# Notes on construction of Great Western leads (turnouts)

(Further details available from www.scalefour.org/downloads/downloads.html)

## Introduction

It is not widely appreciated that semi-curved switches came into use on the Great Western only in the early 1930's and were used **only** for new construction. The older loose-heeled switches remained in use into BR times. In fact a very large part of the GWR was only using loose-heeled switches throughout the life of the company. Indeed the whole of Brent on the South Devon line were loose-heeled except the turnout from the up refuge siding which was altered in 1937 when a B8 was installed. Mike Longridge's photographs taken of Brent in May 1947 prove the point admirably.

Two further matters. The Great Western only used loose-heeled switches on compounds, that is single and double slips. The Great Western regularly ran the turnout curve through the crossing and out on the turnout road, thus not all crossings were straight on straight.

Sadly Great Western layouts in general are not correctly modelled and one can only hope that David J. Smith's book GWR Switch and Crossing Practice published by the Great Western Study Group, together with these instructions and the associated etches will help put that right.

Loose-heeled switches are a little more difficult to assemble than the typical semi-curved B or C switches provided by the two kit manufacturers and built by most modellers. Unfortunately for the Great Western modellers these semi-curved B & C switches are also wrong as **all** Great Western switches had a ⅜" joggle, usually 6" long, at the toe with a set at the end of the planing to restore the run of the rail. It is this joggle and set that complicates matters somewhat. The joggle offsets the length of stock rail between the joggle and the set by between ⅜" and zero so that this section cannot be used to gauge the opposite rail, which also has a joggle and set.

As a consequence the curved stock rail cannot be gauged in the usual manner. It can be placed only by measuring from the running face of the straight stock rail at each timber centre line between the joggle and the set. The instruction sheet has drawings of the 10', 12', 14' and 16' loose-heeled and B & C semi-curved switches with the running face (RF) to running face (RF) dimensions between the joggle and set of the stock rails, at the centres of the timbers. The dimensions are a minimum and must be maintained otherwise the track will be under gauge when the switches are added.

Another important point is the RF to RF clearance at the quoted loose-heeled switch length measured from the toe. This must be 1.5mm (4½"). This means the railhead to railhead dimension at this point must be 0.583 (1¾"), the crossing flangeway clearance. However in P4 this is 0.65mm and so that the edge of the P4 crossing flangeway gauge could be used to check it, I prefer a 0.6mm nickel silver wire. If this dimension is not maintained then there will not be the required clearance between the switch and the stock rail when the switch is opened 4¼" (1.42mm). This dimension sets the clearance at the heel so that the dimension given in the drawings as the heel clearance is effectively the minimum.

In EM the clearance needs to be larger and that makes laying out loose-heeled switches more difficult. My feeling is that many Great Western EM modellers may wish to leave things as they are and accept that the present semi-curved B & C switches without the joggle that are provided by the two manufacturers are the best that they can achieve. Others may have other ideas.

A ⅜" joggle (0.125mm) leaves a very narrow head of the switchblade and is impracticable.

These instructions are based on the use of a 0.2mm joggle and any larger joggle changes the setting out substantially. The principles are the same but the RF to RF dimensions at the switch must be increased by twice the difference. The width of the switchblade at the toe will be 0.2mm, a better proposition.

A joggle jig is provided on the etches to make producing this joggle easy.

 

The term **RF** means running face throughout.

### Loose-heeled and semi-curved B & C switch differences

Loose-heeled switches used circular tie bars and stretchers. The tie bars were taken through the web of the rail and the switchblade and this stopped the loose-heeled switch from lifting.

When making stock rails and switchblades for loose-heeled switches the railhead and the switchblade are drilled out 0.45mm initially, later taken out to 0.5mm.

Semi-curved B & C switchblades used flat flexible tie bars and stretchers. The flat tie bar ran under the railhead and that prevented the switchblade from lifting. The railhead and the switchblade are **NOT** drilled for B & C switches.

## Laying up a turnout with a joggle

### Usual laying convention

The convention for laying up a turnout is, crossing and wing rails first, then the stock rails, switchblades and finally the closure rails (might be part of switchblades), with the check rails last.

### Convention to be used for joggled turnouts

The above convention should not be used. The straight stock rail should be laid first, then the crossing and its point rail extensions, followed by the straight closure rail with wing rail attached. The curved closure rail with wing rail attached is next followed by the curved stock rail. The switchblades are made and fitted last.

### Placing timbers on the template

The usual method of laying up timbers on the template will be followed; the template having been stuck down to a smooth surface like melamine faced chipboard. Details of assembling the operating systems in one of two ways are elsewhere.

Suffice to say at this stage that additional pairs of chairs/timbers 15mm apart for each rail should be set 50mm outside the turnout proper, at each end. The purpose of these is to carry the rails well outside the turnout proper to give strength and protection to the turnout when it has been removed from the building template and handled prior to laying. In particular these extensions make sure that the curved road carries the radii through the turnout proper and does not end up with a flat to the curve at the ends. These extensions are cut away just before laying.

### Making the stock rails and rough switchblades

*Note the comments above that B & C switchblades had flat flexible tie bars that ran under the rail. There were **NO** holes in the switchblades or railhead with B & C switches.*

*In the notes in this section **ignore** the drilling of the railhead and the switchblade if you are using B & C switches.*

Cut two stock rails well over length to cover the two groups of extra chairs/timbers outside the turnout proper. The longer of the two should be chosen for the curved stock rail. You cannot put a smooth curve in a rail if it is short becuase the ends will remain flat.

Mark the head of each rail several times along the length to identify the head and prevent it being fixed upside down, using two different colours, say red and blue.

Form a 0.2mm joggle in the stock rails. The joggle jig should allow you to make two joggles before it is destroyed. Remember that the joggle in one rail is opposite to the joggle in the other.

 

Measure the distance from the far left extra chairs/timbers, add a little and mark the rail face (RF) at this distance. This mark will be where the joggle is to be put.

First make sure that the joggle about to be put in the straight stock rail is away from the running face (RF) and that put in the curved stock rail is the opposite hand and still away from the RF.

Place the rail inside the rectangular notch and place in a vice across the corner of the jaws with **aluminium jaw protectors**. Closing up the jaws will put a joggle of something over 0.2mm with steel rail and 0.21mm with nickel silver. (After the first run I add layer of masking tape to the jig to try to get the next joggle close to 0.2mm). Do not do this with the rail parallel to the jaws, as the jaws may put a kink in it at the jaw's extremities. By holding rail and jig across the corner of the jaws the plain rail is in free air and will not be kinked.

When the first joggle has been formed then make the other joggle for the curved stock rail the opposite hand.

For both rails, measure 4.5mm from the joggle (crossing side of joggle) and on the centre line of the rail drill a 0.45mm hole. This hole will take the end of the tie rod in the operating system and will line up with a hole in the switch. The tie rod prevents the switchblade from lifting.

Take a length of rail from which the switch will be made (at least 80mm over length so that any curve can be easily put in before cutting to final length) and using the stock rails as a template drill a 0.45mm hole through these switches as well. Mark the railhead of each with the same colour used to mark the railhead of the matching stock rail.

Curve the curved stock rail by whatever means you normally use. I usually curve it between my finger and thumb or across my thigh. It must be well over length if the curve is to run through the crossing, as was common practice on the Great Western. The toe end should be straight outside the joggle. Get a smooth curve throughout the section you are going to use and curve the rail so that it follows the template nicely. Don't rely on fixing to hold the curve to the correct radii. Experience shows that such a curve will spring slightly towards the straight when the turnout is removed from the template. Also be careful not to put a twist in the curved rail. If you do then the whole curve will not lie down flat and will spring up when you remove the turnout from the building template.

Put a slight set in the curved rail where the planing ends making sure that the set is in the right direction and restores the continuity of the curve.

Repeat for the straight rail, the set restoring the straightness of the rail.

The holes in the stock rails are now opened up to 0.5mm using a broach, checking that a 0.5mm nickel silver wire can just be run through.

