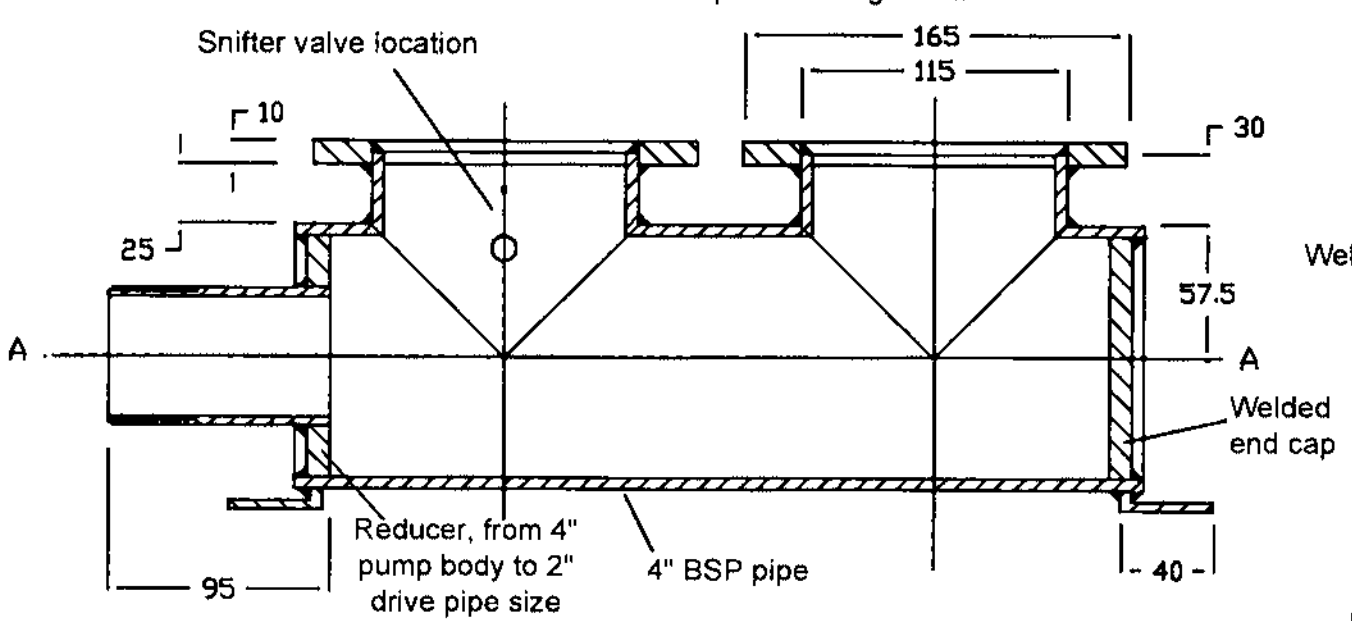
DRAWING NUMBER 1

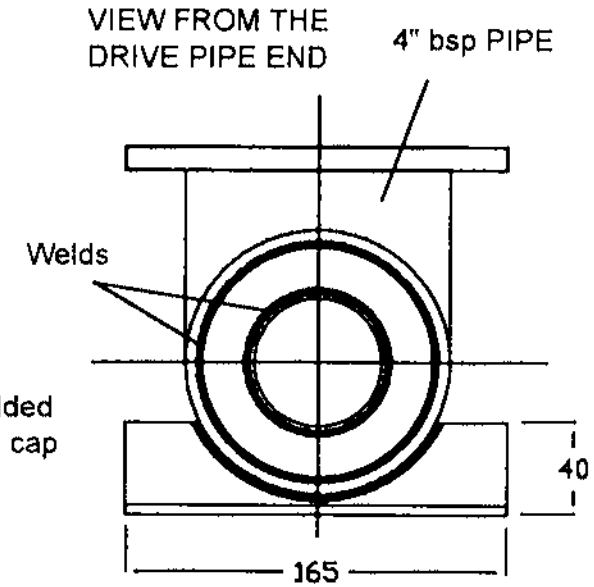
AN EXPLODED VIEW OF THE DTU S2 PUMP

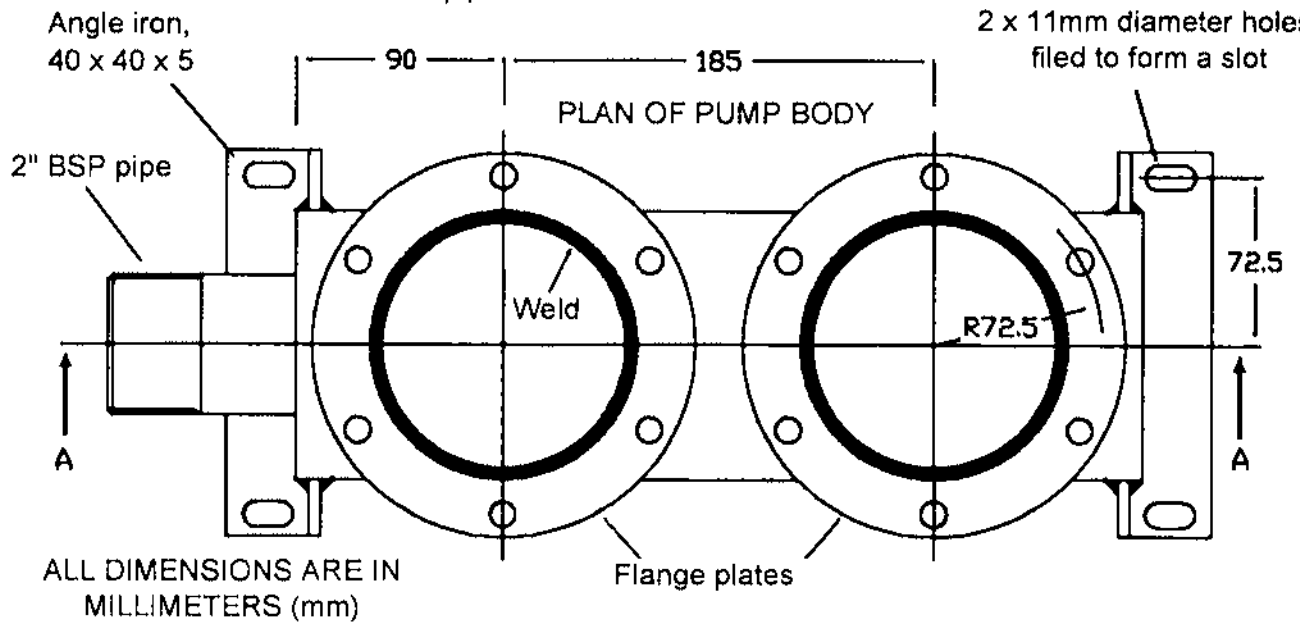
THIS IS NOT DRAWN TO SCALE



CROSS SECTION THROUGH THE MIDDLE OF THE PUMP BODY
that is from A to A on the plan drawing below







MATERIALS

PIPE: the pipe used is mild steel with a 4" (115mm) outside diameter and an inside diameter of 105mm.

PLATE: the plate is mild steel either 10 or 12mm thick.

ANGLE IRON: use 40 x 40mm angle iron, about 5mm thick. Use bigger angle iron if this size is hard to get.

