Ephraim – Bi-directional Rotary Valve

The following describes a modification to the original Ephraim design to permit both forward and reverse running of the locomotive. In principle it is similar to the 'slip eccentric' device found on some steam engines. Ephraim has no eccentric but does have a rotary valve which can be operated in a similar fashion. At first sight it may seem that the slot in the rotary valve that engages with the drive pin on the valve shaft needs to be elongated a bit and the result would be achieved. However, simple as this may sound, the practice is tricky. Steam is introduced into the cylinders every 120 degrees of engine rotation hence the rotary valve must turn through 120 degrees between forward and reverse running to change the order of cylinder working. There is very little space in the rotary valve so I have redesigned it so that the drive pin works through the exhaust cavity rather than having its own slot. But a result of this is that there is insufficient metal surrounding the valve rod to hold the valve in its central position. To overcome this problem I have designed the valve to be in three layers rather than two. Starting from the bottom the first layer is from 1/8 inch brass, and has the main cut-outs for both inlet and exhaust. The central layer is from 1/16 inch brass and has a 4mm hole to keep the valve located on the rod. The top layer is made from 24 swg brass and is merely a plate to make the whole thing steam tight. The overall height of the valve must be less than ¼ inch otherwise it will not fit in the valve chest.

Make the new valve rod first. This is necessary as the new valve requires that it projects above the drive pin to engage with the hole in the middle layer of the valve. Also the valve rod needs to be in place before the geometry of the valve can be finalised. The new rod will be 63mm long and the drive pin centre is 3mm from the top. The pin projects 3mm. However, some slight adjustments may be necessary during the fitting procedure. Make sure the ends of the rod are burr-free and the top slightly rounded.

The drawings give the details of the valve itself. Step one is to make the bottom layer. The method is the same as that given in the book for the original rotary valve. Once this layer has been completed it can be offered up into the valve chest and the valve events examined. Make sure you hold the valve correctly located on the rod. In forward running port 1 should just start to be uncovered as piston 1 comes just past top dead centre. Once the valve timing has been adjusted to achieve this you need to observe what happens in reverse running with the valve timing remaining unchanged. Port 3 should just start to be uncovered as piston 3 goes over top dead centre but, of course, in the reverse direction. On my first attempt this did not happen and piston 3 had not travelled far enough. The solution was to remove the valve and carefully file away the face of the exhaust port upon which the drive pin impinged in the reverse running direction. After several attempts I got the correct result. Make a note as to which way up the valve has been fitted.

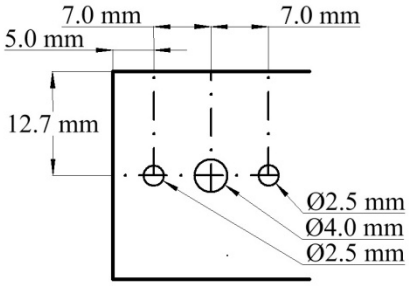
The next step is to silver solder the 1/16 inch middle layer to the top of the valve. Now comes a tricky part. The 4mm hole in the valve needs to be extended through the middle layer, but you can't just put it in the vertical drill because almost half of the hole in the bottom layer, which would normally act as a guide, has been cut away to make the exhaust cavity. Were you to do this it would snatch and the part would be ruined. I took a short off-cut of 4mm rod, turned a point on one end and use it as a centre punch to transfer the centre to the part to be drilled. I did this by squeezing it long-wise in a vice and then picking up this centre mark with a 1.5mm drill making a pilot for the 4mm drill. I then used a hand reamer through the two parts to clean up the hole. This hole needs to be slightly oversize as the valve itself must float on the valve rod.

The final step is to silver solder a piece of 24 swg brass on top of the whole thing, file the top two layers to match the profile of the bottom layer and generally clean up the whole thing taking off all sharp corners and making sure the bottom has a nice clean, burr-free flat surface.

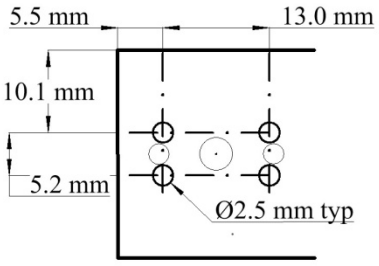
Once tested on compressed air I installed the engine in the locomotive and gave it a test run. Before opening the regulator it is necessary to flick the engine round in the direction you wish to go. To change direction you chase the model round the track, close the regulator, flick the crank shaft in the other direction, open the regulator again and stand back. Straight-forward really.

D120 - Bi-Directional Rotary Valve
seen from under-side

Made from three layers see text



Step 1



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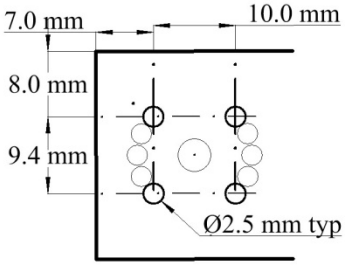

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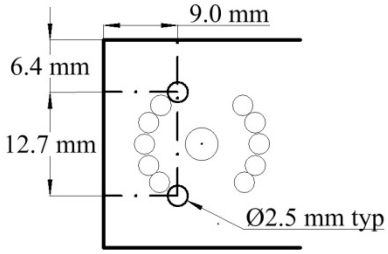

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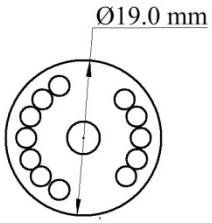
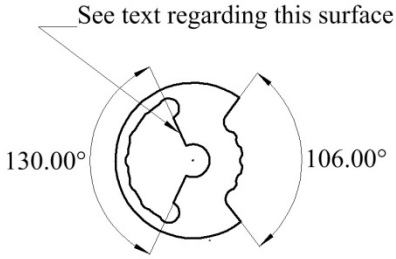
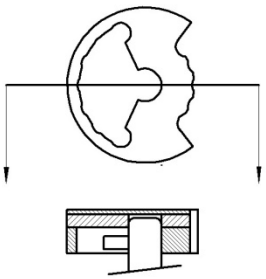


Step 5



Completed valve



Cross Section