TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY

Manufacturing manual CWD 161 D pump

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MANUFACTURING MANUAL
CWD 161 D PUMP

A. KRAGTEN

March 1987 R 850 D

WIND ENERGY GROUP
Technical University Eindhoven
Faculty of Physics
Laboratory of Fluid Dynamics and Heat Transfer
P.O. Box 513
5600 MB Eindhoven, the Netherlands

CONSULTANCY SERVICES | P.O. BOX 85
WIND ENERGY | 3800 AB AMERSFOORT
DEVELOPING COUNTRIES | THE NETHERLANDS

CONTENTS

1. INTRODUCTION

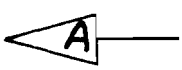
The CWD 161 D pump is a deepwell pump with a cylinder inner diameter of 161 mm designed for use under CWD windmills.
The CWD 161 D pump is except the cylinder inner diameter, identical to the CWD 108 D pump.
Both pumps have separate manufacturing manuals.
A cross section of the CWD 161 D pump is given in the assembly drawing which has drawing number E 8504-00/B.
An overview of all mono drawings and the required materials is given in the parts list non-standard parts.
Experiences with the manufacture presently have not been gained with the last modification with modification letter B but with an earlier version with modification letter A.
The differences between A and B have only a limited influence on the manufacturing method. In future maybe new modifications of the pump are necessary resulting in higher modification letters but it is not sure if this will result in a modification of the manufacturing manual.

2. DRAWING SYSTEM

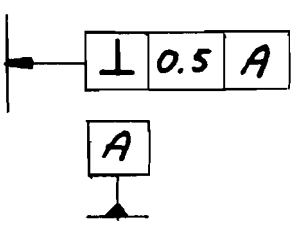
2.1. Standards

The manufacturing drawings for 161 D pump are based on current International Standards in order to obtain uniformity and interchangeability of components and parts. The standards are also of importance to obtain the correct fitting of supplier-procured parts such as bearings and the like.
In editing this manual, it has been assumed that the user has generally sufficient knowledge of how to read and understand a technical drawing.

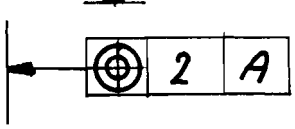
Below some symbols are explained which may give rise to misinterpretation:



This means that the part has been modified and this has been the first of perhaps a number of modifications. The next following modification would be indicated by the symbol with a 'B' and so on.



This indicates that the concerning plane should be perpendicular to plane A within a tolerance of 0.5 mm (for example see drawing E8504-01/B).



This indicates that the concerning plane should be flat with a tolerance of 0.05 mm (for example see drawing E 8504-07/A).

This indicates that the maximum permissible roughness of the concerning surface is 1.6 micron (which has to be obtained by turning). If a general roughness of 6.3 is given in the legend it means that sawing or rough turning is acceptable for all other surfaces with no indication.

If a measure is underlined it means the concerning part has not been drawn on scale.
If a measure is placed between arrows it means the nominal value is given only for orientation but the real value is determined by tolerances of other measures.

2.2. Construction of the set of drawings and the parts list

On the assembly drawing E8504-00/B two kind of item numbers can be distinguished being items (....) referring to non-standard parts which means parts which have to be manufactured and items (..N) referring to standard parts or normalised parts which can be purchased. Both parts have separate parts lists. All non-standard parts have separate so called 'mono drawings'.
Two kind of non-standard parts occur:

1. Single parts or so called 'mono's' which are made ut of one piece of material (for example supporting disk upper cup E8504-05/A.
2. Welding assemblies which are formed by welding (or soldering) some single parts together.
   These single parts are called 'welding mono's'. Welding mono's have not been drawn separately but all measures can be found in the welding assembly.

The welding assemblies are mentioned on the parts list first before the real mono's.
The drawing numbers have been given in sequence of paper size.

The drawing number has been build up as following:
A.b.c.d.e. - f.g./h.i.

A. = The Universith or another establishment producing the drawings (T = Twente, E = Eindhoven).
b.c. = The last two digits of the year in which the project started (e.g. 85).
d.e. = Sequence number of the project in the year concerned (e.g. 04).
f.g. = Sequence number of the drawing.
00 is used for the assembly drawing.
Higher numbers are used for welding assemblies and real mono's.
h.i. = These numbers are only used for the last part of item numbers of welding mono's.