## Laying the straight stock rail

The straight stock rail is first laid in the normal way. Note the slight offset due to the joggle and set. If you formed the joggle and set correctly, then it will be away from what will be the running face (RF). Use a straight edge on the inside (RF) to lay this stock rail absolutely straight. Also make sure that the joggle section is also straight and check that on the outside with a short rule.

Run a length of 0.5mm brass wire through the hole in the railhead and set this parallel to and 3.00mm away from the centre line of the no.3 timber (toe timber) to its left.

Tape the brass wire down on both sides to prevent the stock rail from moving while it is being fixed.

Start by fixing the rail at the chair on the no.3 (toe) timber. With the straight edge placed against this chair and lined up with the template at both ends, and with the joggle section still straight, fix the chair at the end of the planing next.

Fix every 4$^{th}$ or 5$^{th}$ chair only, move outwards towards each end until the extra chairs/timbers well outside the turnout proper are reached. If you fix every chair at this stage then any error that has crept in will get magnified. Check that the stock rail and joggle section remain straight. If not then

you will have to adjust some chairs by re-soldering or moving the timbers slightly. If it is straight then fix all the intermediate chairs to complete the laying of this stock rail. This rail gives a straight datum from which the rest of the turnout is gauged.

### Making the "vee"

The next task is to make up the "vee" to the crossing angle and cut it to the correct length. It is my normal practice to include the point rails on the "vee" and make the isolation at the next rail joint, rather than have a short point rails in addition to the "vee".

The Great Western regularly ran the turnout curve through the crossing so that one side of this vee may be curved. If it is, then what I usually do is to make the curved closure rail over length to the correct radius which I check on the building template and then cut a length off that to make up this leg of the "vee". That ensures continuity of the turnout curve through the crossing.

I use a high temperature solder for the "vee" so that it does not later unsolder because I use an etched brass BC plate at the nose with etched BC chairs. (These are attached by a tag from the underside of the nose timber, which means that a recess has to be cut in the building template to take up the 0.3mm thickness of this tag).

This "vee" and point rail extension is gauged from the straight stock rail and is carefully placed to line up over the template correctly. Check that the "vee" is parallel with the straight stock rail by running a straight edge along it towards the toe and checking the gauge at that end. Do not fix the "vee" until you are sure that it **is parallel** with the stock rail and the "vee" and the point rail extension are in line and gauged from the stock rail. It is critical for the appearance of the turnout to get this right.

## Laying the straight closure rail

*Prepare an Exactoscale brass lost-wax fishplate so that the side into which the loose-heeled switch goes has been relieved a little and that the switchblade can rotate sideways slightly. It must not be tight, or loose for that matter. Mark this side with a marker pen.*

*Decide at this stage whether you are going to solder the Exactoscale brass lost-wax fishplate that forms the heel joint to the ends of the closure rails before you finally fix them in place or whether you are going to add them after the closure rails have been fixed and then superglue the fishplate in place afterwards.*

*Also decide whether you are going to use heel plates. If you do the actual heel may vary a little from the exact position given by the dimensions. This is because the heel plates are set from the 3S timber that supports the closure rails and if the location tabs on these are used this will lock the dimension from that timber. If the tags are cut away then the axis can be position on the heel point.*

Make up the straight closure rail including the wing rail for the crossing. Mark the railhead and RF, set the wing rail over to the correct angle testing it against the turnout side of the "vee" (curving it slightly if the turnout curve runs through the "vee") and checking that it is also parallel to the straight stock rail. Use track gauges to check this. Also lay a straight edge alongside the straight side of the "vee" out towards the toe checking the gauge at the toe end. The "vee", its point rail extension and this closure rail **MUST** be in a straight line. Simultaneously put a crossing flangeway gauge in between the wing rail at the turnout side of the "vee" and press the wing rail tight toward the "vee", keeping the closure rail hard against the straight edge. I know it requires two pairs of hands but it is important to get this closure rail set right.

The heel point is shown on the drawings and is the switch length plus 8mm (2 feet) away from the toe, the toe being 4.33mm (13") left of the hole through the stock rail and on the centre line of that no.3 timber. When all is lined up the heel point can be checked and then be marked.

Check the stock rail RF to closure rail RF or stock rail RF to the back of the closure rail with the dimensions on the appropriate switchblade drawing. The heel point is on the centre of the closure rail. Remove and cut to length.

Solder the brass lost-wax fishplate to the closure rail at this stage or leave it off to fix with superglue later when the switchblades are fitted.

Replace the closure rail with the gauges and straight edge and when all line up again, fix the closure rail, starting from the crossing and working out toward the toe. Once the “vee” end is fixed you can remove the straight edge and gauge using the track gauge with the two legs on the closure rail and the single leg of the triangular gauge on the stock rail. When you get close to the joggle and set, you will have to reverse the triangular gauge, as you must not gauge from the joggle and set section **ever**.

The isolation gap just left of the “vee” will be cut later, either by a piercing saw or a thin disc cutter.

## Laying the curved closure rail

Mark the railhead and put in the curve in the right direction. Set over the wing rail correctly and check this against the template. The closure rail must be longer than the heel point at this stage.

Check that when the wing rail nests against the straight side of the “vee” with the crossing flangeway gauge in place AND a piece of scrap brass curved to match the radius is used to line up the RF of the closure rail to the RF of the “vee”, that the remainder of the curve coincides with the curve on the template.

The heel end must line up correctly and be dimensioned from the stock rail to the dimension shown on the drawing. The heel point is shown on the drawings and is the switch length plus 8mm (2 feet) away from the toe, the toe being 4.33mm (13”) left of the hole through the stock rail and on the centre line of that no.3 timber.

Two other dimensions are given, one the RF to RF and the other between the stock rail RF to the outside of the curved closure rail at the heel. The heel point is on the centre of the closure rail and can then be marked. Remove to cut to length.

Solder the lost-wax fishplate in place or leave it off to be glued and added later.

Now reset the closure rail at the “vee” with the crossing flangeway gauge in place AND with a short piece of scrap brass to be sure that the RF of the closure rail and the RF of the turnout side of the “vee” line up. Recheck the heel point dimensions and then fix this rail at the “vee” end.

The rest of the closure rail is floating but it has to be aligned with the template, checking vertically from above that it is in the correct position and fixed from the “vee” end until the heel is reached. Most important is the position of the heel and this must be checked dimensionally throughout the fixing process.

Cut the isolation gap on the switch side of the “vee” later when the turnout is complete. That ensures that the closure rail remains in line and on a sweet curve. Use a piercing saw with a fine blade or a thin disc cutter.

## Laying the curved stock rail

Take the curved stock rail and put the curve in with the marked railhead the correct way round.

Leave the section left of the joggle straight and put a slight set in the curve at the distance of the planing from the joggle. The set is to restore the continuity of the curve. Check that the joggle and set are offsetting away from the RF. There must be sufficient straight to reach the extra chairs/timbers to the left of the turnout and sufficient curve to reach to other extra chairs/timbers to the right.

Now set up the curved stock rail with a 0.5mm brass wire through the hole in the railhead of the straight stock rail and through itself so that the wire is still parallel to the no.3 timber and 3mm away from that timber’s centre. Tape the wire down to prevent the curved stock rail in place and from moving out of position.

 

Now gauge the straight extension part of the curved stock rail out to the left, past the toe until it reaches the extra chairs/timbers well to the left. When this is all in order and the 0.5mm wire hasn't moved then fix a couple of chairs to the left of the toe, checking with a straight edge run through the crossing that the straight closure rail, the "vee", the point rail and this straight extension of the curved stock rail are all in line. If they are, as they should be, then fix the remaining chairs on this straight extension including the extra ones.

The curved remainder of the curved stock rail is unfixed and floating.

Starting at the no.3 timber check the RF to RF dimension on the centre line of that timber with the drawing for the particular switch and fix that chair. Move to the no.4 timber and do likewise. Place a triangular track gauge with the single leg on the curved stock rail and the two legs on the curved closure rail to locate that section. If you have them, add further gauges down the curved stock rail locating as much of this rail as you can. Hopefully you can locate past the "vee". This is to set up and hold the curved stock rail so that you can check the heel point clearance from the straight closure rail.

