On Valve Gear.
Bob Alderman ©2003

This is a slightly modified from an article that appeared in the Gauge 0 Guild Gazette. The photographs are of 7mm scale models but the principles can be applied in other scales. It resulted from a question about the benefits of riveting or bolting joints in valve gear. This has prompted me to set down my method for jointing rods.

I have chosen to illustrate this with Walschaert's valve gear, partly because that is the motion I seem mainly work to with and so have examples to hand for illustration, but also because it is potentially the most complicated working set of joints a modeller will encounter as a general rule. I discount the special inside valve gear sets that can be assembled as working or cosmetic as a positive choice will have been made to fit these. If your loco of choice has Walschaert's you must get it right as it is a fundamental feature of the locomotive!

Before describing the method it may be wise to consider the positions in valve gear where you may consider making break points to ease taking the motion apart. In general I have found that you can limit these to the components around the expansion link.

1. The joint between the radius rod and the combination lever.
2. The pivot of the expansion link.
3. The return crank –either the joint with the eccentric rod or by removing the crank pin complete with the return crank.

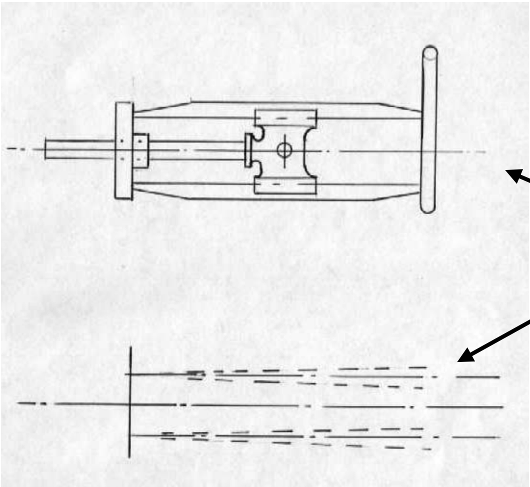
Breaking the joint between the radius rod and combination lever allows the con rod, cross head, union link and combination lever to be removed as an assembly. Removing the pivot from the expansion link allows the radius rod; expansion link, eccentric link and return crank to be removed as an assembly. These are detailed later.

In addition to removing the motion links separate cylinders and motion brackets can be an advantage. Some kits provide for this wholly or in part. Sometimes you just have to get inventive. Whatever is done here the main working part of these are the crossheads and slide bars.

When an investment cast set of slide bars complete with a rear cylinder cover are provided they have a decided advantage. They make good structural unit. Even so these benefit from some attention to ensure smooth operation.

The running surfaces of the slide bars should be smoothed with a small file. Treat etched slide bars the same way by removing etched cusps on the edges. Similarly the running faces of the crosshead and piston rod should be cleaned up. The faces are straightforward, but a cast piston rod poses some difficulty. I use the modelling drill; insert the piston rod into the chuck with a fraction over the width of a flat needle file showing. Start the drill and apply the file. Pull the rod out of the chuck another file width and repeat the exercise. Carry on down the length of the rod in steps. It is important that the file is only applied to the rod next to the chuck to stop a bending load being applied. When an appropriate length has been cleaned up I trim the rod and then further polish the rod with emery paper. This time I work the polishing along the length of the rod.

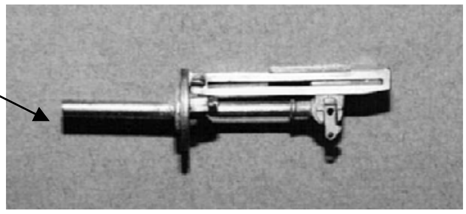
When all parts are cleaned up check the fit of the rod into the crosshead. It may be necessary to gently bend the slidebars to ensure they are parallel to the axis of the piston rod in both planes. See below. A good check for free running is that the crosshead should gently fall out of the bars under gravity.



For slide bars ensure that they a parallel with the piston rod axis in all planes. The crosshead should slide freely.

In some cases where the slide bars are separate from the rear cylinder cover and in the case of a three bar slide bar arrangement I have found it beneficial to add a tube for the piston rod to run in. The two bar slide bar give three points of contact: the upper and lower bars and the piston rod gland. The tube takes over this role and guides the crosshead relative to the slide bars.

Brass tube for piston rod.

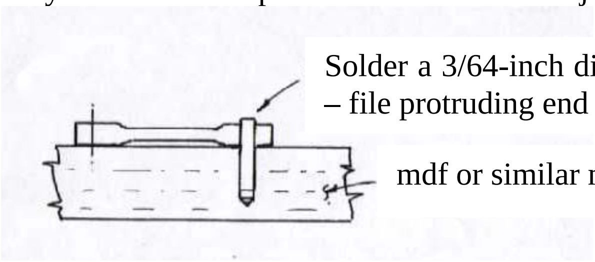


<u>And so to the joints.</u>

I customarily use milled rods when they are available, but the method described below works with laminated etched rods too.