ALL THE JOINTS SHOULD BE WELDED

DRAWING NUMBER 2

DTU S2 pump body

NOT DRAWN TO SCALE

DTU S2 PUMP FLANGE

DRAWING NUMBER 3

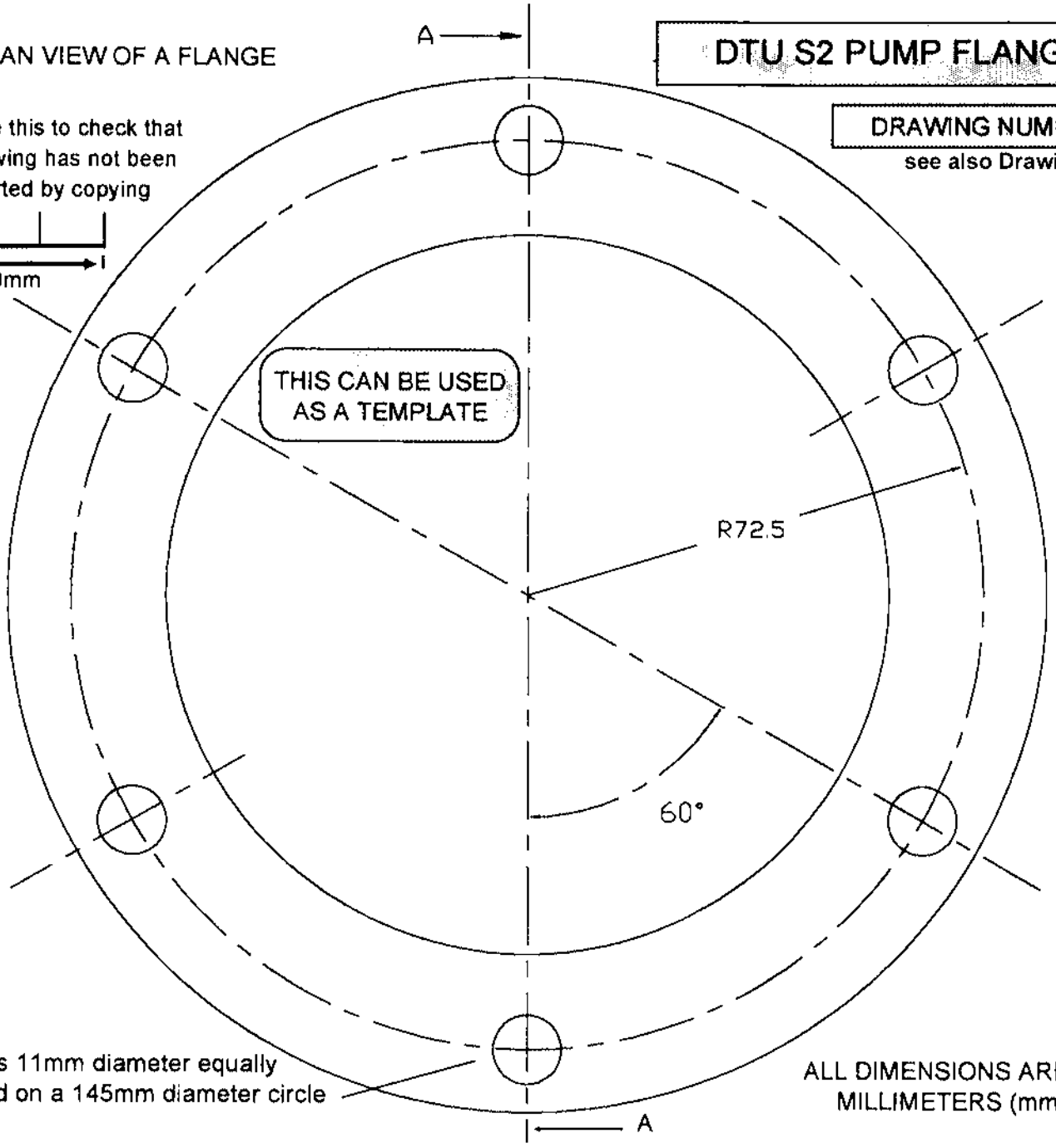
see also Drawing No 13

PLAN VIEW OF A FLANGE

Measure this to check that the drawing has not been distorted by copying

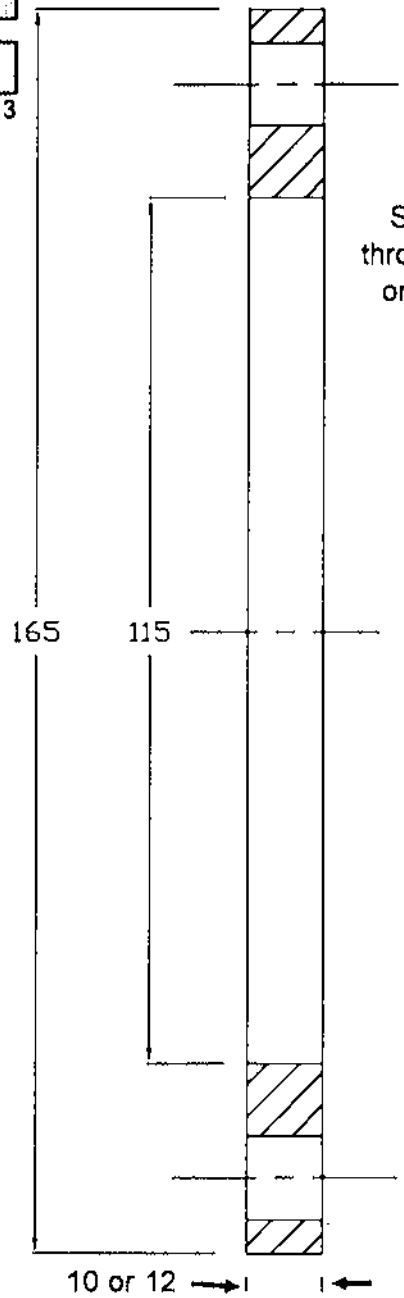
30mm

THIS CAN BE USED AS A TEMPLATE

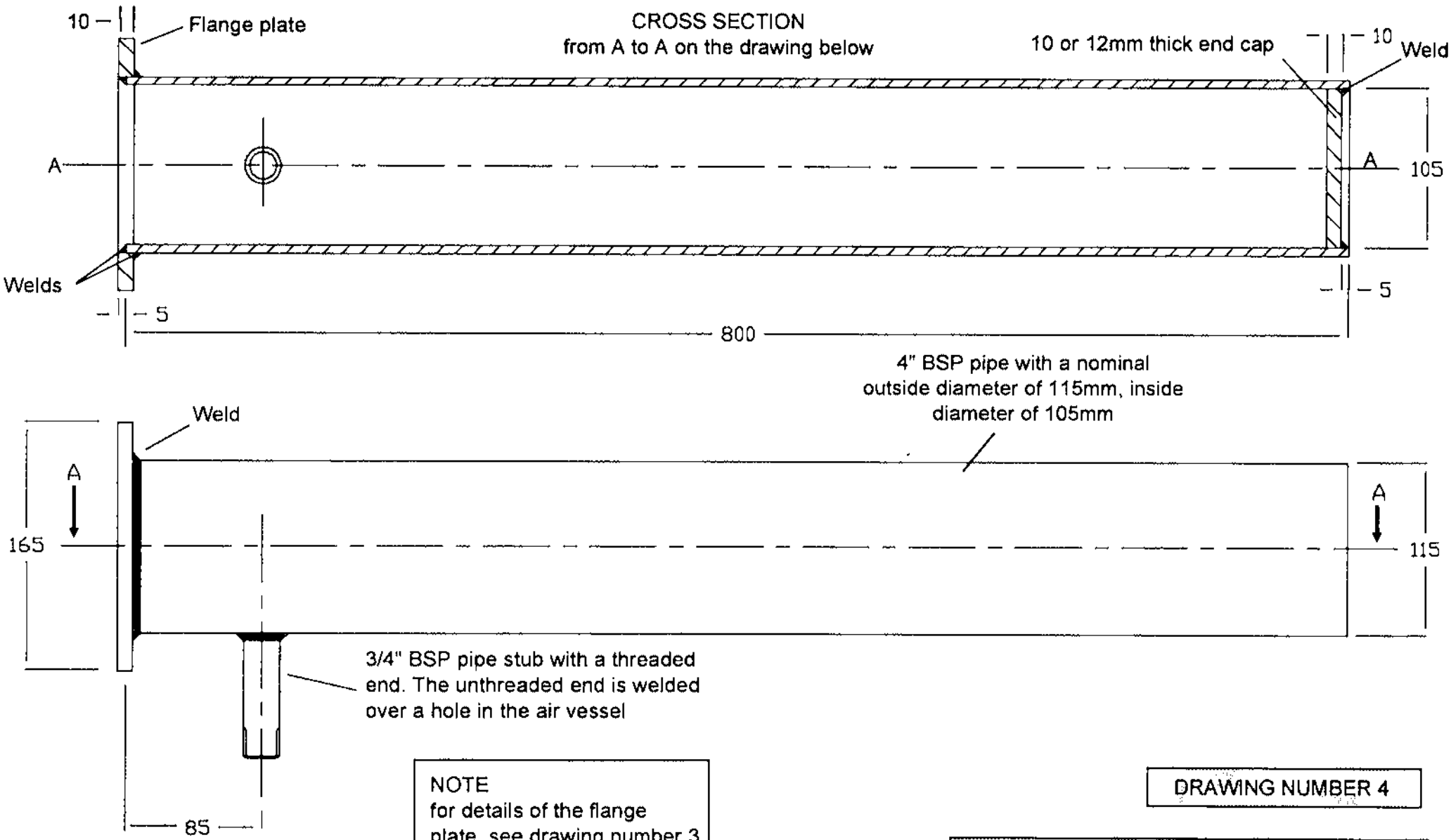


6 holes 11mm diameter equally spaced on a 145mm diameter circle

ALL DIMENSIONS ARE IN MILLIMETERS (mm)



CROSS SECTION through A to A on the plan drawing



NOTE
for details of the flange plate, see drawing number 3

ALL DIMENSIONS ARE IN MILLIMETERS (mm)