Now check the dimensions at the heel. They must be as those on the drawing. Either check the RF to RF at the heel or check the clearance curved stock rail RF and the outside edge of the heel of the straight closure rail. It is crucial to get this clearance right. You may need to be a little over gauge from the curved closure rail to get the clearance right but the clearance must be as the drawing dimension otherwise the switchblade will be under gauge.

When all is in order start to fix the curved stock rail running through the joggled section checking each RF to RF on the centre line of each timber from the drawing until you reach the heel. The dimensions measured must not be smaller than those on the drawing and can be a little greater, say up to 0.1mm greater. Thereafter you use the track gauge to position and fix the curved stock rail. Finally fix the outer extra chairs/timbers on the right side.

### Laying the check rails

Fit the check rails in the usual way, gauging with the check gauge. For plain track at 18.83 you could also use the crossing flangeway gauge but if you have introduced gauge widening to the curved stock rail then you will have to maintain the check gauge and increase the flangeway by the gauge widening you have applied.

## Making switch blades

You may have purchased ready made switchblades. I make them myself as they have to fit into the joogle of a GW turnout. My guess is that ready made switchblades will still need changes and of course would have to be drilled 0.45mm along with the railhead earlier. The method is the same for GW semi-curved B & C switchblades as these too have to fit a joggle.

When you drilled out the railhead and the rough cut switchblades, I asked that it be cut well over length. As the finished length of a 10' loose-heeled switch is 2 feet longer, at 12' something like 120mm would be the minimum length as anything shorter makes is difficult to file and to put in the switch curve later. A 16' switch needs to be 150mm long initially.

First cut back the toe square 7mm past the 0.45mm hole that you drilled for the horizontal leg of the dropper.

Mark with a marker pen on the web of the outer face (RF) of each noting the handing, the length of the planing from the toe. As the toe is 4.33mm past the 0.45mm hole the additional length is 2.67mm and this must be added to the planed length for you to mark from the square end that you have just cut.

Thus,

| Switch | Planing from toe | Plus 2.67mm to get o/a | Switch radius | Stretcher distance from |
|---|---|---|---|---|
| 10' | 25.5mm | 28.2 overall | 1920mm | 12.83mm |
| 12' | 30.83mm | 33.5 overall | 2800mm | 12.67mm |

 

Operating system

| | | | | |
|---|---|---|---|---|
| 14’ | 35.67mm | 38.3 overall | 3800mm | 12.67mm |
| 16’ | 40.67mm | 43.3 overall | 5760mm | 12.67mm and 29.33mm |
| B | 33.42mm | 36.1 overall | 2920mm | 16.33mm |
| C | 41.83mm | 44.5 overall | 4520mm | 16.33mm and 36.3mm |

David J.Smith’s book GWR Switch and Crossing Practice on page 11 describes the Swindon practice of planing switchblades. I have drawn both blades for a 10’ switch from the drawings of poor quality that I photographed at the Wiltshire and Swindon Record Office.

The drawing is for a right hand turnout. I should esxplain what my drawing shows and how to produce your own switchblades from it.

At the rear of these instructions is a card with the switch radii for the above switches. Use them to assist in making switchblades.

## Straight stock rail switchblade

Take the curved switchblade that closes to the straight stock rail. Mark on the RF the length of planing overall as above. Working on the back face (that is the face the faces the stock rail) file from the planed length back toward the extended toe until you have a flat straight filing that runs from the start of the planing and finishes at the web at the toe end. At this end you should have filed down to the web, just. When the 2.67mm is cut back later you should end up with the back face looking like the section on the drawings –stages 1 & 2.

Turn that rail over and put in a curve approximating to the switch radius quoted above, so that the side that you have just filed is now a concave curve (ie.hollow). The RF that you are about to fil is now convex. File just the **railhead** straight from the planning point back to the toe so that it is a straight line and the thickness at the extended toe end is 0.27mm. In real practice this second filing should be a 1 in 10 slope. See drawings – stages 3 & 4.

It should be easier to file this side over a piece of hardboard just hanging over the corner of your bench. A narrow strip of hardboard should give and take up the curve that you put in.

When you have completed the second filing reverse the curve that you put in so that the back face is again straight. That leaves you with a curve on the running face (RF) which is where is should be. Curve the remainder of the solid rail section to the same curve checking with the template.

Note that the foot of the rail below the second filing was not touched. This is to maintain the strength of the blade as was the 1 in 10 slope had you put that in.

Now cut the extended toe end back until it is 4.33mm from the centre of the 0.45mm hole. The hole will have become filled with metal so broach it out to just 0.5mm diameter and check with alength of 0.5mm nickel sliver wire. Then thin the last 2mm or so of the length of the head at the toe to reduce the thickness at the toe to 0.2mm. This should be a gradual taper not a sudden chamfer. Finally put a 0.7mm radius to the tip of the toe to complete that blade.

*Note: The 2mm gradual chamfer is true GW practice but as the GW blade would likely have been thinner further along the railhead consider making this chamfer longer and thus more gradual.*

Lastly prepare to cut the blade to the nominal switch length PLUS 8mm (2 feet) from the toe. Personally I leave it a little longer and check it against the space on the straight stock rail side and it will eventually have to fit between the heelpoint plate axis or lost-wax fishplate, and the toe with a 0.5m wire run through the two holes and held parallel to the no.3 timber. As you gradually reduce its length to fit check that the straight back face lies against the planed length of the stock rail between the joggle and the set, as it must.

You may need to make small adjustments to achieve this but in the end the blade must fit, but not be tight, between the heel plate axis or fishplate, and the toe end held by the 0.5mm wire run parallel through the hole in the blade and the stock railhead.

You might have to put a slight angle at the base of the back face to make sure that the planed length does seat against the stock rail and the slide chair working face.

A final check can be made by pressing the 0.5mm wire toward the toe slightly and seeing if you can move the switchblade the requisite 1.5mm (4½") opening. Some of my Paddington drawings give this as 4¼" but personally I am happy with 4½" as a maximum.

**Final check**

Finally check that at the nominal switchblade length (10' for a 10' switchblade) from the toe there is a 4½" (1.5mm) clearance checked by a 0.6mm nickel silver wire used as a gauge between the stock rail RF and the back of the switchblade. You could use the edge of the crossing flangeway gauge but note that the actual dimension is 0.583mm so that might distort the switchblade. What is important is the clearance between the stock rail RF and the back of the switchblade when the toe is opened 4½" (1.5mm). It should be 0.583 throughout but as the effective wheel flange is 0.40mm a wheel set should easily pass.

## Curved stock rail switchblade

The planing of the straight switchblade on the curved stock rail side is the reverse of the above. The straight side is the running face (RF) and the back face against the stock rail is curved.

Starting as before file the back face straight and then put a curve in it so that it becomes convex, the concave curve being on the RF that you are about to file flat. It will not be so easy to do this because of the blade will roll about on a flat surface and it is no help to work over a piece of hardboard as that flexes the wrong way. You could form the overhang of hardboard into a matching concave curve using masking tape to hood the curve in place. Alternatively you could transfer the curve from the template to a piece of wood and use that clamped to the work bench.

Whatever way you manage to file the concave curve of the RF flat, when completed bend the blade back so that the running face is straight. That leaves you with a curve on the back face that follows the curve of the stock rail.

Now cut the extended toe end back as previously, until it is 4.33mm from the centre of the 0.45mm hole. Broach the hole out to just 0.5mm diameter and check with a length of 0.5mm nickel sliver wire. Thin the last 8mm or so of the length of the head at the toe to reduce the thickness at the toe to 0.2mm, this being a gradual taper not a sudden chamfer. Finally put the 0.7mm radius at the tip of the toe.

Lastly prepare to cut the blade to the nominal switch length PLUS 8mm (2 feet) from the toe. As before leave it longer and check it against the RF of the joggle and set of the curved stock rail. Eventually the blade must fit between the heelpoint lost-wax fishplate and the toe with a 0.5m wire run through the two holes and held parallel to the no.3 timber. Gradually reduce its length to fit. The planed length of the curved back must lie against the curve of the stock rail between the joggle and the set, and the heel end sit inside the lost-wax fishplate.