A drawing may have an extra capital letter appended at the end. This indicates that a modification has been made in the drawing. A is for the first modification. B for the second and so on.

The item numbers of real mono's and welding assemblies as used in the assembly drawing and the parts list are equal to the last two digits of the concerning drawing number.

The item numbers of welding mono's as used in welding assemblies and the parts list are equal to the last two digits of the drawing number of the welding assembly followed by a dash and a sequence number of two digits.

3. DESCRIPTION OF THE PUMP (see drawing E8504-00/B)

The pump is a single acting piston pump.
This means the water is lifted only during the upwards stroke when the piston valve is closed and the foot valve is open.
To get a fairly constant flow in the rising main a pressure air chamber is used which is formed by the ring shaped chamber between the inner 2'' pipe item 01/02 and the 6'' pipe item 01/03. To keep the air chamber filled with air an air supply system is used (not a part of the pump) which produces a stream of water and air bubbles which enters the pump at the 1/8'' fitting of the suction valve seat item 03. In the pump 3/4'' gas pipe has been used as pump rods and 2'' gas pipe as rising mains.
The connection between piston and pump rod is made by a M20 threaded rod item 02/04.
The pump has flat ring shaped valves item 11 and suction and pressure valves are identical. The suction valve seat item 03 is provided with two 'O' rings items 02N and 03N to achieve a perfect closure. The valves are guided centrally by bronze valve guides item 13.
The pump has been provided with two leather cups item 10 for total pumping heads up to 80 meters. The cylinder item 09 is made of seamless stainless steel pipe and is clamped between 'O' rings item 01N mounted in the suction valve seat and in the air chamber flange. These elements are clamped together by means of eight threaded rods M10 item 08.
To facilitate starting of the mill a V shaped groove has been made in the upper piston disk item 07 which intentionally creates a leak between both sides of the piston. Some dimensions of the pump depend on the mill at which the pump is coupled. Differences are caused by different maximum strokes and by different air chamber volumes caused by different rotor speeds. An overview of these variable dimensions is given in the table on the assembly drawing.

4. MANUFACTURE OF THE NON STANDARD PARTS

4.1. General remarks

The pump contains a number of disks which probably will be torch cut out of sheet or strip.
It is important that sufficient oversize is given to guarantee the correct size after machining.

The surface treatment is not specified on the mono drawing but will be defined by the one who gives the order to the manufacturer. If parts will be galvanized tolerances are valid after galvanizing, so the expected thickness of the layer has to be taken into account by the manufacture or a surface with an accurate tolerance has to be machined after galvanizing.

4.2. Non-standard parts

4.2.1 Delivery air chamber E8504-01/B

This component consists of four welding mono's being: 01/01 Flange, 01/02 (2'') Pipe, 01/03 (6'') Pipe and 01/04 Disk.
Only the flange may give some problems to manufacture because a small tool is required to turn the groove 5x6,5.
To realize the required squareness between the flange and the 6'' pipe it is necessary to turn or file the 6'' pipe square on at least one side.
To realize the required concentricity between the 2'' and the 6'' pipe three pieces of wood can be clamped between the pipes during welding of the 6'' pipe to the disk. Because the disk must be welded on two sides to the inner pipe this must be done first before welding of the outer pipe to the disk. (The double weld is necessary to prevent crevice corrosion.)
All welds must be gas tight.
The weld between the flange and the outer pipe must be made only on the inner side to make space for the nuts on the threaded rods.

4.2.2 Pump rod E8504-02/B

This component consists of four welding mono's being:
02/01 Pump rod pipe, 02/02 Coupling, 02/03 Pump rod guide and 02/04 Threaded rod.
Manufacture of these parts probably will give no problems.
The weld between the coupling and the pipe is very important because this is the part most sensitive to fatigue loads.
It is advised to rotate the pipe during welding to prevent the need for starting welding several times. Slag inclusions must be prevented and the surface of the weld must by ground smooth.
The welds between the pump rod guides and the pipe can be light but they must be laid round on all sides to prevent crevice corrosion. It is meant to use black pipe and if the pump rod is to be galvanized this must be done after welding the couplings and the guidings. The threaded rod must be glued in the coupling after galvanizing.
If galvanizing is not possible one can use galvanized pipe but now the zinc coat has to be removed at the welds and all non-galvanized parts have to be painted with zinc compound.

