

Aster Lion Water Feed Pump



How to make an axle driven water feed pump for the gauge 1 Aster Lion

Version 1.2

© 2002 by Markus Neeser – Usage allowed for non-commercial purposes only

Introduction

The **Aster Lion** is an extraordinary basic kit for Gauge 1 enthusiasts for refining and detailing. Work will pay out you'll get a really nice little engine out of the kit with some additional work on it.

One little inconvenience is the lack of running time between two water refills. Even if not steamed full power, it will not run significantly longer than 6-7 minutes before the boiler has to be refilled. Aster does provide a syringe to do this, but even if you modify the water inlet (cut a M5x0.5 thread on it) to use a trackside pump, this not the real thing.

To overcome this disadvantage this axle pump kit has been designed. Fitting it to the Lion does not require watchmaker skills but a little lathe and mill. You should also have some silver soldering know-how (or at least you need to know someone who knows somebody which ...)

After the modification, running times up to 45 minutes can be achieved with one meths tank filling and amazingly a well run in engine may show a better behaviour on the track than many much larger engines do sometimes.

This document is supposed to be an addition to the set of drawings. The numbers used are always referring to the according drawing (e.g. 7.1 refers to part 1 to be found on drawing number 7).

It's intended to make kits and single parts available for those with limited machining possibilities or to fit complete pump units to assembled and run in Lion's upon request. For enquiries please refer to the address listed below.

Please note that the usage of this document and of the drawings are allowed for non-commercial purposes only. Commercial usage by written permission from the author only.

I hope you'll have a great time too when modifying your Aster Lion and I'm sure you'll be also amazed about how well it works.

Summer 2002

Markus Neeser
Badmatt 6
6260 Reiden
Switzerland

m.neeser@bluemail.ch

Parts manufacturing

Making the feed pump is separated into parts manufacturing (turning, milling and drilling), followed by silver soldering and installing the pump into the locomotive.

Drawing 1 gives you an overview and first impression how the pump unit will later fit into the Lion chassis. Some internal details of the pump unit can already be seen in detail.

Drawing 2 shows the whole assembly from three different sides. All tubing is coloured pink, pump and bypass and all other parts as eccentrics are coloured blue.

Drawing 3 is a bottom view of the installation. The new parts are drawn using the same colours as above mentioned.

Drawing 4 finally shows a line up of some of the parts giving an idea about the sequence of installation.

The making of the split eccentric is described on **drawing 5**. Although the making of a split eccentric is more difficult than the making of a one piece eccentric, I still recommend taking this little extra work although the wheels of the Lion can be removed easily. If you decide to do this, you shouldn't worry too much about quartering since this is done by the flats on the axle and not by the position of the wheel on the axle.

One advantage of a split eccentric is undoubtedly a much better access in case of servicing.

Making of the split eccentric:

1. Take a piece of mild steel with a diameter of about 20 mm (0.8") or more and split it in length using a hacksaw.
2. Mill both half's down to the same thickness until the hack saw scratches are no more visible.
3. Soft solder both half's together (don't use silver solder since we want to separate the two halves later again)
4. Chuck the soldered piece and turn it down until it get a true cylindrical shape again
5. Turn the front side. If you did a good milling job, the solder line goes now directly through the centre line of the piece.
6. Drill the 1.6 mm hole for the M2 clamping screw

7. Drill the countersunk using a mill. It will later take the head of the M2 clamping screw
8. Ream the 6H7 diameter bore. The centre must exactly go through the solder line
9. Make the groove for the eccentric strap in reference to the 4mm countersunk. Polish it with fine emery cloth
10. Cut of the eccentric
11. Put the eccentric on a conical thorn and turn it to the final shape
12. Heat the eccentric carefully until the two pieces fall apart
13. Clean the soft solder remains using a very fine emery cloth (I prefer 1200 grain)
14. Open the 1.6 mm boring on the sunk side to 2.1 mm diameter
15. Cut an M2 thread into the other half of the eccentric

The also split eccentric strap on **drawing 6** has a little bit unusual appearance since the little Lion does not provide too much space for fitting a nicer shaped strap but it does what it's intended to do:

To bolt the two parts together, two special bolts are to be made from steel. They are to be blackened to protect them from getting rusty.