Make small adjustments to achieve this but in the heel end not be tight.

As before you might have to put a slight angle at the base of the back face to get a good fit.

Finally, check as before by pressing the 0.5mm wire toward the toe slightly and seeing if you can move the switchblade the requisite 1.45mm (4¼") opening.

Carry out the **final check** as above.

## Checking the switch gauge.

With both switchblades in place, check the gauge from them, from the toe down to the end of the planing. Of course the joggle to set section gives some relief particularly in the middle and it is either end of the switchblade that may need further work. This is more likely at the toe end but you can remove more from the head along the gradual taper section that you put in.

The alternative is to re-file the back face of the straight stock rail switchblade. Try not to alter the curved switchblade back unless of course the RF is not straight and not in line from the crossing through to the far left.

 

It may take a little time to fettle these blades but with patience you will get them into gauge.

Making switchblades is laborious but it doesn't take that long. Fitting them is more time consuming.

## Preparation of templates for loose-heeled turnouts in P4

David Smith's book deals in part 2 entirely with the preparation of B & C type turnouts. It is not difficult to prepare similar templates for loose-heeled switches but it is helpful to have the transition point of the turnout radii, which is not given in his book.

It would seem helpful to publish six of the GWR Chief Engineer's Office Paddington/Aldermaston drawings which as a matter of interest have been made available by the Scalefour Society on http;//www.scalefour.org/resources/permanent _way_notes2.htm

R1787 gives the arrangement of the switch chairs.

R3794A gives the dimensions for loose-heeled switches and the chair spacings.

R1755 is the table of loose-heeled leads. This is identical to that published in David Smith's book except that he does not give the dimension "T", the distance of the tangent point from the 4½" opening of the turnout radius plus half the gauge.

R2998/9 gives the dimensions at crossings.

R1739 gives the details of the main running chairs. Note the 00 - Z chairs.

Read carefully David Smith's early chapters on 00 and BS95R rails and chairs. Each had their own chairs and fishplates and whilst the difference between 00 and BS95R was essentially in the depth of the rail head and thus the height of the web, it does determine whether 14" timbers with Z chairs are used or BS95R chairs with L1 chairs on a 12" timber.

It is my view that if the model is of a period earlier than 1923 then 00 should be used throughout. If it is after 1930 and on the main line then relaying could well have meant replacing all the chairs with BS95R. On branch lines 00 would have continued well into later GW life as it would have been financial reckless to throw out chairs that still had many years of life left in them. Consequently 00 chairs taken from the main line in the 1930's would likely have been used again in branch line work if the 00 chairs needed replacing.

New work in the later 1930's would have been all BS95R and flexible B & C switches.

David has reduced many dimensions to 4mm scale but I prefer to use full size dimensions and reduce them as required. Those in feet are multiplied by 4 and those in inches divided by 3.

It is assumed that the template will be prepared using CAD. There are several packages available like TurboCAD or DesignCAD, but check out that they can plot out to your printer.

For this exercise we are going to draw a 10' switch with a 1 in 6 crossing, using 00 rail with 14" timbers and Z chairs- just cut down a standard chair to 2mm width. If using BS95R and L1 I am not sure how to produce L1 chairs – presumably severely cut back standard chairs.

**Figure 1**

First draw a circle the radius of the turnout curve (339 feet), 1356mm. The turnout curve is always on the centre line of the turnout so it needs to be offset either way by 9.415 (half 18.83) giving the outer radius of 1365.415mm.

Draw a tangent horizontally to the right, to this circle; this being the straight stock rail. From the tangent point draw a circle the distance of dimension "T" from R1755, in the case 16' (64mm). That gives the far end of the nominal length of the switch, 10' in this example, and the position of the 4½" opening, RF to RF.

Set up another circle radius 10 feet (40mm) from this point to determine the position of the toe of the switch on the straight stock rail.

From the toe set up a circle the radius of the lead of 50' 6" (202mm) and drop a vertical down from this. Offset the straight stock rail a distance of 4' 8½" (18.83) to form the straight point rail. The point where the vertical line crosses this point rail is the intersection of the "vee".

The original centre line turnout radius plus half the gauge curve should also run through this point or be extremely close to it. You can ignore the very small difference as I do and leave the intersection of the crossing between the straight and the curve. Alternatively you could move the tangent point slightly to suit or move the "vee" so that its intersection coincides with the intersection of the straight and curved rails.

The lead lengths are usually quite accurate but remember that full sized trackwork was always calculated by hand and laid out by measurement in those days.

Draw the "vee" independently using a "T". Set out the long leg of the "T" a length equal to ten times the crossing angle. Draw two lines either side at right angles to form the head of the "T", each side having a length of 5mm. Thus the long leg is 60 and the head 10. Draw lines from the ends of the head to the bottom of the "T" to give the crossing angle.

Rotate this crossing angle so that one line is parallel to the point rail and position it so that the intersection of the two legs is at the intersection point of the "vee".

**Figure 2**

At a point 40mm (10' switch length) from the toe is the position of the 4½" opening, RF to RF. Draw a circle 4½" radius (1.5mm) and drop a vertical its centre. The point where this vertical meets the circle is the offset point for the switch radius.

Run a curve equal to the switch radius of 480' (1920mm) from this point back to the toe.

Next either offset this line 8mm to the right or draw a circle from the toe 2 feet longer than the nominal switch length, that is at 12' (48mm) and drop a vertical line from it. Extend the switch curve to this line so that the curved switchblade's overall length is 12' from the toe, running along the straight stock rail and is at the switch radius throughout.

The turnout + ½G curve should be trimmed back to this line, and should meet the switch curve at this point. They are joined together. The remainder of the turnout curve + ½G is trimmed at the crossing "vee" unless the curve is to extend through the crossing out on to the branch, as it regularly did on the Great Western.

The main elements of the turnout are now completed and the other rails can be offset by 4' 8½" (18.83).

**Figure 3**

From the toe run a circle the length of the planing, 6' 4½" (25.5mm) and drop a vertical to the opposite rail, the straight closure rail.

The final task is to put in the joggles at the toe on both stock rails.

**Figure 4**

Draw a 0.2mm radius circle and a second 2mm radius circle at each toe. Draw a line vertical between these circles and extend this line to hit the outside diameter of the 0.2mm circle. (On my CAD I have to extend them much further and then trim them back).

Draw a line from the intersection of this vertical line with the outside of the 0.2mm circle back to the intersection of the 2mm circle with the straight stock rails to the left, thus forming the two joggles.

 

Operating system

On the straight stock rail side simply draw a line from the end of the joggle to the planing point and trim that to the right side of the stock rail going towards the crossing. This is the position of the slight set that is put in the stock rail to restore its alignment.

The curved stock rail side is a little more complicated. Draw the joggle the same way. Break the curved stock rail at the planing point and rotate the section between the planing point and the toe such that it intersects with the end of the joggle and forms that offset.

**Figure 5**

Note in figure 5 where the heel points are. They are in fact at the mid point of the end of the switchblades and the closure rails and not at the RF.

**Figure 6**

Set up a line bisecting the crossing outside of the crossing. On a flexible crossing using B or C switches the timbers are set at right angles to this bisection line. With loose-heeled switches they do not but you have to initially offset the 1C to 6C timbers as shown, as if you are building a B or C switched turnout. David Smith's book (page 34) gives the dimensions but you might just as well use Paddington drawings R2998/9 where the distance from the intersection to the nose is given. This is actually 11/16 x N (the crossing angle). For a 1 in 6 it is 11/16 X 6 = 4⅛" as R2998 shows.

David Smith's book (page 112) gives the dimension from the nose to the centre of the BC timber as **3"** whereas R2998 gives **4"** below a 1 in 6 and **5"** for all angles 1 in 6 and above.