4.2.3 Suction valve seat E8504-03/B

The diameter of the seven holes ϕ 30 is equal to the diameter of the piston holes but to create enough space for the two 'O' ring grooves seven in stead of eight holes have to be made in the suction valve seat. It is very important that the two inner 'O'ring grooves have the same depth (also after galvanising) to guarantee that the valve touches both 'O' rings. The thread G 1/8'' must be made after closing the hole ϕ 4 with a welded plug.
Accurancy in manufacturing is important because of the small walls between the holes and the 'O' ring grooves.
If the seat is painted the contact area with the valve shall be free from paint.

If the seat is galvanised this place and the groove shall be free from zinc lumps.

4.2.4 Supporting disk lower cup E8504-04/B

This component consists of two welding mono's being 04/01 Disk and 04/02 Pin.
The main problem is to get the eight holes on the correct pitch circle and at the correct pitch if no turntable is available. One needs a sharp pair of scribing compasses and scriber to mark the correct position of the holes.
Accurate centering and predrilling with one or two smaller drills is required.
In some occasions it might be easy to drill the eight holes together with hole for the pin in all four piston disks simultaneously. The four disks have to be clamped together with a bolt M20 x 80 to prevent rotating of the disks.
For the supporting disk upper cup and the lower piston disk no manufacturing problems are expected which differ from the supporting disk lower cup.

4.2.5 Upper piston disk E8504-07/A

This disk differs from the lower piston disk because the upperside has to be machined to get a good closure of the valve.
If the pump is painted the upperside shall be free from paint.
If it is galvanized it shall be free from zinc lumps.
A V groove also has to be made forming the starting hole. If a milling machine is not available the V groove can be made with a square file.

4.2.6 Pump cylinder E8504-09

Both ends of the cylinder shall be flat and square within the required tolerances. This can be realized by filing or by machining on a big lathe. If a lathe is used precaution shall be taken to prevent plastic deformation of the pipe at the headstock and the stay.
If seamless stainless steel is used the inner side of the pipe needs no machining and will be polished by the leather cup.
But the first leather cup will wear faster than later ones.
To prevent this, it is advised to hone the cylinder, if a hone is available. Hones for hand drilling machines as used for honing car motor cylinders can be used.

4.2.7 Leather cup E8504-10

The procedure of manufacturing leather cups is partly taken over from a Dutch firm who makes leather cups professionally.
The main difference is that the diameter of the die in which the cup is pressed is taken 1.5% smaller than the cylinder inner diameter. This is done to limit cup friction for new cups.
For the manufacture of the leather cup one needs:

a. A sheet of vegetable tanned cow leather of good quality and with the correct thickness. Chrome tanned leather cannot be used because it is too flexible after impregnation. Chrome tanned leather has a light green colour at the cross section and vegetable tanned leather is brown.

The leather may not have been impregnated before as is the case with sole leather.

b. A steel die (see figure 1) with an inner diameter which is 1.5% smaller than the cylinder inner diameter and with a height of the cup height plus ten (10) mm. The upper inner edge shall be rounded off. The inner surface shall be very smooth.
c. A steel punch (see figure 1) with an outer diameter of the inner diameter of the die minus two times the leather thickness and provided with a stud to place it in the headstock of a lathe. The upperside has a somewhat smaller diameter to allow cutting off the border.
d. A steel pressure plate (see figure 1) to press the cup on the punch during cutting off the raised border.
e. A drill ϕ 30.
f. A tin with enough stearine (as used for white stearine candles) to immerse the leather cup completely.
g. A press preferable with a hole ϕ 25 in the upper plate.
h. A small fire to melt the stearine.
i. A thermometer with a range up to 100° C.
j. A lathe to facilitate cutting off the border.

The manufacture can be devided in the following steps.