DRAWING NUMBER 4

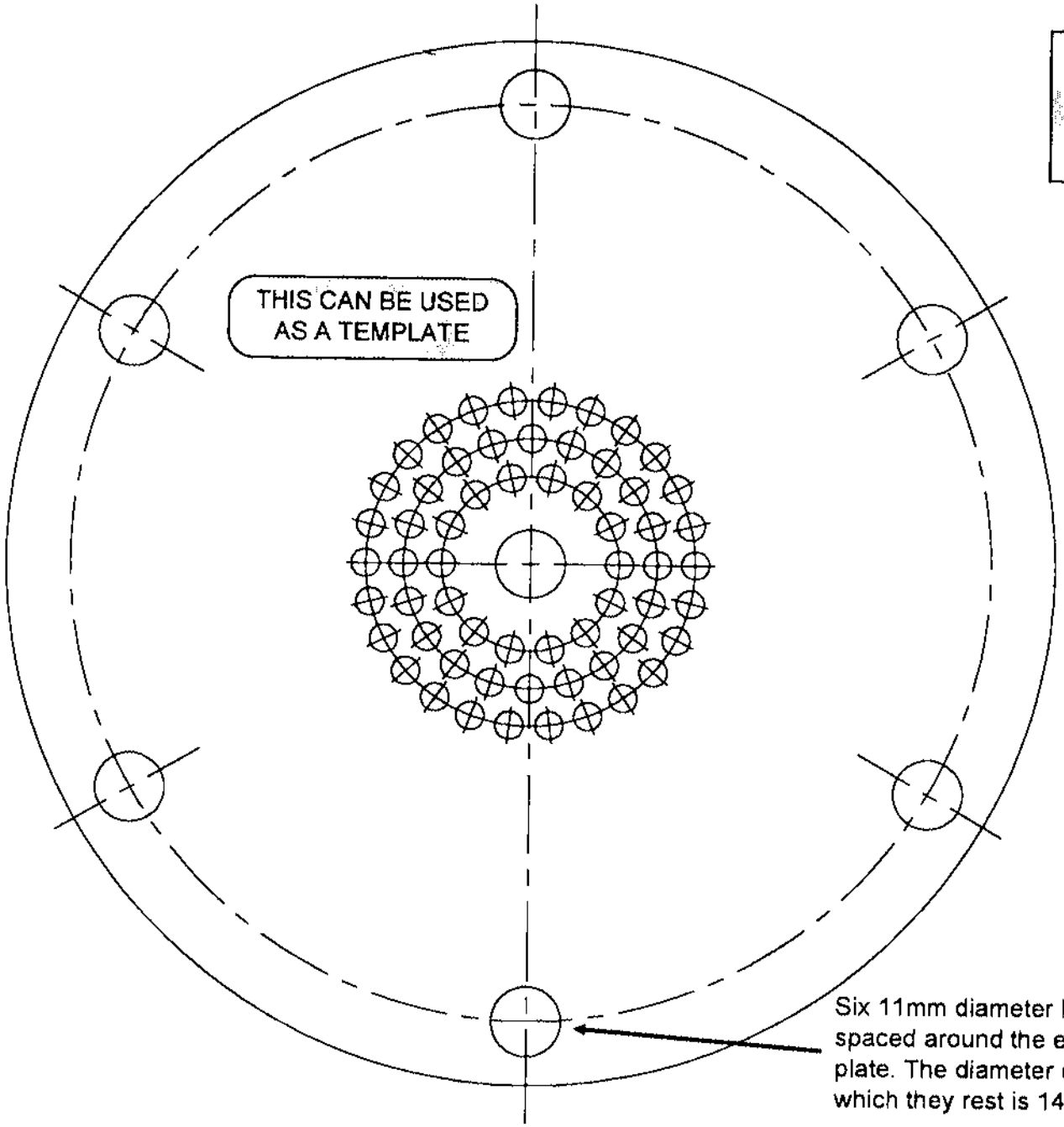
DTU S2 AIR VESSEL

NOT DRAWN TO SCALE

DELIVERY VALVE PLATE 1

Suitable for delivery heads over 75 meters
DRAWN TO SCALE: 1:1

DRAWING NUMBER 5



NOTES

The centre hole is 10.5mm in diameter.

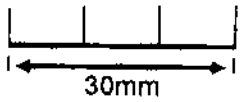
The rings of holes are 4.5mm in diameter. They are equally spaced on circles drawn from the centre with a radius of 14, 20 and 26mm. All these holes must be deburred and chamfered on one side. The chamfered side will be the underside of the delivery valve.

The valve rubber diameter is 64mm and it should be at least 3mm thick.

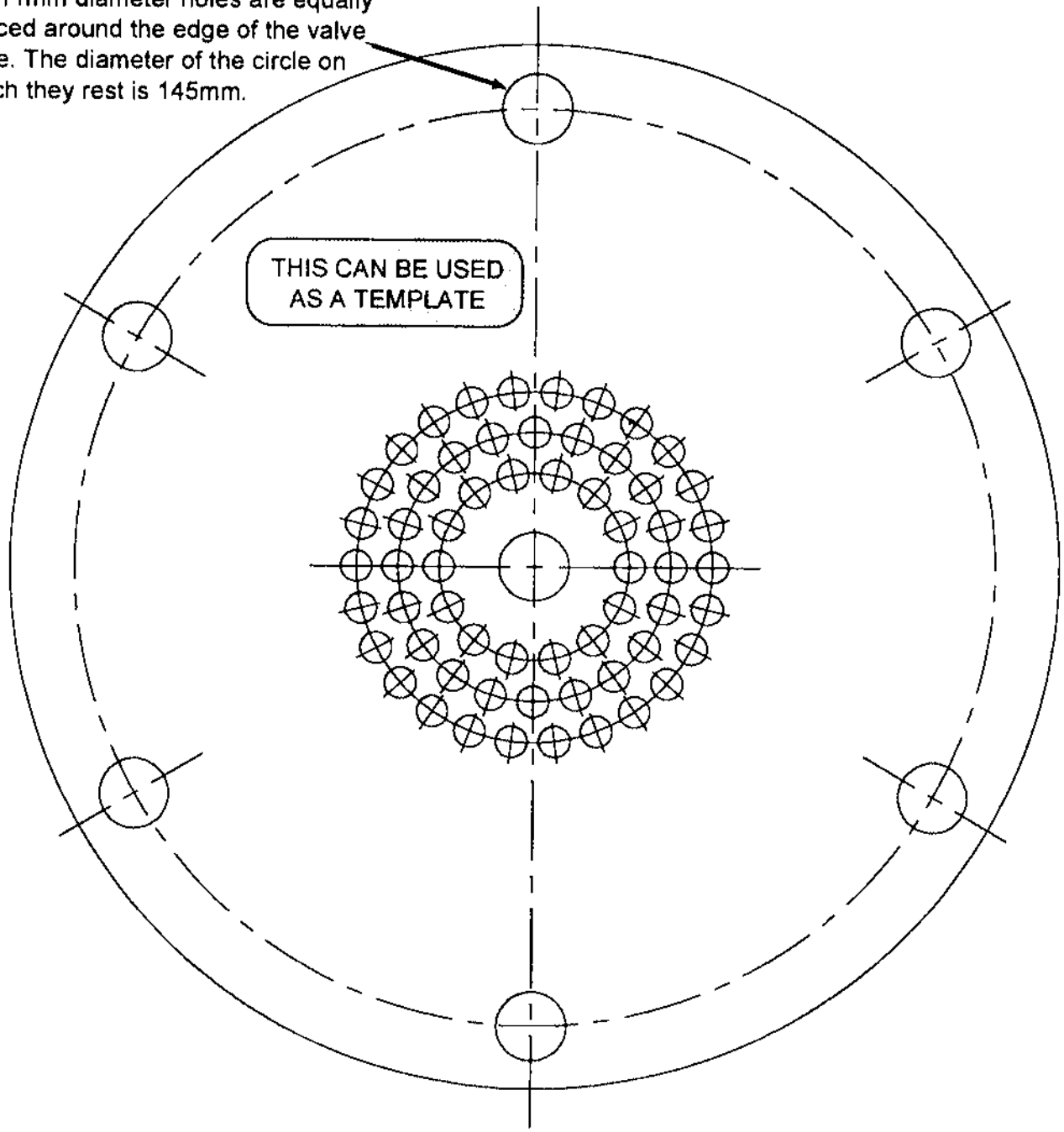
The plate should be 165mm in diameter and 10 or 12mm thick.

Six 11mm diameter holes are equally spaced around the edge of the valve plate. The diameter of the circle on which they rest is 145mm.

Measure this to check that the drawing has not been distorted by copying



Six 11mm diameter holes are equally spaced around the edge of the valve plate. The diameter of the circle on which they rest is 145mm.



Measure this to check that the drawing has not been distorted by copying

NOTES

The centre hole is 10.5mm in diameter.

The rings of holes are 5mm in diameter. They are equally spaced on circles drawn from the centre with a radius of 15, 21.5 and 28mm. All these holes must be deburred and chamfered on one side. The chamfered side will be the underside of the delivery valve.

The valve rubber diameter is 68mm and it should be at least 3mm thick.

The plate should be 165mm in diameter and 10 or 12mm thick.