Making of the eccentric strap:

1. Take a piece of flat brass or even better bronze of 4 by 10 mm dimension and mill away about 0.1 mm on one of the narrow edges. Make both half's the same width.
2. Mill both half's to the specified length
3. Drill and cut the M2 threads
4. Screw together both half's touching on the milled side
5. Start to make the 14H7 bore by drilling a 10 mm hole on a vertical drill or on the mill.
6. Make the flat for the connecting rod and cut the M2 threads to attach this to the strap
7. Mill the external contours of the strap
8. Glue (use fast glue) or soft solder the strap on a piece of round piece of brass with a 10 mm journal
9. Open the 10 mm boring to the final 14H7 diameter
10. Warm the glue or soft solder until you can remove the strap and clean off the soft solder with fine emery cloth.

Drawing 7 shows driving parts as the connecting rod and fork end. The connecting rod may be milled or filed to its final shape.

The fork end is made out of a piece of square section brass. To chuck it, make a sleeve with the appropriate inner diameter and slit it with a hacksaw. Now put the brass rod into the sleeve and chuck it in your lathe. Now you can cut the M2 thread.

The slit in the fork end can be made on the mill using a saw blade or directly with a small file.

The valve body is shown in **drawing 8**. This is a pretty easy lathe job but some words are to be lost about the ball seats and the silver soldering of the 3/32" copper tube to the body.

Important remark: The diameter of boring A depends on the diameter of the used valve balls. The prototype pump was equipped with balls of 3.5 mm diameter. Please drill the boring A according to the ball-diameter you use as listed in the table on drawing 8. The adjustment of the height clearance is described on drawing 9.

Valve ball diameter	Diameter of boring A
3mm	2.4 mm
3.5 mm	2.8 mm
4 mm	3.2 mm
1/8"	2.5 mm
5/32"	3.2 mm

Cut off a piece of round brass which is about 10 mm longer than the final valve body will be. Make first the $\varnothing 2.8$ mm boring through the whole valve body length

Now mark the position of the $\varnothing 4$ mm boring and drill it into the valve body into the $\varnothing 2.8$ mm boring. Don't drill through.

Then turn both valve body ends to the final length. Take the 4 mm boring as the reference when measuring.

Drill the $\varnothing 4.5$ mm bores for the threads into both ends of the valve body and cut the threads.

Now it's time to drill the $\varnothing 2.3$ mm boring for the copper tube installation. Don't drill this hole earlier or the core boring for the thread will not go through the centre line of the valve body.

A few words about the steel ball valves:

If possible turn the valve seats instead of boring them only. Press the steel balls onto their seats by using a small hammer and a piece of brass. Give it just one hit, that's enough.

If you want to use phosphor bronze or plastic balls, hit the seat with a steel ball of the same diameter. Don't use a soft ball to do this.

Important remark: This shall be done after the silver soldering off the valve body is completed. Otherwise the valve seats might be deformed by the heat and will not seal reliably!

If you want or have to use different diameter of the balls then follow this rules:

Height clearance of the valve ball = $0.2 \times$ diameter of valve ball

Diameter of valve boring = 0.8 x diameter of valve ball

Drawing 9 contains all other parts related to the valve body. They are easy lathe jobs.

Important remark: The dimensions of the lower (9.4) and upper (9.1) valve screw as well as the diameter of boring A depend on the used valve ball diameter. Add (+...) or subtract (-...) the value B as listed in the table whereas the dimension is written "dimension+B" :

Valve ball diameter	Diameter of boring A	Dimension B
3mm	2.4 mm	+0.6 mm
3.5 mm	2.8 mm	-
4 mm	3.2 mm	-0.5 mm
1/8"	2.5 mm	+0.6 mm
5/32"	3.2 mm	-0.5 mm

Not visible on first sight is the groove at the position of the cross boring. Turn the groove about 4 mm in diameter using an appropriate cutting steel or use a small file.

Making the boring for the 3/32" copper tube in banjo ring 9.3 only ø2.3 mm wide, allows the copper tube to be pressed slightly into the ring. This will make silver soldering easier and even more important, it doesn't allow the silver solder to flow into the tube.