1. Out of the leather sheet one cuts a circular piece with a diameter equal to the diameter of the cylinder plus two times the cup height. This means D = 215 mm for the CWD 161 D pump. Because of the elongation of the leather during pressing the diameter may be somewhat smaller but then an accurate centration on the die is required.
2. The disk is soaked for about half an hour in lukewarm water of about 30° till it is saturated. (No air bubbles escape.)
3. The disk is placed concentric on the die and pressed inside it by means of the punch and a press. The hairy side of the leather must become the inner side of the cup because this side is less flexible and it will burst at the edge if it would have been taken as outside.
4. Die and punch are removed and the leather is dried on a warm and dry place during a full day. The raised border will yield somewhat to its original flat position but that does not matter.
5. The next day the stearine is heated up to 90°C and then the dry leather is immersed during 45 seconds, not longer, otherwise the leather will be burned.
6. Immediately after the leather is pressed again in the die (see point 3).
7. Now the assembly of die, leather and punch is laid in cold water to cool the stearine.
8. Then the assembly of die, leather and punch is placed in the headstock of a lathe and the central hole is made with a drill ϕ 30. Turn slowly to prevent heating the leather and to prevent coming loose of the die.
9. The die is removed and the leather is clamped on the punch by means of the pressure plate and a bolt M12 x 40.
10. The raised border is turned off at the cup height plus 1 mm.
11. An angle of 30° is made on the upper side of the cup with a cutting tool at the correct height.
12. The cup is removed from the punch and a hole ϕ 6 is made with a hollow punch at the correct radius.

13. Now the spacer washer E8504-14 is placed in the central hole of the cup and the cup is placed between items 04 and 06 which are clamped together with a bolt M20 x 70 (03N) and a nut M20 (05N). The pin 04/02 must fit in the hole ϕ 6 in the leather cup.
14. Now the eight holes are copied from the steel piston disks by drilling.
    The piston disks must be provided with the eight holes before drilling the holes in the leather cup.
    If one would try to drill the holes in steel and leather together the stearine will melt by the heat produced in the steel during drilling.

Now the cup is ready and has to be stored under a moistened piece of cloth to prevent drying out too much before mounting in a pump.

4.2.8 Valve E8504-11

No special problems are expected with the manufacture of the valves. Only one side of the valve has to be machined if one can realize the tolerance for the thickness.
If the valve is painted the machined side and the inner hole shall be free from paint.
If the valve is galvanized no zinc lumps may occur on the machined side and on the inner hole.
The non-machined side must be provided with the letters 'UP'.
If the disk is flat enough it is possible to machine both sides and still realize the required thickness and tolerance.
In this case marking with up is not necessary and the valve cannot be mounted wrong.
The valve stop, valve guide and spacer washer are expected to give no manufacturing problems.

5. ASSEMBLY OF THE PUMP

5.1. The piston assembly

It is assumed that the threaded rod item 02/04 has already been glued in the pump rod item 02.
Now the spring washer item 06N and the nut item 05N are placed and tightened strongly by clamping the coupling in a wrench.
Now all the pump parts are put on the threaded rod in the correct sequence (see assembly drawing E8504-00/B.
The valve item 11 must be placed with the side marked 'up' in the direction of the valve stop item 12. The rounded off side of the piston disks items 06 and 07 must be placed against the leather cups item 10. The supporting disk upper cup item 05 shall be placed with the largest size above.
The spacer washers item 14 shall not be forgotten. Now the first nut M20 item 05N is placed and tightened strongly.
Then the spring washer item 06N and the second nut is placed and tightened strongly too but the first nut must be prevented to rotate. It must be checked that the valve can be opened fully on one side without sizing on the valve guide.

5.2. The suction valve assembly

It is very important to check that no paint or zinc lumps fill up the '0' ring grooves in item 03 because this would result in leackage of the valve.
First the '0' rings item 02N and item 03N are pressed in the grooves and than the valve item 11 is mounted identically to the piston valve.

5.3. The overall assembly

First the plug 07N is screwed in the air chamber (use teflon tape).
Then two nuts are screwed on the eight threaded rods and tightened strongly in such a way that both nuts have the sides about parallel.
Next the eight threaded rods are put in the air chamber holes.
Further the piston + pump rod is put in the upper side of the cylinder. Next the two '0' rings 01N are pressed in the grooves of the air chamber and the suction valve seat.
Further piston, pump rod and cylinder are placed against the air chamber.
Further the suction valve seat assembly is placed and eight nuts are turned on the lower ends of the threaded rods. The nuts must be turned on not too strongly to prevent damage of the '0' rings.
Further the second nut is placed and tightened strongly but the first nut must be prevented to rotate.
Next the pump is ready.
To prevent rattling of the pump rod in the air chamber during transport, it is advised to press three wooden wedges between the pump rod and the inner side of the open end of the air chamber with the piston touching the footvalve bolt.