DRAWING NUMBER 6

DELIVERY VALVE PLATE 2

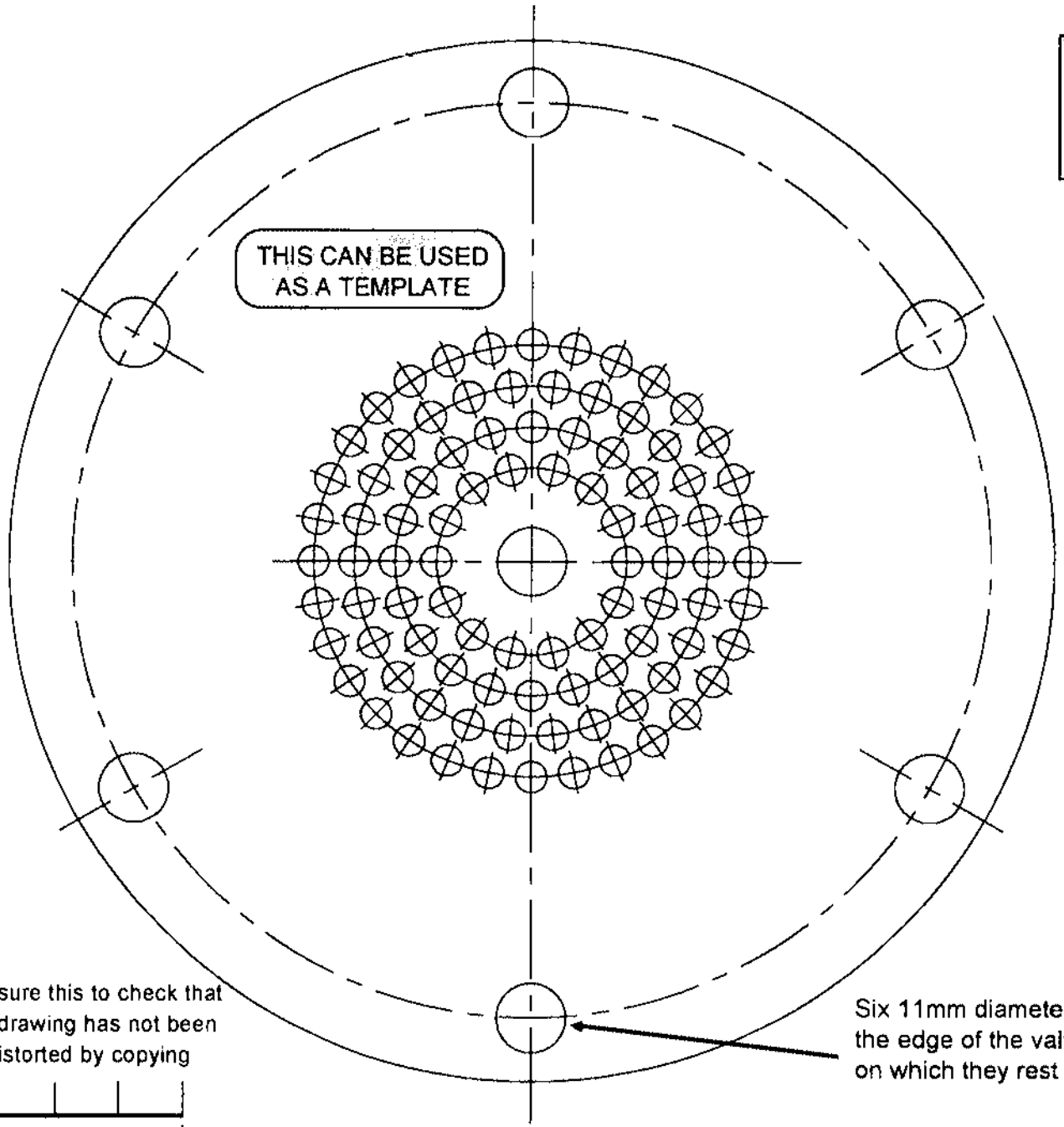
Suitable for delivery heads of 35 to 75 meters

DRAWN TO SCALE: 1:1

DELIVERY VALVE PLATE 3

Suitable for delivery heads up tp 35 meters
DRAWN TO SCALE: 1:1

DRAWING NUMBER 7



NOTES

The centre hole is 10.5mm in diameter.

The rings of holes are 5mm in diameter. They are equally spaced on circles drawn from the centre with a radius of 15, 21.5, 28 and 34.5mm. All these holes must be deburred and chamfered on one side. The chamfered side will be the underside of the delivery valve.

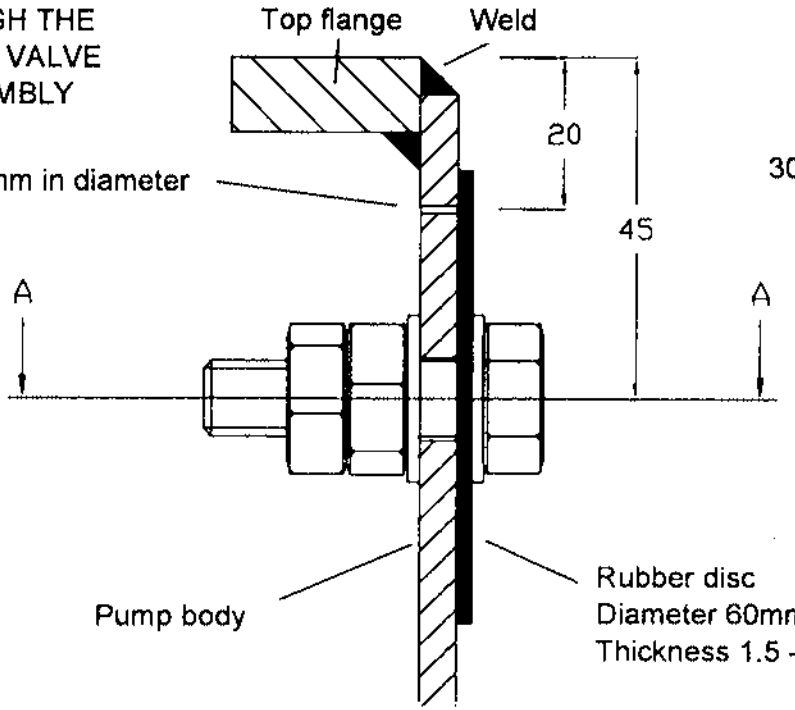
The valve rubber diameter is 80mm and it should be at least 3mm thick.

The plate should be 165mm in diameter and 10 or 12mm thick.

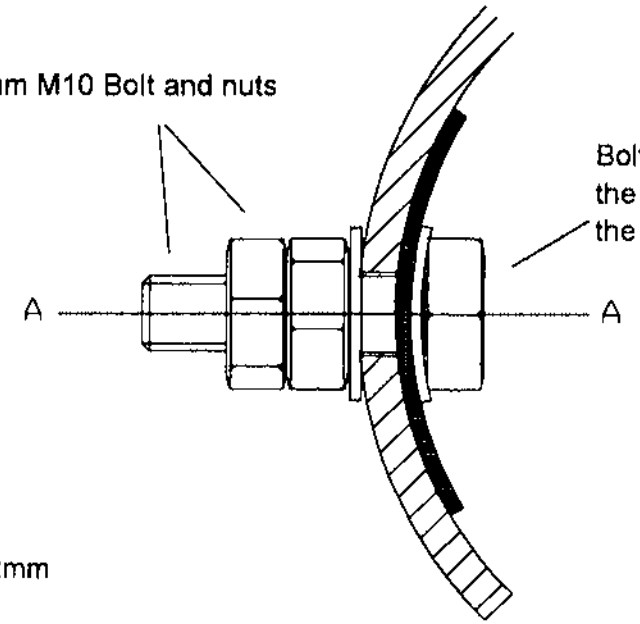
Six 11mm diameter holes are equally spaced around the edge of the valve plate. The diameter of the circle on which they rest is 145mm.

Measure this to check that the drawing has not been distorted by copying

CROSS SECTION THROUGH THE SNIFTER VALVE ASSEMBLY

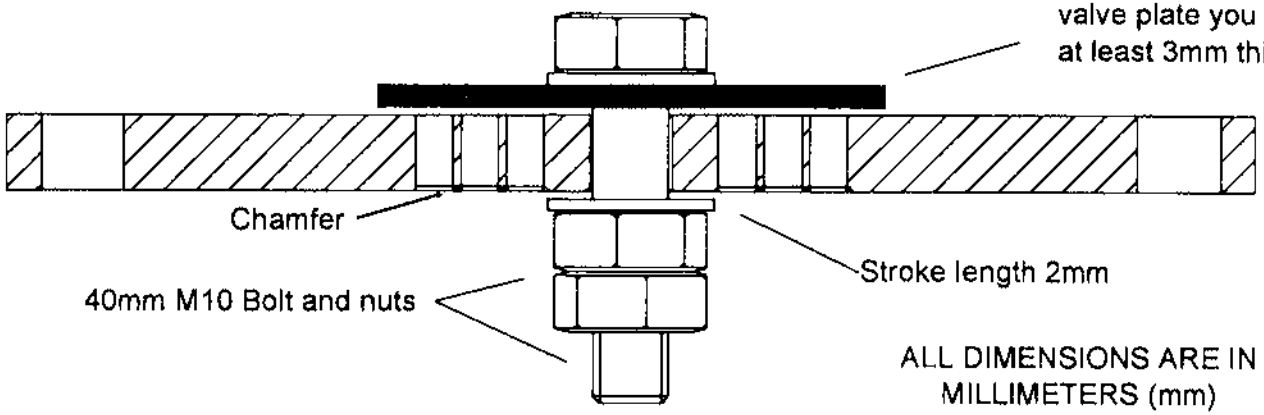


PLAN VIEW CROSS SECTION
that is from A to A on the assembly drawing



Measure this to check that the drawing has not been distorted by copying

CROSS SECTION THROUGH THE DELIVERY VALVE ASSEMBLY



Rubber disc
Its diameter depends on which delivery valve plate you have chosen. It should be at least 3mm thick.

