Instructions for the assembly of the turnout operating unit

Index of drawings. TOU folder

Drawing No.	Title of drawing
031	10' loose-heeled switch lead (turnout) showing position of TOU
043	Tie rod details
055	TOU expanded construction drawing
056	Mechanical levers available

Note: It is important that these instructions are read before commencing work on assembly. These instructions and those for designing templates and building loose-heeled and joggled turnouts are on the Scalefour website.

Parts supplied by Scalefour Stores.

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 for operating bar.

Parts needed.

0.5mm nickel silver wire for operating droppers from switchblades. 0.6mm nickel silver wire for keeps, Loctite to secure 8BA nut and Araldite Rapid

Apart from usual tools the following will be required.

0.5mm, 1.4mm (1.35m preferred). 1.7mm (1.8), 2.2mm (2.3) drills. 10BA Taper tap.

Useful solder to use. Carr's 179 No Clean Solder Cream from C & L.

Construction note: **ALL BEND LINES ARE ON THE INSIDE OF THE BEND**
EXCEPT WHEN MARKED ON THE ETCH

Introduction

These turnout operating units were designed originally for the P4 Great Western loose-heeled switch turnout construction used on Milverton, which was re-designed to be universal (left or right handed).

Special versions are available for single and double slips (compounds) which were **always** loose-heeled on the Great Western and later BR(W) times, never B or C switches. An adjustable lever from the lever set can be supplied to enable the switch throw at each end of a compound to be equalised.

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

Note: The Great Western always used joggled stock rails to nest the toe of the switch, both in loose-heeled and semi-curved B and C type switches. There is a later note as to how to use the joggle jig that is provided on the etch.

Loose-heeled switches

A loose-heeled switch produces the characteristic "dog leg" of Great Western turnouts and is essentially a fully curved switchblade that is held by a loose fishplate at the heel point, such that the heel end of the switchblade can rotate enough for the toe to be moved 4¼". The other characteristic is that the point rod is taken through the web of the rail so that the switchblade cannot lift. Sadly these and the joggle are rarely modelled and yet they are quite easy to achieve.

There are two simple methods of making the loose heel, using an Exactoscale lost wax brass fishplate or fabricating the fishplates. Both methods are described in "Notes on the construction of Great Western old style curved (loose-heeled) leads (turnouts)".

Old style heel plates are included on the DN.1430 etch but these have been superseded by using the Exactosacle lost-wax cast fishplate or the fabricated type.

B & C switches. The heel of these switches is an integral part of the flexible switchblade.

Assembly

The TOU's can be used with any standard turnout kit by either fixing to the nos.3 and 4 timbers using holes through the timbers with the tags bent up from the main part to locate and hold the timbers, or alternatively simply placing and glueing to the underside of a completed turnout using Araldite Rapid.

The 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 TOU is set. The centre line of radiused slots and the 0.5mm holes in the rail are 3mm the crossing side of the no.3 timber centre line.

Two methods of assembly

1. Building the TOU in-situ 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.

The main part is universal so choose the correct side facing upwards, depending on the turnout being left or right handed. If the turnout is left-handed then the words left handed must be facing upwards. Before positioning 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 timbers fitted to them.

The main part has the outline of the no.3 timber, marked by a series of holes and these must line up with the no.3 timber. There are different holes at the ends 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.

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 a 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.

A later section details the actual construction procedure. None of the remaining parts can be added until the turnout has been completed and removed from the building template.

2. Adding operating system to a 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.

The main part is universal, one side left handed, the other right handed. Choose the correct side that is to be uppermost thus if the turnout is left-handed then those words must be facing you. Now turn it over as the parts to be added are on the underside.

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 when the timbers are glued. This would add strength to the assembly.

Assembling the TOU, as a separate unit (2 above) or after building in-situ (1 above)

First make up as a sub-assembly 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 an 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. De-burr 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 the sides are 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 so 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 bolt head clears the plate when 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 little flux and it and any unused solder will wash away with hot water. Put this assembly to one side.

Assembling the main part as a separate unit (2 above)

Again check that you have the correct side uppermost and that the “str stock rail toe” is on the straight stock rail side.

You are now working on the underside of the main part, so turn it over.

Assembling the main part after building in-situ (1 above)

Do not at this stage bend down the holding tabs at the sides on the long edges. They will be removed **ONLY** after the assembly has been completed. The timbers are on the upper side and you are now working on the underside so turn it over.

Assembly

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 the sides 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, it can easily cant over when soldering. After fitting, 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 marked with solder cream applied to both faces and to the inside of the "legs" before they are brought together.

Soldering this lever is a little tricky. 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 with the slot.

Actually I find neither necessary but then I have soldered up several of these levers. If you solder the middle section down flat it is likely that the solder will flow at the corners and up the sides leaving one with a badly soldered construction and the legs not lining up.