*I think the explanation for this is that David is setting out a B switch which uses a 12" timber for the BC plate and being 2" narrower than the 14" used for a 00 loose-heeled switch, the dimension is truncated by 2". Since we are laying out a 00 loose-heeled switch using a 14" timber in this position then the **5"** dimension **must** be used.*

*Of course if you are laying out a loose-heeled switch for the intermediate period (late 1920's onwards) using BS95R rail and chairs with a L1 chair on the same timber in line then in that case the BC plate would be on a 12" timber. By that time 14" timbers had been discontinued and the Z chairs were obsolete. The offset would still be 5" otherwise the geometry would go awry. The BC plate would overhang the timber on the nose side.*

The wing rails are dimensioned along their lengths from the intersection. The distance from the intersection to the ends of the point rails is given as 12'. I run this down the bisection line and then drop off lines at right angles to set the final length.

**Figure 7**

Draw lines perpendicular to the straight stock rail from the intersection of the 1C to 6C timber centre lines with the crossing bisecting line, as shown. These are the centre lines of the 12" timbers, which with loose-heeled switches are always at right angles to the straight stock rail. At the rail ends at either end of the crossing put in a line joining the ends and then a vertical at right angles tot he stock rail from the mid point. Use these lines to offset 13" (4.33mm either side) to give the centre lines of the two timbers either side of these rail joints. At the 6C end place a timber mid-way between the 6C and the last timber before the joints.

The BC plate timber is always a 14" timber when the rail is 00.

Now lay out the timbers at the switch. The drawing R3794A has a small sketch bottom left, which shows the spacing of the timbers from the joint to the toe timber, the toe being 4" back from this timber's centre line. The first stretcher which carries the operating rod is 13" (4.33mm) further along. The remaining stretchers are shown for the various switches above, for the 10' switch it is 25½" (8,5mm) but you may disregard this as it is near impossible to fit. *What I have done is to drill out the switchblade and solder a 0.5mm nickel silver wire across and then cut it through so that on the main turnout road it appears to be one but on the branch road the angular movement misaligns the two halves.*

Note that the main timbers start at 9' and gradually increase in 3" increments down the turnout. They are set by offsetting the curved stock rail 1' 6" (6mm) and 2' 0" (8mm) and trimming the timber length to increments of 3" within these two lines as figure 7 shows.

Being an 00 turnout the stock rail is 24' 6" long to the joint. Draw a line vertically at this joint and space the joint timbers 13" either side. However this is whaer the Z chairs come in so it is not that simple.

**Figure 8**

You will note that the drawing has three broken lines parallel to the straight stock rail near the switch, the straight closure rail near the crossing and another the other side of the "vee" parallel with the straight point rail. They are spaced 1' 3½" (5.17mm), 10½" (3.5mm) and 1' 9" (7mm) respectively.

These are the minimum clearance lines for two standard chairs placed end to end on the same timber and inside them 00 and Z chairs must be used on 14" timbers.

1' 3½" is the minimum clearance between the last tied chair of the switches, the 3S chair, and the next timber that can take two 00 chairs end to end. Within these limits a 00 chair is placed on the main road and a narrower Z chair placed on the branch road as figure 8 shows. The 00 chair and the Z chair are side by side and are always placed on 14" timbers.

10½" is the minimum clearance between the last chair of the wing rails and this distance.

1' 9" is the minimum clearance between the last chair of the "vee", the 6C chair and this distance.

On a 1 in 6 crossing these last two limits do not give rise to the use of Z chairs. As the crossing angle rises they will come into play.

On the 14" timbers the 00 chair predominates and is always on the main line. At the joint 24' 6" out from the toe joint where a vertical line was placed, this line is offset 13" (4.33mm) either side and this is the centre of the 00 chair, see figure 8. The distance between this chair and the centre of the 3S chair is divided up so that the distance is no greater than 30" (10mm) and 00 chairs are placed at those centres, as figure 8 shows. Z chairs are then placed on the switch side of the 00 chairs on the curved road and the 14" timber placed under them accordingly.

Likewise the other side, keeping the 00 chairs on the main road. Outside of the joint with a 10' switch an additional 00/Z/14" is required and this would be at the same spacing.

The remaining 12" timbers with 00 chairs between this last 14" timber and the joints at the crossing are again spaced at no more than 30" apart. However you should note that the spacing between the last Z chair and the first 00 chair may exceed 30". You could, being on the branch take it out to 32" but no more. Better to reduce the spacing of this first timber to keep it down to 30". Space out the remaining 12" timbers equally up to the crossing joint timber.

Note that I always offset the RF by half the railhead width 1⅜" (0.45833mm) and place a circle 1.2mm diameter on the centre line of each timber to represent the hole one would have punched through a Brooksmith timber at that point if one was using his track building method. It is the centre of the rail when lying in the chair so it is still relevant whatever method of construction you are using.

Finally place the check rails at the crossing. For a 1 in 6 crossing these are 11' 6" long with 3' 6" end splays. Place the check rail on the straight stock rail side first. Note that the knuckle more or less lines up with the knuckle of the crossing wing rail as you would expect. In fact I make the ends line up as figure 8 shows as they have to be clear of the chair jaws on the 5C and equivalent chair at the other end.

On the branch side one could line up the outer splay radially with the wing rail as the a full line on the drawing shows. However that leaves the splay chairs unequalised and the dotted lines shows the slight displacement necessary to equalise the splays.

 

Figure 8 could have been reduced to fit the page. I thought it more helpful to leave it full size and cut off the last two timbers and turn them sideways so this template could be used intact. Do not forget that photocopying can reduce lengthwise dimensions fractionally but it may be two small to be important.

Finally, once past the joint after the 6C timber the first timber runs through both roads as shown. Blocking out timbering is always a hit and miss affair. Generally there would be just the one long timber past the joint and then it reverts back to 8' 6" timbers 10" wide. The first one to place is hard against the through timber on the outside of the branch road with the main road timber placed just clear of the inboard end of that. The chair spacing should not exceed 30" but there are occasions such as here where it might be necessary to go up to 32" with 33" the maximum, to get these to fit. The inboard end of the first branch timber can be cut back short to assist in closing up the main road timber. It might be necessary to cut back the end of the main raod timber but one quickly wants get them interlaced and left at 8' 6" long.

All timbers in 00 loose-heeled turnouts are 12" wide except those that carry 00 and Z chairs which are 14" plus the BC timber at the crossing. BS95R loose-heeled turnouts only use 12" timbers.

**Further reading.**

David J. Smith's GWR Switch and Crossing Practice, a design guide for 4mm modellers, published by the Great Western Study Group.

British Railways Track, the early bull head rail editions published by the Permanent Rail Society and long since out of print. The Great Western is barely covered by this book as the GW in general ploughed its own furrow when it came to permanent way work. However the many calculations and much other information is valuable and if you come across an early copy it is worth buying for a few pounds.

Great Western Magazine from 1924 onwards published a series of articles on GWR Standard Permanent Way Practice by F.T.Bowler. They followed two lectures given to the South Wales section on June 23rd and October 27th 1923.

The Paddington CME's office drawings already been referred to and are available on the Scalefour Society's web site. There is an extensive index listing of all available drawings.

A large number of working drawings of Great Western switch & crossings are held by the Swindon and Wiltshire Record Office, which used to be at Trowbridge and in recent years moved, I think, to Chippenham. Take a digital camera as they did not have photocoping facilities for large drawings and that may still be the case. Hopefully today they have all been catalogued.

**Instructions for the assembly of operating system**

**It is important that these instructions are read before commencing work on assembly. If building joggled turnouts read those instructions also.**

## Parts provided with the etch

One 8BA x ¼" brass cheesehead bolt, washer and nut.

One 10BA x ½" brass cheesehead bolt for operating pin.

2mm thick Tufnol approximately 50mm x 60mm

## Parts needed

0.5mm nickel silver wire for operating droppers from switchblades

0.6mm nickel silver wire for keeps.

Loctite to secure 8BA nut.

Araldite Rapid

## Tools needed

Apart from usual tools the following will be required.

0.45mm, 0.5mm, 1.4mm (1.35m preferred). 1.7mm (1.8), 2.2mm (2.3) drills.

10BA Taper tap.