ALL DIMENSIONS ARE IN MILLIMETERS (mm)

DRAWING NUMBER 8

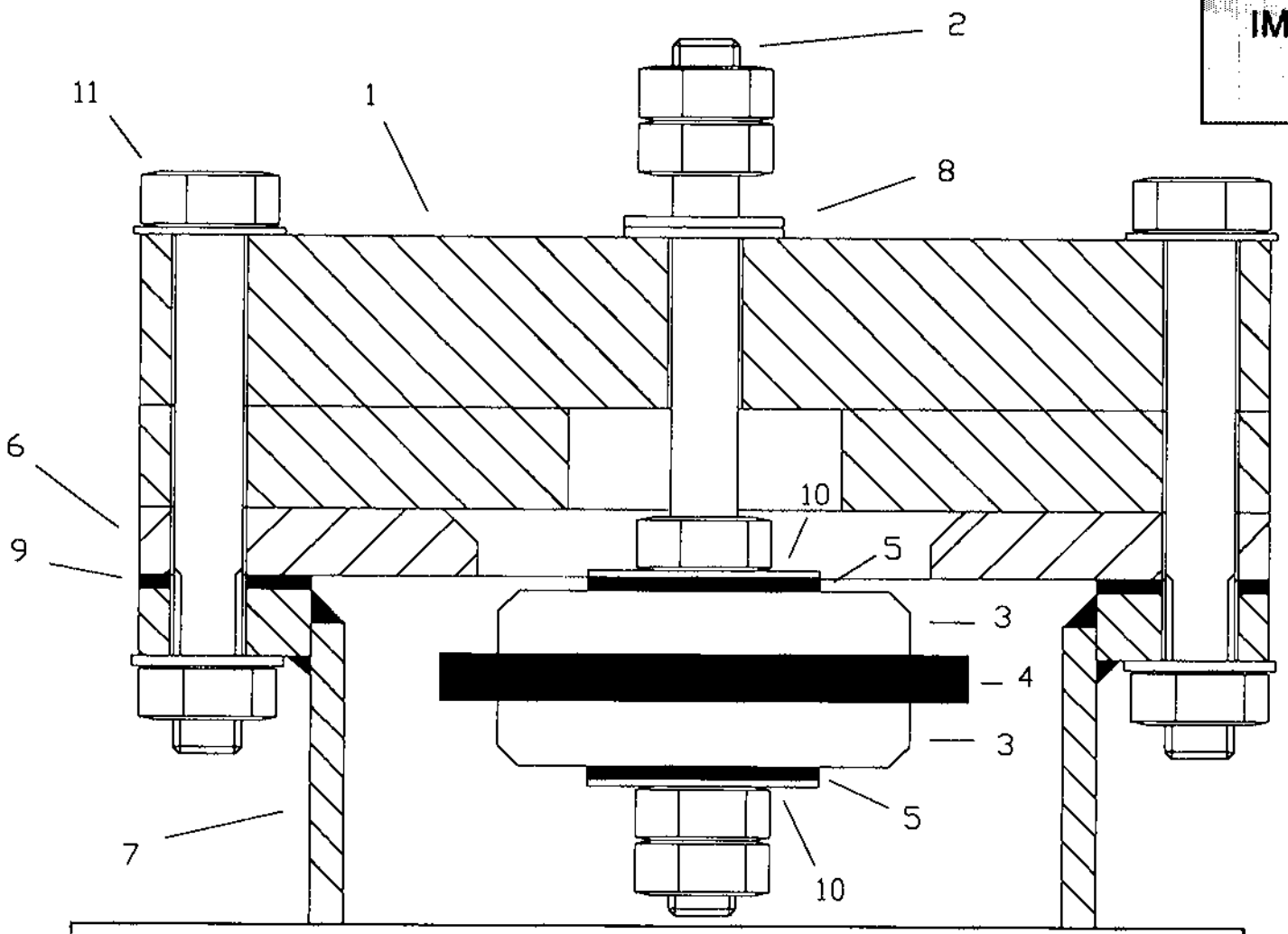
SNIFTER AND DELIVERY VALVE ASSEMBLIES

DRAWN TO SCALE: 1:1

IMPULSE VALVE ASSEMBLY

DRAWN TO SCALE: 1:1

DRAWING NUMBER 9



PARTS LIST

1 - Stop bar
2 - Valve stem
3 - Valve disc (x2)
4 - Rubber disc
5 - Rubber washer (x2)
6 - Valve plate
7 - Pump body
8 - Stroke adjustment washers
9 - Rubber gasket
10 - Large steel washers, about 35mm in diameter (x2)
11 - M10 Bolts, nuts and washers

BOLTS

M10 x 80mm (x2)
M10 x 40mm (x4)

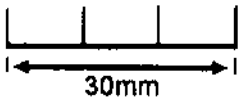
NOTES

The rubber disc (4) is 76mm in diameter and 6mm thick. Do not use a larger disc.

The rubber washers (5) are made to the same diameter as the steel washers (10) and can be 1.5 to 3mm thick.

The rubber gasket (9) can be 1.5 to 3mm thick and is cut to match the pump body flange. Drawing number 3 can be used as a template.

Measure this to check that the drawing has not been distorted by copying



ALL DIMENSIONS ARE IN MILLIMETERS (mm)