I have a block of hardwood with the sides at right angles and I work on that. My RSU has a small brass plate as the other electrode, which helps to hold parts down when soldering.

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 the middle section to the other corner keeping up the vertical pressure until I reach the corner. I then release the footswitch. That should have pulled the second leg into line at the corner but not soldered it flat. Check that the middle section is properly down and if not, work 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 lining up, then turn the part on to each leg in turn 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 so as not to unsolder. 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 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). I make up a small bench hook to do this.

File it down the edges until it just fits the bottom of the jig. *A belt sander is useful to do this quickly*. 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 cannot slip down when being drilled.

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 as a guide. The mark 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 when it is later placed in the operating channel.

The 0.5m holes will later be drilled out 0.55mm or bushes fitted, as the droppers must be able 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 in the operating bar

I use 0.55mm internal diameter brass tube, and drill out the 0.5m holes slightly under size to suit the diameter. I then slightly countersink these holes on both sides and tap the brass tube in with a small hammer. Cut off flush and then, using a centre punch, open out the ends of the tube into the countersunk holes to rivet it in place. De-burr the hole.

Countersink the thread a little on both sides (by hand) and roughen the underside of the bar around the 10BA thread to give a key for Araldite. Secure the bolt with Araldite run on to the thread. Run the thread well through from the underside, put more Araldite on the thread on the topside and run 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 and file the top side flush.

Finishing the operating bar

The bar was filed to just fit the drilling jig. Both sides now need to be reduced equally so that the overall width is about 4.5mm. 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 thus tight in its location then 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 wire 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 TOU in-situ 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.

Do a trial run setting the centre line of the two radiused slots through which the droppers go 3mm from the centre line of the no.3 timber and parallel to it. It will help if you run a 0.5m wire through the stock rails for sighting. The curved ends of these slots need to be equalised so that they are in effect centralised within the track gauge.

When satisfied with the position that will be used for fixing, use masking tape on one side of the timbers so as to form a hinge that will allow the assembly to be hinged away. Check that it does hinge away and returns 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. Leave for several hours, preferably overnight, to set.

Assembling the operating bar

Before completing the assembly it will be necessary to paint the inside of the rails as far as the heel but keeping the paint away from the planing length of the railhead and leaving the planed 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 brass/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.

The other hole is for the fine wire flexible connection from each dropper to each half main part for electrical continuity.

Now take one of the switchblades and insert it into the end of the heel fishplate of whatever type. Check that it can be rotated 1.5mm away for the stock rail at the toe. Repeat for the other switchblade. Now insert a 0.5mm brass wire through the stock rails and switchblades and check that the blades will move freely along the wire. Check that the switchblades are not bottoming on the slide chairs and properly nest into the joggle section of

each stock rail as intended. The switchblades may need some more fettling to achieve perfection and you have to shorten the switchblades slightly.

Cut the horizontal 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 moves 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.

With brass lost wax or fabricated fishplates it will now not be possible to remove either switchblade once the droppers are soldered, because they will be held at the heel. You should therefore paint the inside faces of the switch and stock rails now as this will not be possible after soldering up.

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

Put a small thin 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 this 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 1.45mm away from the stock rail 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 it should be larger, something like 0.75mm.

Check that both switchblades move freely. If all OK then secure the operating bar in the two channels running 0.5mm keep wires through the holes in the operating bar channels.

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 stock rail and vice versa. Do this carefully as you must not remove too much otherwise the leg will disengage from the rail head and that will defeat the object of taking the leg through the railhead.

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 tufnol operating bar location channels, for electrical continuity. There are larger holes on 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.

The nut can finally be set by painting it and the thread with paint. It can still be undone but with more difficulty.

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 and 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 so you can use Nylock nuts for securing.

The levers are linked together by using 1.5mm brass tubes which have a 0.8 or 0.9mm brass wire inserted 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 separate etch. They all use 10BA x ⅛" bolts, nuts and washers which Scalefour Stores can supply. Obviously the lengths of these sections can be adjusted to suit. The Omega loop and simple supports are for the 1.5mm dia tube.

There are two adjustable levers that allow one to take up the differing throws, one having a lower height for compounds.

Tie rods

The drawing 043 shows 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 modelled but the small etched part could be trimmed 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. Fortunately the Great Western ran the tie rod flush with the top of the ballast/sleepers so that this section can be added cosmetically and does not need to move, just keep it proud of the droppers. Other ties can be added similarly. Note the shape in turnout photographs in David Smith's book.

Reducing underlay thickness before laying turnout

The TOU and heel plates 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 can be used in that way with these switches. It must not go through a hole in the switchblade/stock rails as on the loose-heeled switch.

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

A facing point lock has also been drawn but not at this time etched. That will be included in a later etch and will include cranks, compensators, lineside signal posts, pulleys and old pattern point rodding stools for 0.45mm wire rods. I am aware that turnouts with facing point locks often used flat flexible tie bars but these are not included.