## Useful tools and materials

Carr's 179 No Clean Solder Cream from C & L.

## Construction note

ALL BEND LINES ARE ON THE INSIDE OF THE BEND.

## Loose-heeled switches heel

There two methods of making the loose heel. One is to use the Exactoscale lost wax brass fishplate, relieving the end in to which the switchblade is later inserted. Either the fishpalate is relieved or the rail web is filled down. Either way, the switchblade must be free to rotate sideways a total of 1.5mm ( 0.75mm either way) .

The alternative is to use heel plates (DN1360). Like the operating system, these can be added at the building stage cutting out a pair of rectangles in the 0.3mm card under the template, or they can be made up and added after the turnout has been completed.

**B & C switches.**

The heel of these switches is as a conventional turnout.

 

# Assembly

This operating system comes from my Great Western loose-heeled switch turnout construction which was re-designed to be universal and can be used for any P4 turnout using loose-heeled switches. I separate etch has been made to enable the toe plates on my original design to be added if they are required. They do complicate turnout construction slightly.

There is a separate etch for semi-curved B & C switches as the timber spacing is slightly different.

Loose-heeled operating systems are available for P4 compounds, that is single and double slips. An adjustable lever from the lever set will be supplied to enable the switch throw at each end to be equalised.

The operating systems can be used with any standard turnout kit by either fixing to the no.3 and 4 timbers using holes through the timbers and tags bent up from the main part to locate and hold the timbers, or alternatively simply placed and glued to the underside of a completed turnout using Araldite Rapid.

The included drawings show the position of the etch in relation to the timbers at the switch toe and also the cut-out in the baseboard necessary to allow the operating lever to project into the space beneath.

The single turnout etch is double sided, one side for left handed and the other for right handed turnouts. The position of the straight stock rail toe is marked on both sides and this matches the drilling jig used to produce the Tufnol operating bar.

The marking “str stock rail toe” indicates the toe on the no.3 timber. This is the datum from which the operating system is set.

*There are two methods of assembly and they require slightly different assembly techniques.*

1. Building the turnout using tags to hold the operating system plate in place, then building the turnout on top

**This method is not recommended if you are building using plastic timbers as the soldering of the later parts is certain to destroy plastic timbers. The method is really** ONLY **suitable if you are using ply timbers.**

When using the tags to locate the timbers the main part will have to be set 0.3mm below the level of the building template. This can be achieved by first mounting a 0.3mm thick card on the building surface and then gluing the template to that, maybe with double sided tape. A rectangle is then cut from the card to allow the main part to sit in a recess so that the top is level with the building template, see drawing 1.

The main part is universal. Choose the correct side facing upwards depending on the turnout being left or right handed. Before positioned the main part make sure that the marking “str stock rail toe” is on the straight stock rail side, thus confirming the handing left or right.
The four tags are then bent upwards and the plate then held in place with masking tape.

The main part has the outline of the no.3 marked by a series of holes and these must line up with the no.3 timber. There are different holes to indicate an 8’ 6” or a 9’ timber.

The no.2 to no.5 timbers are also covered by the plate so that the cut-out through the baseboard is well covered. This was a fault on my original design.

Using the tags as a guide mark the centres of the holes to be drilled 1.2mm on the centre line of the no.3 and no.4 timbers. Note that the compensating lever for the point rods usually has an 5 ‘ extension of these timbers on that side on the Great Western. I have no knowledge of other railways but it would seem sensible to include these longer timbers now as they can always be cut back later. The extra 5’ length runs from the end of the standard timber and the holes indicating the end of the timber will be a guide.

 

Set these two timbers over the tags, having first run a little Araldite Rapid under them to secure. The tags topside may need cutting back a little if when bent over foul the chair base.

When the no.2 and no.5 timbers are placed a little Araldite Rapid on the inside edge to secure them but do not allow the resin to run out on to the building template for obvious reasons.

The remainder of the parts cannot be added until the turnout has been completed and removed from the building template.

If you are using DN.1360 heel plates and adding them at this stage then they need to be positioned with the axis immediately over the heel point. This may need slight adjustment as the turnout is built so the 3S timber, the one that supports the end of the closure rails, needs to be left slack until later. The tabs turn up to support the edges of the 3S timber. Again both timbers need to be fixed with Araldite Rapid. If would be useful to cut these two timbers overlength and trim them back later.

## 2. Adding operating system to turnout after building

Gluing the completed assembly after the turnout has been constructed is the alternative method and requires no prior action. Note that the main part covers between no.2 and no.5 timbers but only partially the outer timbers. This means that the cut-out in the baseboard is well covered by the plate.

You could combine the two methods by drilling out the holes for the tags in the timbers and cutting the tags off at the same height as the timber so that the cut tags/holes serve as locations, making sure that glue penetrates the holes as the timbers are glued. This would add strength to the assembly.

The main part is universal, one side left handed, the other right handed. Choose the correct side that is to be uppermost and turn it over as the parts to be added are on the underside.

## Assembling the operating system

First deal with the 8BA bracket that forms the pin for the operating lever.

This bracket is in two parts. The larger part is drilled 2.2mm and broached to just accept the 8BA bolt. The smaller part is drilled 2.5mm so that it is well clear of the thread under the head of the bolt and is a larger diameter to ensure that the bolt head sits down. These holes may have burrs caused by broaching or drilling that would prevent either the head of the bolt or the lever from sitting down. These can be removed by using a sharp 5mm drill rotated by hand to remove any edges.

Make sure that the underside of the bolt head and the sides are well cleaned with a fibreglass brush before assembly.

Both have the sides folded up at right angles. I always apply a little solder cream to the bend line with a toothpick before bending. Place the smaller plate upside down as figure 1 shows and locate it to the larger plate with the 8BA bolt, washer and nut, having put a piece of paper on the thread between the bracket and the washer to prevent the nut from being soldered.
Make sure that the smaller plate is rotated round 90° to the larger plate and that it forms a shallow box. Tighten the nut and test that the lugs of the larger part fit the slots in the main plate, adjusting the sides if they do not. If necessary file off some of the bolt head or the sides of the smaller piece so that the head sits down with the lugs are properly seated.

Apply solder cream liberally around the bolt head and in the four corners of the assembly.
I usually use the RSU as the amount of heat required is substantial. The reason that I use 179 No Clean Solder Cream is because there is very little flux to wash away, only solder that has not been picked up.

Put this assembly to one side.

## Assembling the main part

Again check that you have the right side uppermost and that the “str stock rail toe” is on the straight stock rail side. Do not at this stage bend down the holding tabs at the sides on the long edges. They will be removed after the assembly has been attached to the underside of the turnout.

Fold up the two operating bar location plates that form into channels, applying a little solder cream to the bend lines before bending. Check that they fit the slots. **Note that they are handed** and the lowered section of each faces each other at the centre. This lowered section is to give clearance to the operating lever when fitted.

Solder the two in place keeping solder away from the inside faces in which the operating bar will run. Put some solder cream under the two linking pieces and in the slots so that the whole gets well soldered in place. Again I find that the RSU helps as one can hold down each end firmly to get these two location channels flat against the main part.

Now take the 8BA assembly and solder in place. Put solder cream into the slots so that it forms a fillet on both sides. Again because of the mass the RSU is the solution as one can get both lugs well soldered quickly without disturbing the 8BA bolt and the top part. This part must be held firmly down when being soldered as the 8BA bolt must remain vertical.

My RSU has a small brass plate forming the second electrode. This means that I can place this horizontally on top of the bolt (with some heat protection) above the nut to apply pressure vertically as I apply the carbon electrode to the outside of each lug. If you allow the second electrode to slip the whole can be canted over as you solder. Beware.

There has been much redesign of this assembly to get to a design that can be soldered to get this bolt vertical.

When fitted remove the nut and paper washer, not before.

## Folding the operating lever

Fold up the lever with the bends on the inside applying a little solder cream to the bend lines. Fold over and under as indicated with solder cream applied to both faces. Apply solder cream to the inside of the “legs” before they are brought together.

Soldering this lever is a little tricky. I have a block of hardwood with the sides at right angles and I work oh that.