IMPULSE VALVE PLATE

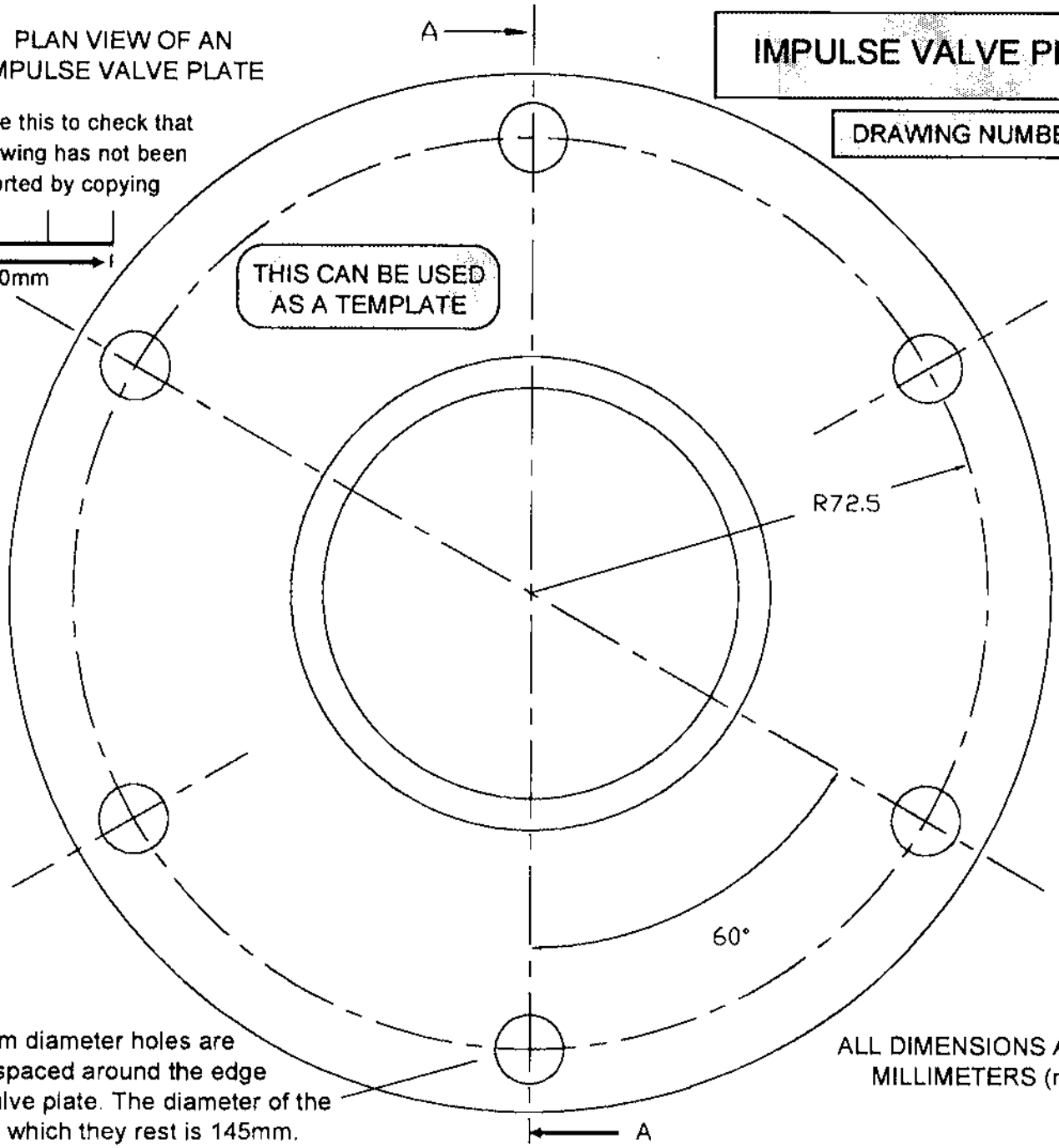
DRAWING NUMBER 10

PLAN VIEW OF AN IMPULSE VALVE PLATE

Measure this to check that the drawing has not been distorted by copying

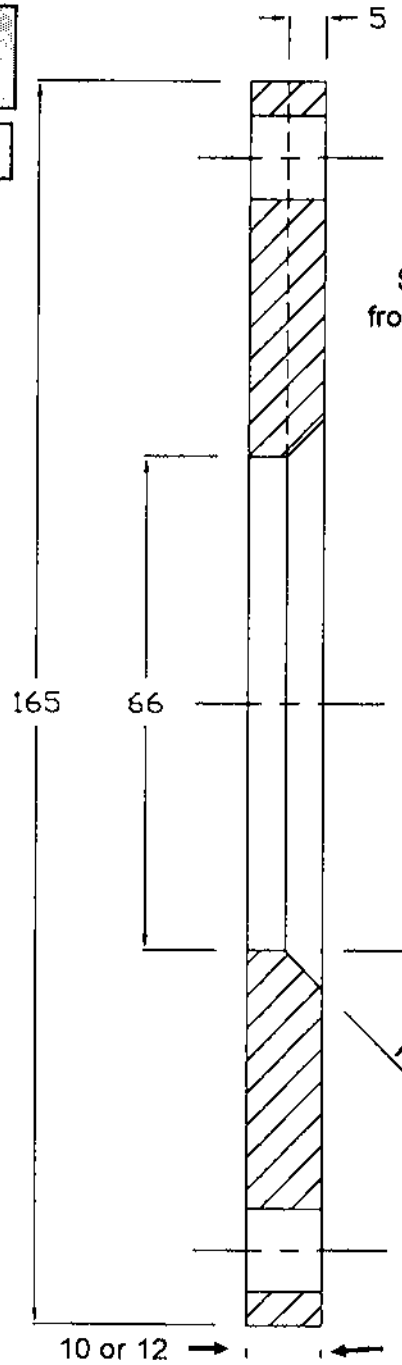
30mm

THIS CAN BE USED AS A TEMPLATE

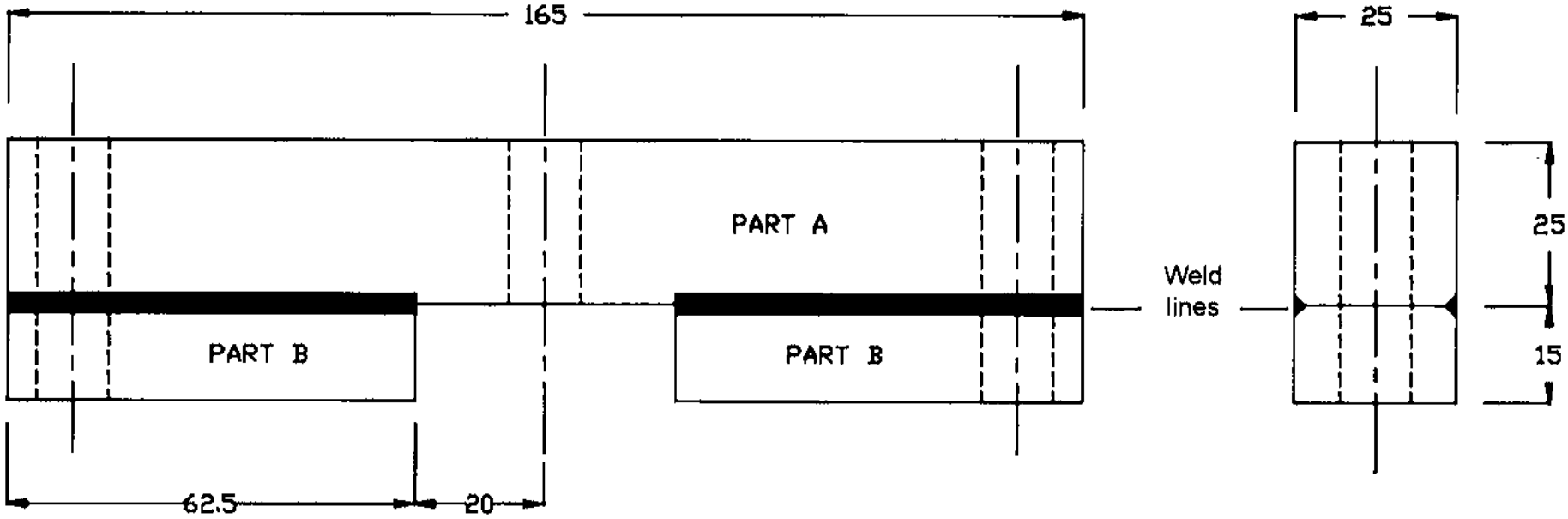


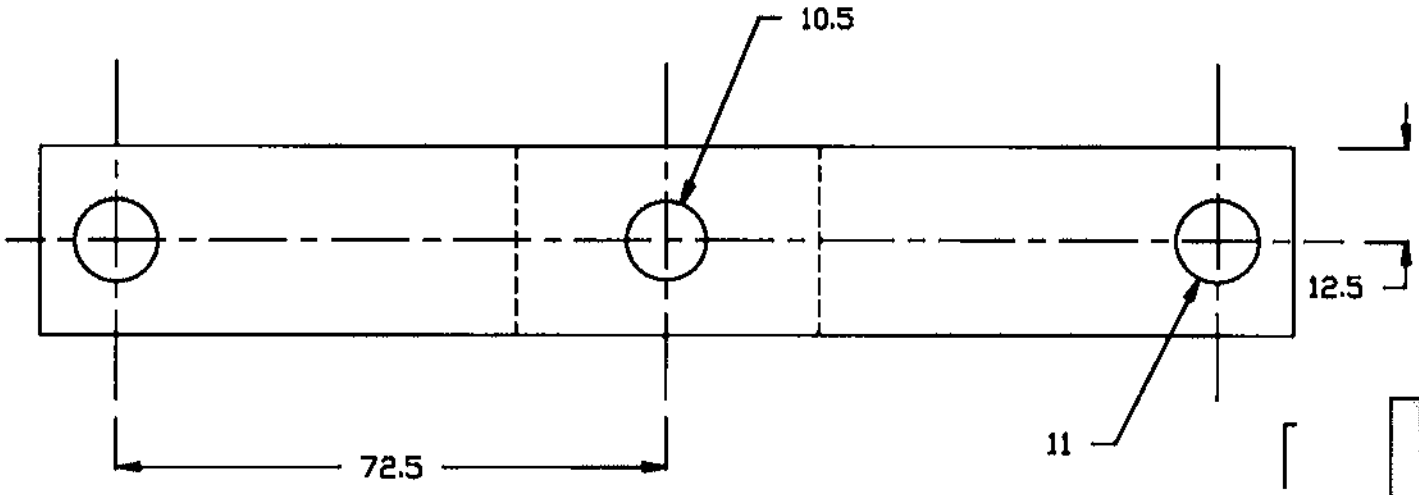
Six 11mm diameter holes are equally spaced around the edge of the valve plate. The diameter of the circle on which they rest is 145mm.

ALL DIMENSIONS ARE IN MILLIMETERS (mm)



CROSS SECTION from A to A on the plan drawing





ALL DIMENSIONS ARE IN MILLIMETERS (mm)