The paper gaskets can be made using self made paper drills (a sharp edged piece of silver steel tube, hardened in oil). The gaskets are cut out of a piece of 0.5 mm thick gasket paper.

Pump body, ram and counter nut are shown on **drawing 10**. If you ream the 3 mm boring precisely, no additional lapping in is required to my experience but feel free to do so and you certainly get an even better working pump. The prototype works very reliable without lapping.

The pump body is a simple turning job including the 4 mm journal at the valve body end.

After you have finished the lathe job, take a file and remove 1 mm of the journal on both sides and the top of the journal. The remaining tiny part will serve to limit the valve ball's height clearance (see also drawing No 1 for better understanding).

Drawing 11 shows the bracket used to install the pump under the Aster Lion. It's a simple milling and drilling job. Make the slot with a hack saw, that's fine, or do it on the mill using a saw blade.

If available use a reamer for the 8 mm boring that takes up later the pump cylinder.

Drawing 12 contains the parts for the water tube connection to the lower pump end. Part 12.1 is later to be silver soldered to the banjo ring 9.2 after you've made the first pump tests.

When making the counter nut, you have to decide for a simpler hexagonal type A or the much nicer looking type B, which requires some silver soldering. Make two of the desired type.

Nipple 12.2 will take the tubes from the tender to the engine. Also make two of it.

Check right now if the counter nuts fit over the nipple, if not, then turn down the nipple diameter slightly.

To fix the tube used for the bypassed water to flow back to the tender, the parts shown on **drawing 13** are required. They are again very simple lathe jobs.

The nipple 13.1 will be silver soldered later after test fitting the whole unit to the Lion and finding the correct position on the tube.

Drawing 14 contains all fittings for the tender. They have to be silver soldered later as shown on the drawing. Right now, we just make the parts.

To bend the copper tubes, I recommend making a small tool. Take a piece of round brass and turn a groove in it with the same width as the copper tube diameter is. Make sure the groove's ground is rounded (use a small file) so the tube fits into it perfectly. The groove depth is according to the desired bending diameter.

While bending, make sure the copper tube fits nicely into the groove; otherwise the bend will not be as nice as desired. Work carefully and you'll get perfect bent tubes.

Drawing 15 shows the basic shapes of the tubes. They're shown in their final lengths so please add an additional half an inch at each end since it's still easier to cut away an excess than doing the opposite.

Final lengths have to be found out later after test installing the pump and the bypass to the Lion. Not very comfortable to do but still the most precise way.

Drawing 16 shows the water distributor bar. All tubes are later silver soldered to this bar.

A try from my side to use nipple and nut system turned out to be pretty frustrating in regards of tightening when the unit was installed: There's simply not enough space for access with a spanner. So I soldered everything in position.

Now we come to the moment where you have to drill holes into your Lion. I've placed them in such a way (see **drawing 17**) they don't disturb much even if you should remove the pump unit later.

To allow the installation of the bypass valve, the right hand side of the driver's stand has to be modified slightly. You may paint up the cut edge to make them invisible, but this is not really required.

If you place a piece of plywood painted brown on the driver's stand as I did, all additional nuts and bolts will be completely invisible later.

After messing up your Lion by drilling holes in it, the next step is pretty easy (see **drawing 18**). The tender requires two borings for water outlet to the pump and the water inlet from the bypass.

Deburr the borings carefully after drilling.

The new meths burner shown on **drawing 19** turned out to be more powerful especially when running at very slow speed. Meths consumption is not significantly higher so meths last more or less for about the same time.

The biggest advantage of the new burner is that it seems to be much less often blown out than Aster's original burner. The wicks shall only be about 3 mm longer than the cups. Just give it a try when you have test run the converted Lion for the first few times.

Drawing 20 shows another improvement compared to the original set-up. The new burner bracket allows the removal of the trailing axle without deinstalling the whole boiler unit. Again it's not required but after removing the pump a first time you'll know what I'm speaking about.