Using the RSU my first task is to solder the middle section down flat. However this will cause the solder to flow at the corners and up the sides leaving one with a badly soldered construction and the legs not lining up.

There are two ways to get the sides located before soldering. One is to clamp the centre and then the legs firmly with mini- clamps, removing the centre clamp before soldering. The other is to run a toothpick through the top hole of one leg and jam another between the two legs of the “u shaped” leg.

Actually I find neither necessary but then I have soldered up several of these levers.

Using the block of hardwood I sit the middle section on the top with one leg over the edge.
I hold the brass plate electrode hard against that leg and keeping this leg lined up by applying pressure with the carbon electrode held firmly in that corner. While keeping one’s foot on the footswitch I move the carbon electrode slowly across to the other corner keeping the vertical pressure on until I reach the corner. That should have pulled the second leg into line but not soldered flat. I check that the middle section is properly down and if not work with the carbon electrode along the fold edge using the edge of the brass plate electrode held firmly vertically to prevent the middle part from lifting up or the corners unsoldering.

 

Once the middle section is down and the corners soldered with the legs lines up, then I turn the part on to each leg and solder those down flat.

The bends may need a little adjusting to pull them back square after soldering.

When done, run solder cream as a fillet into the corner of the two bends and give that a quick flash. Keep solder way from the 2.2m hole at all times.

Then drill out all holes, the smaller holes 1.7mm for 10BA bolts and the larger 2.2mm for 8BA. Both may need a little broaching to get to size. I am not anxious to use a 1.8 and 2.3mm drills as these will leave both slightly slack. Remove any cusp with the hand held 5mm drill so that the lever will sit down flush. Clean up the edges to tidy up.

## Making the operating bar

Fold up the etch to form a channel for use as a drilling jig for the operating bar. Note that this is marked “top” and “str toe” on the top and “str stock rail toe” down one side and with a note indicating the turnout type on the other in case it gets mixed up with others later.

These marks must match those on the main part when assembled.

Cut a length of 2mm Tufnol, 5mm wide and 50mm long (trim back later).

File it down the edges until it just fits the bottom of the jig. Hold in place with a small piece of masking tape and place an offcut of a timber under so that when the Tufnol is drilled it remains immediately under the inside of the jig and has not slipped down.

Drill out on a vertical drill press the two 0.5mm holes and one central hole at 1.4mm (1.35 if you have one).

The jig is the correct length and the bar should now be trimmed back to length before it is removed from the jig. The end marked on top “str toe” has a notch. Put a mark with a file or a piercing saw across the end of the operating bar using this notch. It must be deep enough so that it cannot be removed later when cleaning up. The mark must be across the corner of the end so that it is visible from the top and the end when it is later assembled in the operating channel.

These 0.5m holes will later be drilled out to 0.55mm later or bushes fitted, as the droppers must have clearance to move and rotate slightly.

Remove from the jig and tap the central hole 10BA keeping the tap as vertical and as square as is possible.

Now the two choices. Drill out the 0.5 to 0.55mm or bush.

### Fitting bushes.

Use the Brooksmith rivets enclosed. They are tubular and have a relatively thin head. Being soft they can be easily drilled.

Drill out the 0.5 holes to 1.2mm for these and drill a slight countersink from the top side (check against the jig or the mark cut in the top/end) 2.3mm to allow the rivet head to sit down flush. Drill out the underside slightly 1.4mm to give space for the rivet to be expanded into to hold it. Do that with a centre punch.

If the rivet heads are proud then file them down flush.

Place the operating bar back in the jig, the right way round and secure with the 10BA bolt. Drill out the rivet heads 0.55mm.

Remove and roughen the underside around the 10BA thread to give a key for Araldite.

 

Secure the bolt with Araldite run into the thread. Run the thread well through from the underside, put more Araldite on the thread on the topside and run back the bolt back to pull the resin inside the tapped hole. Put a fillet of Araldite around the thread on the underside and leave to harden. When set, cut off the head leaving about 7mm of thread proud.

## Finishing the operating bar

The bar was filed to just fit the drilling jig. Both sides now need to be reduced by about 0.3mm so that the overall width is 4.5mm or so. The operating bar must be a slack fit in the channel and it must be able to move sideways. The reason is that switchblades rotate radially about the heel points and so impart a sideways movement on the operating bar as it slides to and fro. If the operating bar is too wide and close to being tight it will put a force on the soldering of the switchblade to the dropper. The need for the sideways slack will be apparent when you move the operating lever from underneath when the turnout has been completed. If you need to thin further just remove the keeps.

## Droppers

Form the operating droppers from 0.5mm nickel silver wire about 40mm long with a 12mm leg at right angles.

### Assembling to complete

**1.** If you built up the system under the track on the building template you will have placed the main part correctly so that the slots for the droppers are in the right place.

Turn the turnout over on to a smooth surface so you can add the operating bar channels and the 8BA assembly as above.

**2.** If you have built the assembly separately then it must now be attached to the turnout and positioned correctly.

You will find it helpful to have about six blocks of softwood of identical thickness available to support the turnout and to support the area around the main plate when fixing.

Do a trial run setting the centre line of the two radiused slots through which the droppers go must be placed 3mm from the centre line of the no.3 timber and parallel to it. The curved ends of these slots needs to be equalised so that they are in effect centralised within the track gauge.

When satified with the position that is is going to be fixed tape one side to the timbers on one edge with masking tape side so as to form a hinge that will allow the assembly to be hinged away check that is does hinge away and return to the selected position. Then hinge away and apply Araldite Rapid sparingly to the no.3 and no.4 timbers and the inside edges of no.2 and no.5 timbers.

I have found that this operation is quite straightforward if one uses a small piece of masking tape to initially support/hinge one side of the assembly, then shuffling it around slightly to get it into the correct location and using more masking tape on the other side before holding it all down under a small weight for the resin to set.

Use the wooden blocks to support the turnout at both ends and around the main part of the assembly. Leave for several hours, preferable overnight to set.

## Assembling the operating bar

Before completing the assembly it will be necessary to paint the inside of the rails to as far as the heel but keeping the paint on the planned section of the railhead to a minimum and the outer of each switch rail now leaving the planned part of the switchblade unpainted.

Put the operating bar in the location channel the right way round (note marking on the drilling jig and the notch that you should have cut to indicate the “str toe” end and secure using 0.6mm

 

nickel silver wires as keeps. Leave them long at this stage and do not bend to secure until the switchblades have been added and are working properly.

One at either end is all that is necessary but two holes are provided for choice. The other hole to allow for a fine wire flexible connection from each dropper to the two halves of the main part for electrical continuity.

Insert the switchblade into the heel fishplate checking that it will rotate so that a gap of 1.5mm can be opened easily at the toe. If not then either the rail end needs to be thinned a little or the fishplate needs opening up slightly. If it has been soldered to the end of the closure rail then it is doubtful if the fishplate can at this stage be relieved. If it can be removed then the problem can be dealt with. It should have been checked when the switchblade was made.

Cut the leg of one dropper back until it can just be inserted through the hole in the stock rail, taking the switchblade with it and also passed down through the hole in the operating bar and just touching the far end of the radiused slot. This is to ensure that the horizontal arm of the dropper cannot disengage from the hole through the railhead.

Check that moving the operating bar does move the horizontal dropper leg cleanly through the railhead hole taking the switchblade with it. You may need to repeat this process several times, bending the dropper leg slightly before having a smooth movement.
Check that the operating arm will move the switchblade smoothly. If it doesn't find where it binds and free it. Do not solder the dropper at this time.

Repeat in exactly the same way for the other switchblade.

Now with both switchblades are in place and are seating correctly against the stock railheads, we can move to soldering up.

Put a small piece of paper over the dropper legs of each switchblade, between the switches and the stock rails. The next task is to move one switchblade hard against the stock rail and clip it so that it cannot move and move the dropper to about 1.4mm from the far end of the radiused slot, securing it by a small piece of masking tape temporarily.

Move the other switchblade to the other stock rail with the dropper moved to 1.4mm away from the far end of that radiused slot.