Measure this to check that the drawing has not been distorted by copying

30mm

IMPULSE VALVE STOP BAR

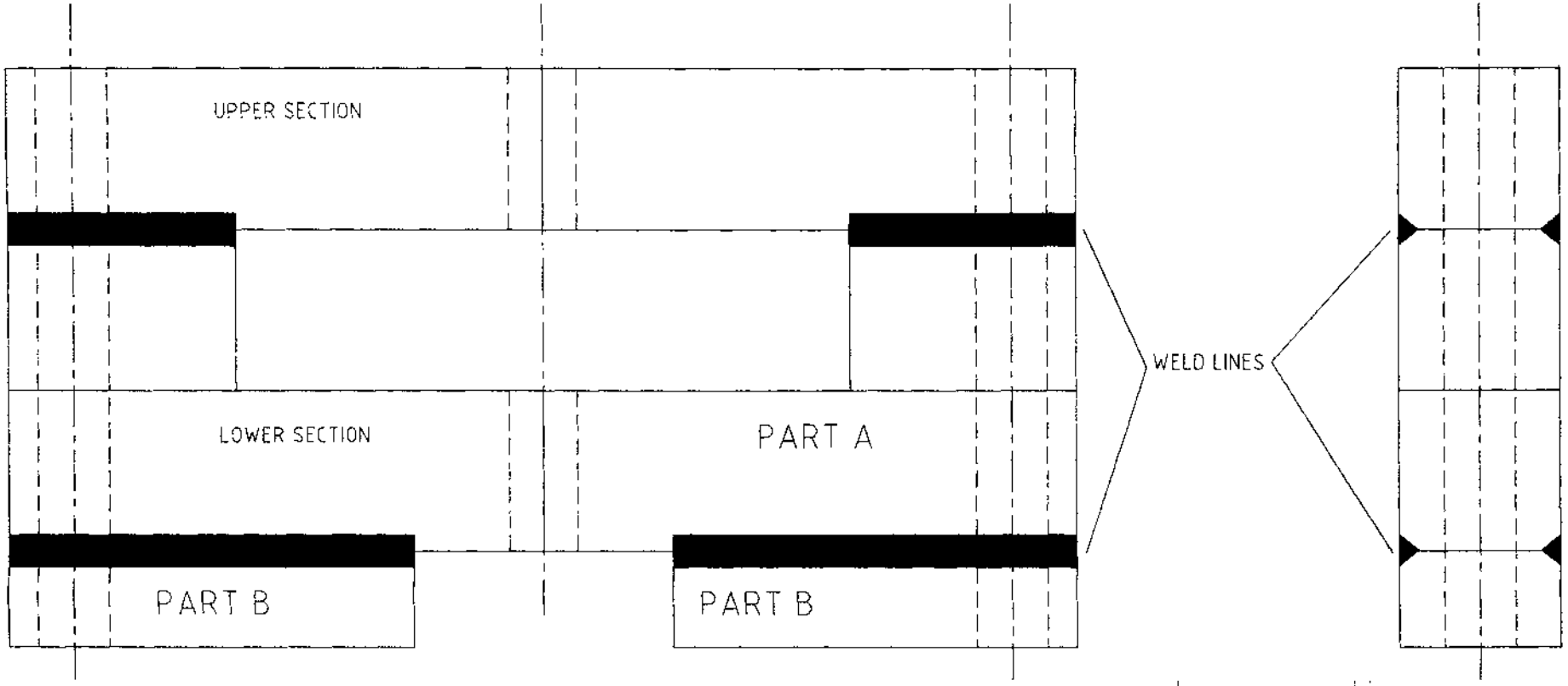
DRAWN TO SCALE: 1:1

DRAWING NUMBER 11

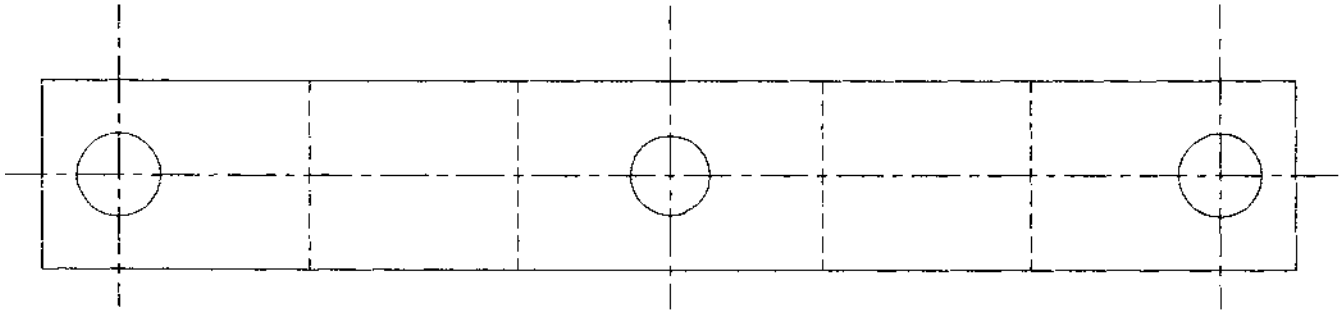
NOTES

If you cannot get the right size of bar, the height of Part B must be a minimum of 15mm. Part A should be 25mm high, but sizes down to 20mm can be used. The width of Parts A and B should be 25mm but a width down to 20mm can be used.

Make the bar from mild steel. Only use stainless if it is available and you have the tools.



Lower section as per drawing No. 11
Upper from 25' x 25 mm and drilled to match lower assembly



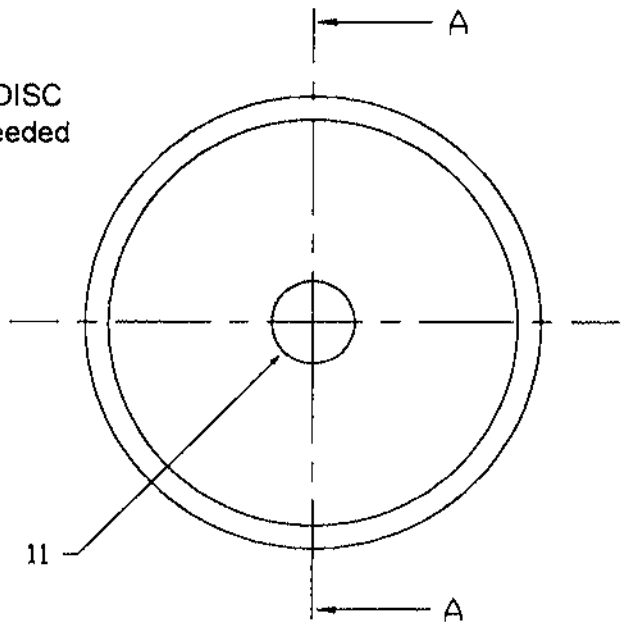
Outer Holes 11.0 mm dia. Middle Hole 10.5 mm dia.

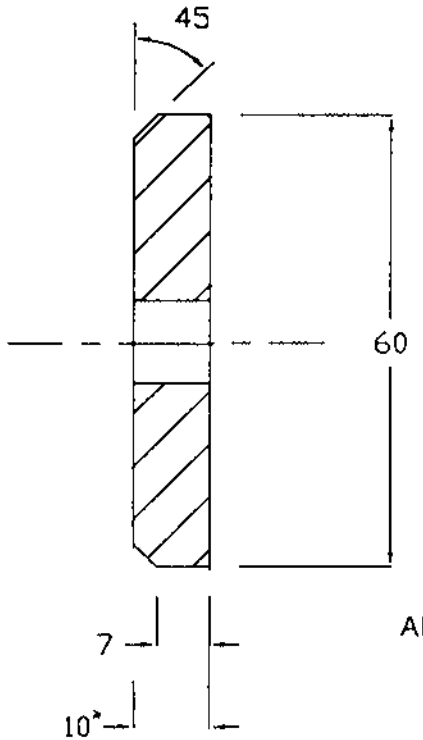
TWO STAGE IMPULSE VALVE STOP BAR/GUIDE

DRAWING NUMBER 11a

DRAWN TO SCALE 1:1

PLAN OF AN
IMPULSE VALVE DISC
Two of these are needed
for each valve



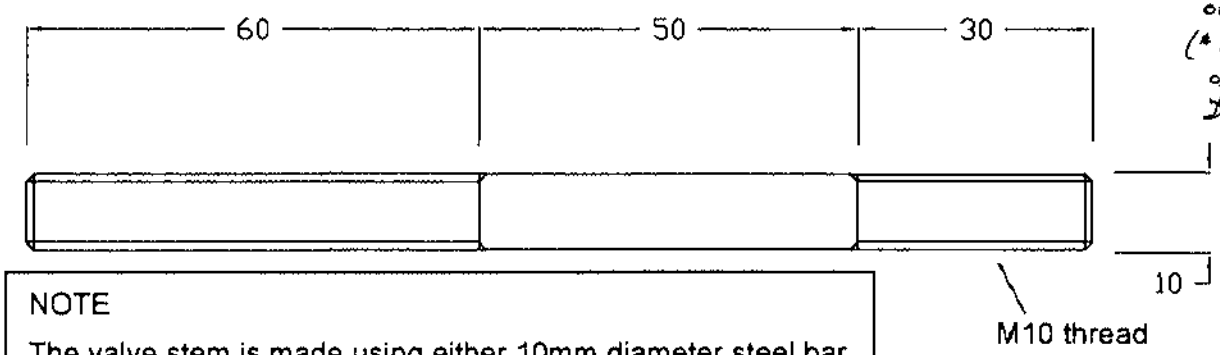


CROSS SECTION
From A to A on the
Plan drawing

ALL DIMENSIONS ARE IN
MILLIMETERS (mm)

Measure this to check that
the drawing has not been
distorted by copying

IMPULSE VALVE STEM



NOTE

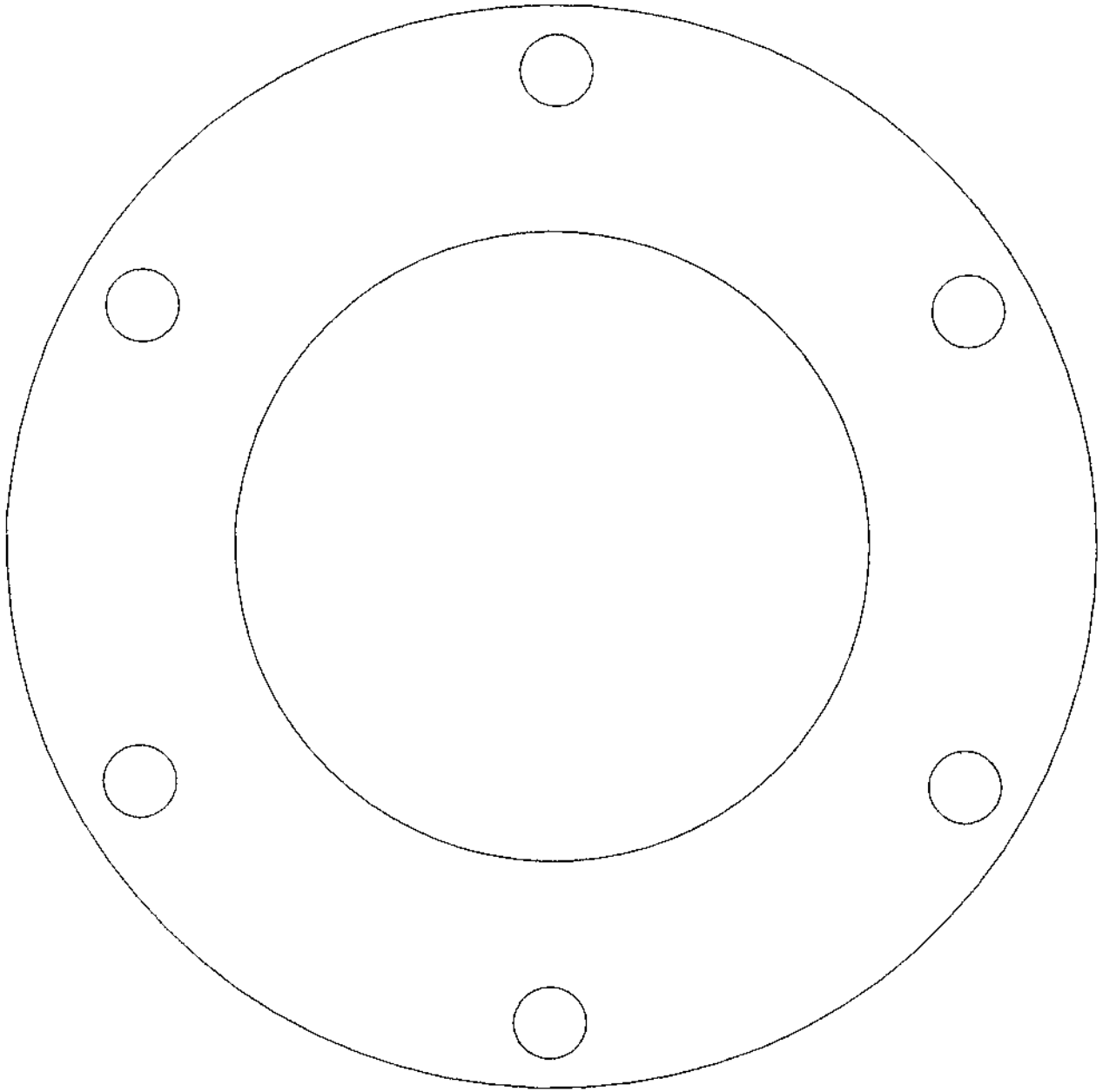
The valve stem is made using either 10mm diameter steel bar or 10mm diameter reinforcing bar. Use stainless if you can.