Finally **drawing 21** shows the complete bypass unit. This is a pretty little bypass valve since there's only little space left underneath the Lion's footplate. Work will pay out since you'll get a nice little unit fitting perfectly into the Lion's and which is very easy to adjust while running on the track.

Before drilling the two $\varnothing 2.3$ mm borings into the bypass body 21.1, screw in the bypass needle 21.4 and tighten it. Make sure the little handle looks to the outer side. Now mark the position of the borings on the front end side and drill them after removing the bypass needle 21.4

This procedure makes sure the borings will show in direction of the front end of the Lion whilst the handle 21.5 is positioned exactly to the right hand side.

The flat areas on the bypass needle can be made with the mill or even simpler and faster with a file. Polish the flats after filing/milling with fine emery paper until the flats are getting shiny.

To make the handle, use piece of round brass into which you drill a M2 thread. Now screw the handle into the brass piece (after cutting the M2 thread onto the handle) and chuck it into your lathe. Form the shape of the handle with a file and polish it with fine emery paper.

Silver soldering

Use a silver solder with a high silver content (at least 30%) and a low melting point (maximum 650°C). The flux should be available as a separate paste, don't use flux mantled silver solder.

I personally prefer the 1 mm diameter Castolin 1802 silver solder, which melts at about 610°C and the 1802 flux also from Castolin. You may use the silver solder you usually take for fine work and which you are used to work with.

For fixing the small parts, you may either use a copper wire or even better use some fire resistant fixing putty. The parts may be stuck into this putty for fixing, but make sure the putty doesn't touch the solder area. Otherwise the silver solder won't flow correctly.

After soldering, any flux remains are to be removed. This can be done in different ways:

- A) Take a pint of vinegar and add 2 spoons of salt to it. Stir well. Put the soldered piece in the vinegar for half an hour and then clean off any flux with an old toothbrush. Put the piece back into the fluid for another half an hour.
- B) 10% sulphur acid (attention: sulphur acid is poisonous and splashes will burn holes in your clothes). The acid can be obtained at car repair shops as battery acid.

Rinse the parts well in flowing water after pickling to remove any vinegar / acid from the parts.

Water connection to valve body: We now start with an easy job and solder part 12.1 into the banjo ring 9.3. Check for free water flow after pickling and cleaning.

Water distributor: Start with soldering the nipple 16.1 onto tube 16.2. Cut the tube 16.2 length so, that the overall length distributor to nipple is according to the drawing. Then solder the unit into the distributor 16.3, but don't forget to install the counter nut.

Pump cylinder / Valve body: First solder pump cylinder 10.1 into the valve body 8.1. Make sure, the pump cylinder's spigot is correctly aligned before soldering. Put enough flux paste to the joint and solder.

Next step is to solder the 3/32" copper tube to the valve body. Protect the earlier soldered joints with fixing putty or aluminium foil from the heat.

If you are enough experienced, solder both joints in one step.

Make sure the tube is not reaching into the thread of the valve body. The M5x0.5 threads in the valve body should already be cut. If not so do this now please. Press the slightly coned tube (use a file) into the valve body and make sure the tube doesn't protrude into the valve body too much. After soldering and pickling cut the thread again to remove any copper tube or silver solder remains.

Don't forget to hammer the valve balls into their seats after pickling.

Tender fittings: Don't care too much about the direction of the tube 14.1 when soldering into nipple 14.2: It may be aligned perfectly after soldering since the tube will get pretty soft.

Solder parts 14.3 and 14.4 together and check after pickling if the water still flows freely through the tubes. Then solder parts 14.5 and 14.7. Check again for a free flow.

Assembly and first pump test

First fit the tender fittings and seal with silicon putty as used for bathrooms.

Now install the pump arrangement consisting of the parts 9.1 to 9.4, 10.2, 10.4 and fork head 7.2 a first time. Don't forget to hammer in the valve balls once and to install the paper gaskets and the package to the pump ram.

The package between pump ram and pump cylinder is made using twisted Teflon tape as used for plumbing. Wrap the twisted tape around the pump ram so it doesn't get untwisted when attaching the counter nut. Tighten only little, so the ram can move free. It can be later tightened until it doesn't leak anymore.