Neither horizontal leg should have disengaged from the hole in the stock rail web.

Without moving the dropper on the second side move the switchblade out away from the stock rail by 1.45mm and wedge it there. With the dropper still 1.4mm from the far end of the radiused slot solder the horizontal leg of the dropper to the switchblade. Once soldered release the wedges and any holding masking tape.

Now return to the first switchblade. Remove the holding tape and clip. Move the soldered switchblade hard over to its stock rail and clip.

Move the first switchblade out 1.45mm and wedge. The dropper should have set itself 1.4mm from the far end of the radiused slot because the operating bar would have moved when the soldered switchblade was moved. Solder this switchblade to the dropper.

Remove all wedges and holding tapes and check that the two blades move smoothly from stock rail to stock rail. The 1.45mm opening equates to 4¼", the usual GW opening. At this opening there should be crossing flangeway clearance between the stock rails and the switchblades as far as the heel. At the heel is should be larger, something like 0.75mm.

Check that both switchblades moves freely. If all OK then secure the keeps.

Now it will not be possible to remove either switchblade because they will be held at the heel. It should be necessary to trim back the horizontal leg of the droppers but only do this on one side when the other switchblade is hard against its stockrail, and vice versa. Do this carefully as you must not remove too much else the leg will disengage from the rail head and that will defeat the object of taking the leg through the railhead.

 

**With my method of using a heel plate and vertical pin rather than the lost-wax fishplate I am able to remove both blades for painting. You are will to have had to paint the inside of the railhead and switchblade before this final soldering.**

*Finally*

***Twist away the two joining pieces to isolate the two sides of the main part and connect a fine flexible wire to the dropper and the location channels for electrical continuity. There are larger holes of the outside of the two halves that can connect to the main wiring circuits.***

## Lever arms

These are attached by 8BA bolts already on the operating system assembly and they are held by an 8BA nut and washer, locked by Loctite. Do not over tighten but do not leave slack.
I find that a nut locked with Loctite can actually be moved and slightly adjusted. The lever needs to be free to move but without much slack.

### Additional lever arms and connections to a mechanical lever frame

The lever included is offset 12mm to get it clear of a 9mm baseboard. More 12mm and longer 15mm offset levers are available on DN.6080 and DN.6090 etches. These both carry additional "Z" shaped as well as "U" shaped levers and right-angled versions. These are all to be drilled 2.2mm for 8BA bolts.

A whole range of additional and varied levers are available to get from the operating lever to a remote point motor or a mechanical lever frame. These all use 6BA bolts and have Nylock nuts which makes setting easier.

The levers are linked together by using 1.5mm brass tubes into which have been inserted a 0.8 or 0.9mm brass wire. And soldered at the end of the tube. These are connected to a "U" shaped connecting piece which is supplied on each lever etch and also on DN.6040. They use 10BA x ⅛" bolts, nuts and washers that are be supplied. Obviously the lengths of these sections can be adjusted to suit.

DN.6050 are supports for the 1.5mm dia tube.

DN.6001 is an adjustable lever that allows one to take up the differing throws and DN.6035 is a spring lever (requires a piano wire made spring that is not presently supplied). Omega loops could of course be used soldered into the ends of the brass tubes as an alternative.

## DN.1360 Heel plates

These plates are simply a vertical axis into which a 0.9mm nickel silver wire is run. This wire would be soldered to the end of the switchblade, not an easy operation because the switchblade has a finite length from the 0.5mm hole in the toe through which the dropper runs and this axis. The advantage of using heel plates is that it allows you to remove the switchblades for painting and for any late fettling.

After completion, fit a fine spring on the 0.9mm axis under the bracket and solder a 12BA nut with two 12BA washers, one above and one below the spring. The spring is to prevent the axis from lifting. Solder a fine flexible wire to the 0.9mm and to the bracket for electrical continuity, do not rely on the axis.

Open out the holes with a broach until a 0.9mm wire just passes through.

Setting up the heel plates depends on whether you are fitting the main part under the 3S and 2S timbers at the building stage, or later.

 

Operating system

**1.** If you are fitting at the building stage then template must have **an** accurate position of the heel point marked and it must comply with the dimensions given on the particular switch drawing from the stock rail RF's.

The heel plate has to be attached with Araldite and the longer setting type might be better as that gives moves time to get it set up correctly. Worth putting a piece of cling film under so that the Araldite cannot stick the part and the timbers to the building template.

It helps to set up both plates accurately if you run a 0.9mm drill vertically into the building board at the heel points and insert a 0.9mm wire into to these holes. Take care not to glue up this also, alternatively remove the wire before the heel plate has set.

The closure rails must be just clear of this 0.9m wire so it needs to be back in place when the closure rails are set in place.

Carefully file the heel end of the switchblade until it just fits, whilst locating it at the toe end by a 0.5m wire run through the two stock rails and the switchblade toe, and with the switchblade clipped to its stock rail. You can then solder the heel end to the 0.9mm wire and remove to clean up.

Once the turnout is removed form the building board the bracket part can be folded and soldered in place. The side fold is there to keep the bracket square so that the lower hole is vertically under the upper hole.

**2.** If you are fitting under the turnout after construction then make sure that the closure rails are correctly positioned just outside of the heel point and that the heel point is accurately marked and conforms to the dimensions given on the drawing for the particular switch.

Fold up the bracket part, using the side fold to keep the bracket square. Solder to the main part, with the bend lines uppermost. Whether you use these tabs depends on the position of the 3S timber. If it in a position such that the axis hole is correctly positioned for the 0.9mm nickel wire to be located just at the end of the closure rails then use the tabs to locate 3S timber. If it is adrift then cut off the tabs.

Run a length of 0.9mm wire through the axis. Place under the turnout with the 0.9mm wire just clear and adjacent to the end of the closure rail and in line with it. Glue the whole assembly on one side using Araldite. It might be better to use longer setting Araldite for this but you must have a means of holding the plate in place while it sets. Araldite Rapid will set quickly and can be used if you are confident that the plate is accurately.

Leave to set and then repeat for the other closure rail.
Then fit up the switchblade, carefully filing the heel end of the switchblade until it just fits, whilst locating it at the toe end with a 0.5m wire run through the two stock rails and the switchblade toe, and with the switchblade clipped to its stock rail. You can then solder the heel end to the 0.9mm wire and remove to clean up.

## Tie rods

The drawings show loose-heeled and B & C switchblade types of tie rods.

The earlier loose-heeled tie rod with different castings at either end has not been modelling by the small etched part could be clipped to make a reasonable representation.

The small etched part is to represent the later type where both end castings were the same.

The tie rod between the switchblades cannot be put in place because of the necessary electrical isolation, neither can a PVC/ABS rod be glued in place as the change of radii with loose-heeled switches makes that impossible. One could set the rod up for the straight road and then crop it into two parts. On the curved road they will be well out of alignment.

On B & C switches the flat flexible tie rods cannot be easily modelled. However the drawing shows an alternative running the 0.5mm droppers under the stock rails. There will not be a lot of clearance as the rail to timber dimension is only 0.6mm. Consequently it might be worth filing the

topside of the horizontal part of the dropper flat to reduce the thickness and improve clearance. Doing so would make soldering a little more certain.

## Reducing underlay thickness before laying turnout

The operating system, and heel plates if they are used, add 0.3mm to the underside of the turnout. The foam or cork underlay must be reduced locally in thickness to accommodate this, perhaps by using a rotating abrasive disc or cutting away with a scalpel.

### Note

Later GW semi-curved B or C switches used flat flexible tie bars. These have not been included. With these switches the tie rod did not go through the railhead but the flat tie bar ran under the railhead to stop the switch from lifting. It is suggested that the 0.5mm dropper uses that method with these switches instead of going through a 0.5mm hole in the switchblade and the railhead.

The rod tie bars were always used on compounds, that is single and double slips as these were always loose-heeled.

I am aware that turnouts with facing point locks often used flat flexible tie bars but I have no details. A facing point lock has also been drawn but not at this time etched. That will be included in one final etch that will pick up any missing details.

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