The thread is hand turned using an M10 x 1.5 die.

DTU S2 IMPULSE VALVE DISCS AND STEM

DRAWN TO SCALE: 1:1

DRAWING NUMBER 12

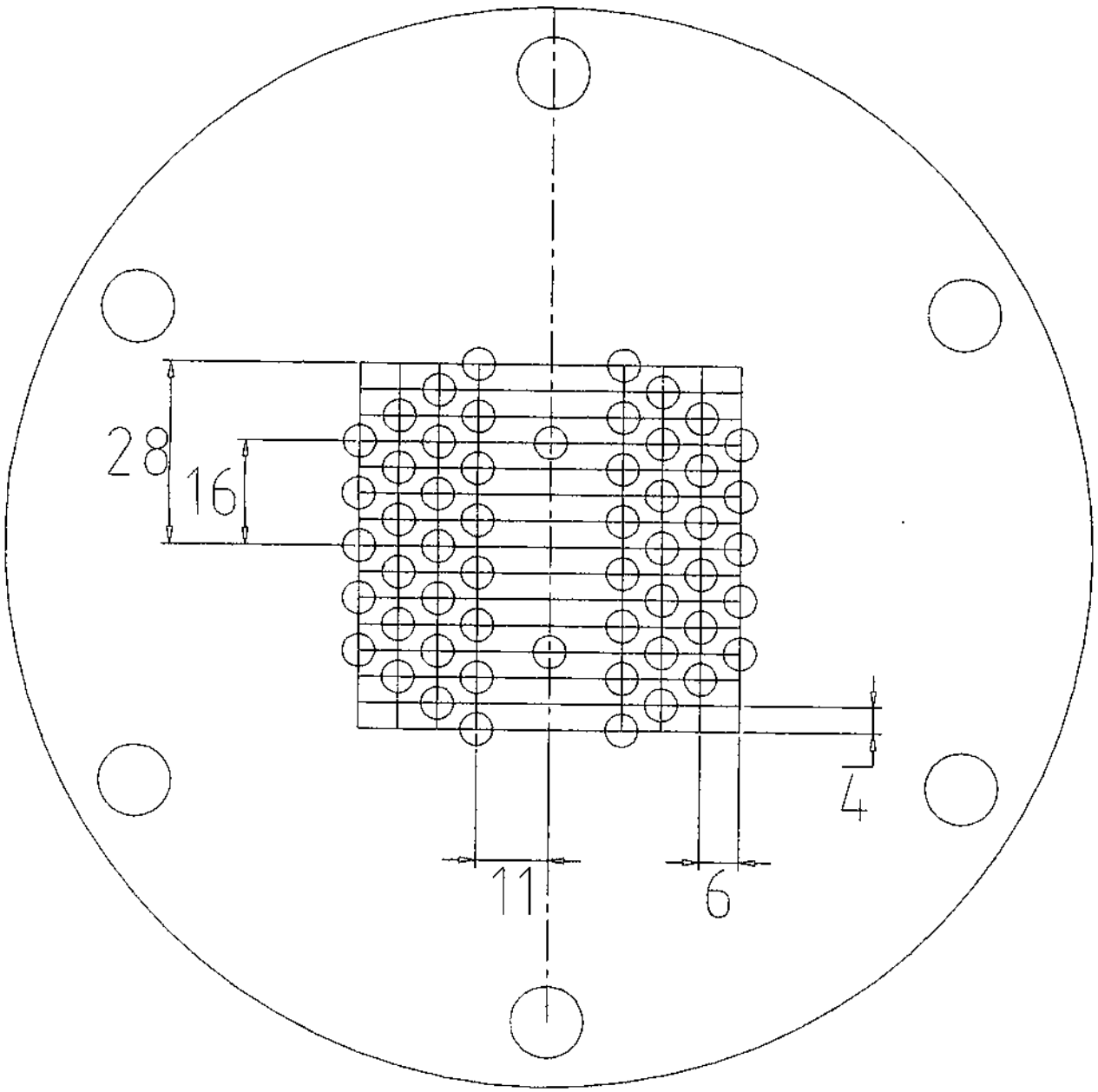


Inner diameter 96.0 mm
Outside diameter 165 mm

DTU S2 GASKET

DRAWING NUMBER 13

DRAWN TO SCALE 1:1



Delivery Holes 52 off
4.5 mm dia. High Head
5.0 mm dia. Low Head

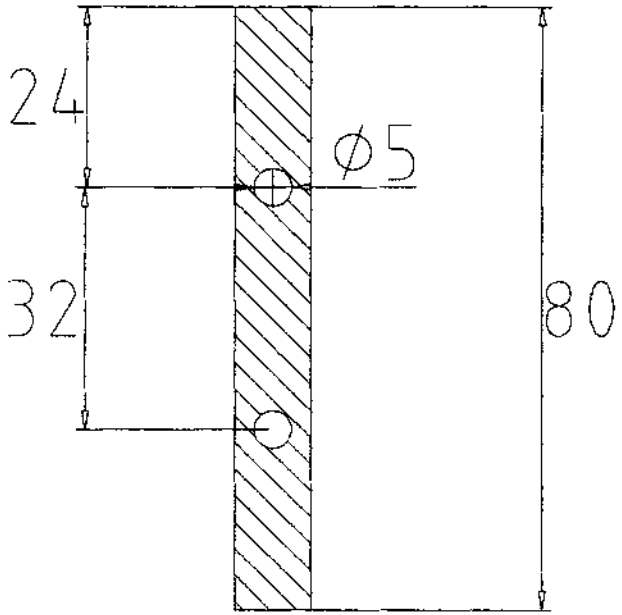
Centre Holes
5.0 mm dia.

PLATE FOR ALTERNATIVE DELIVERY VALVE

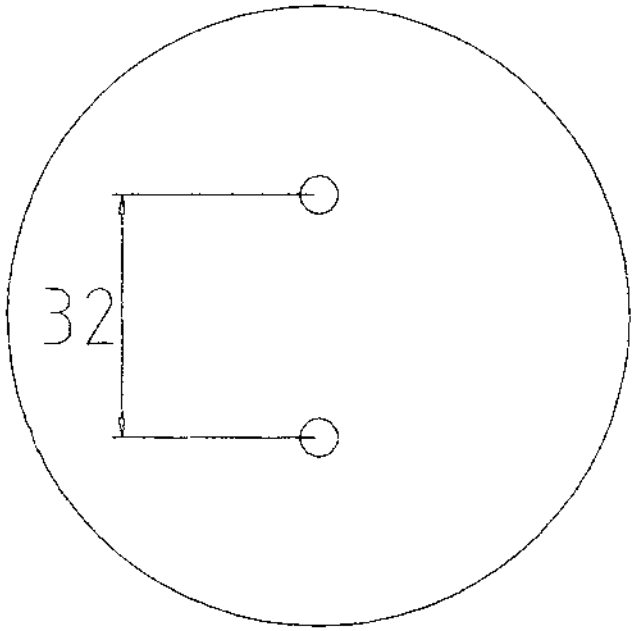
DRAWING NUMBER 14

DRAWN TO SCALE 1:1

Steel Retaining Bar
5 mm thick
10 mm wide



Delivery valve rubber
Diameter 82 mm
3 mm thick for low heads
6 mm thick for high heads



DELIVERY VALVE RUBBER AND RETAINING BAR
FOR ALTERNATIVE DELIVERY VALVE

DRAWING NUMBER 14a
DRAWN TO SCALE 1:1