E8610-01

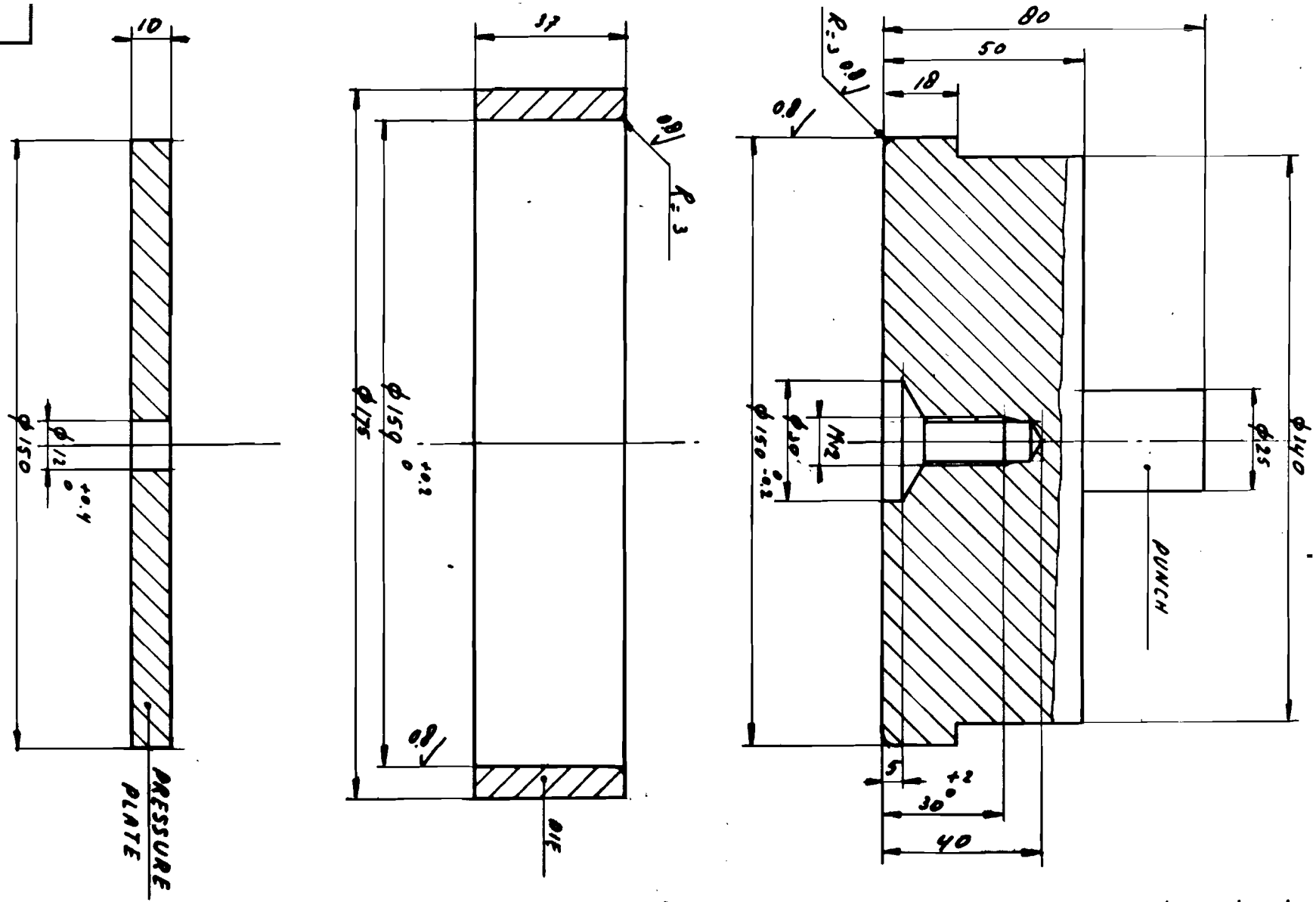


FIG 1

Modification description						Date	Initials
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Treatment:							Date: 15-12-86
Format: A3	Scale: 1:1	Drawing No. 20	Angular projection	All dimensions in mm	Mass:		Approved by:
							Date:
							Drawing No. E8610-02