That's the moment to make a first test with the pump. Hold the lower end into a cup of water and move the ram. If you have done the job correct, water will flow out of the tube after a few ram moves. Ask someone to keep his finger on the tube and that person will remark a considerable pressure being built up with any ram move.

If the pump doesn't work correctly most probably the valves either don't seal or open correctly.

Disassemble everything after the test so it can be further silver soldered.

Tubing

Now we start with soldering the tubes into place.

Install the water distributor, the bypass and the pump into the Lion. The borings of the bypass body should show towards the front end of the Lion.

Now the final lengths of the tubes 15.1, 15.2 and 15.3 are measured. Remind to leave a little excess – about 1.5 mm – to press the tubes later into the borings.

Also mark the position of nipple 13.1 on tube 15.1. Best make a little scratch to mark it.

After cutting the tubes, deburr them inside as well as outside. Shape the outside a little bit conical so the tubes can be press fitted into the Ø2.3 mm borings for easier silver soldering.

After checking the tube lengths, remove the bypass, water distributor and the pump again for the next soldering jobs.

Bypass:

Stick tubes 15.1 and 15.2 into bypass body 21.1. Check a last time for correct position / alignment before silver soldering.

After removing any flux remains, check if water flows free through all tubes.

Solder nipple 13.1 on tube 15.1 at the correct position.

Solder the other end of tube 15.2 into the water distributor. Protect earlier soldered joints with fixing putty or aluminium foil from the gas flame.

Solder the remaining end of tube 15.3 also into the water distributor. Again protect the earlier made joints from the flames.

Finally close the water distributor 16.3 with the plug 16.4 after a last check under the water tap. Check if all tubes are still free.

Final assembly

Polish al I brass parts with silver polish until all surfaces are again shiny or just simply paint it black.

Deinstall – if not yet done – the right hand side drive stand side frame.

If you have decided to install the new burner mount, then it's now time to remove the flap attached to the firebox using a Dremel tool or anything similar. Protect the mechanics of the locomotive by wrapping it into a clean cloth. After removing, deburr and remove any emery dust thoroughly and carefully.

Start with the installation of the eccentric onto the middle axle according to the drawing. Put some graphite grease into the grove of the eccentric.

Fit the eccentric ring onto the eccentric. Check if the ring touches anywhere while turning the axle.

Install the preassembled pump unit underneath the Lion chassis plate using following attaching points: Counter nut on bypass body, two M2 bolts at the pump mount and the counter nut of the clack valve.

Install the new burner mount.

Screw in the bypass needle and attach the little handle to it so it shows to the right hand side when the valve is closed.

Fix the water return tube to the tender to the flap at the rear end of the Lion footplate using the counter nut (the same position as where the original copper tube has been fitted to).

Connect the fork head of the pump ram with the connecting rod using the M2 bolt. If ram and connecting rod are not in line, then shift the eccentric sideward but make sure it doesn't touch anywhere when rotating.

Now oil any moving parts. Use a machine oil of medium viscosity so it does flow into the gaps but doesn't drop off too easily.

Reinstall the rear axle and the meths burner and connect tender and locomotive with rubber tubes.

First steamup

Now it's time for a first steamup on the roller bed. If you don't have one it would be worth reflecting about making one. Grease and oil the engine and fill up water and meths. Once steam pressure is there, open the regulator and get rid of the condensed water inside the cylinder. Open the bypass for the first half minute of running time, then close it more and more while checking if the water is pumped back to the tender.

If the water doesn't flow, then fill the whole pump unit using the Aster supplied syringe. It should now start to pump. You may close the bypass and pump water into the boiler.

If this doesn't help too, you have to disassemble the pump unit and to check the proper sealing of the balls inside the valve body as well as the clack valve fitted to the boiler.

Operating

Operating the feed water pump isn't different from other locomotives. Close the bypass until water is squirted out of the stack. This indicates clearly the boiler is full since there's no water gauge.

You may also partially open the bypass. As a rule, about one drop of water per second should flow back into the tender, not more. You soon will get more experienced and will find out that finding the correct setting isn't hard to learn at all.

I now wish happy steaming and always enough water in the boiler

(end of description)