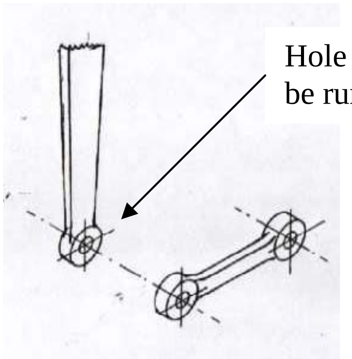
I use 3/64-inch diameter (1/32inch in 4mm) brass rod soldered into one half of the joint. If you drill a hole the same size squarely into a piece of mdf. This will support the rod whilst soldering. The holes in the rods usually have to be opened out to fit the rod. I use a cutting broach rather than a drill. It is then possible to get a relatively tight fit for the soldered side of the joint.

I use a paste flux for this job in preference to any other; it only goes where you want it. Just a touch of the iron with a very small quantity of solder is enough to make the joint. If you feel there is too large a fillet of solder around the pin I put a pin vice over the pin, nearly gripping it and rotate it down onto the solder. The jaws then mill away the fillet. The pin is then reduced to be just proud of the surface of the rod

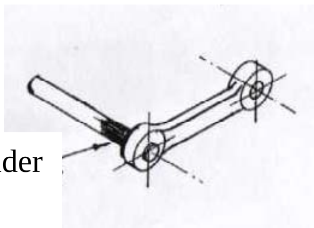


.

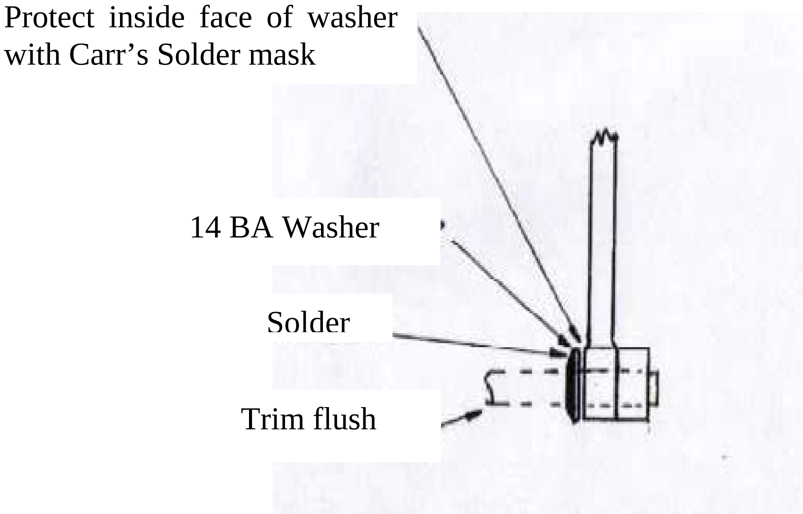
The hole in the rod on the other half of the joint I make very slightly larger than the rod to ensure it is a free fit. Again it is broached rather than drilled.



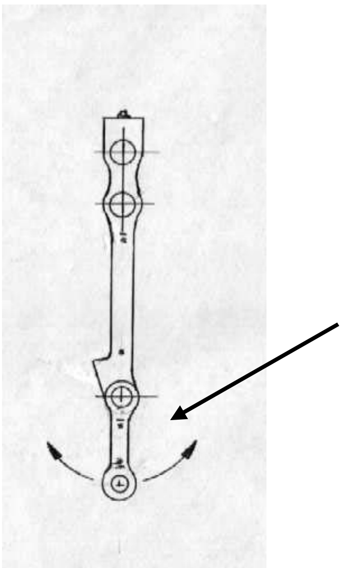
The pin is then given a good coating of Carr's Solder Mask. I have found that if the lid is left off the pot for too long it dries out. To resuscitate it I have used isopropyl alcohol. Stirred in it becomes a paste again. If over-thinned it can be painted on. This is a benefit for these joints. By gently applying a hot soldering iron it can then be encouraged to dry rapidly onto the components.



Assemble the parts together with more solder mask. Slip a 14 BA washer over the pin and solder. Again paste flux is best here. To make really sure the solder takes to the washer I brighten one face by polishing it on some emery paper. The soldering only take a moment and the joint can be made without appreciably heating the earlier soldered joint. Trim off excess pin and file nearly flush to the washer. Now you have a very low profile joint. For 4mm special washers will be required to suit the diameter of the rod used. Take a strip of thin brass and drill a suitable sized hole and snip he strip off to make a small square-ish washer.



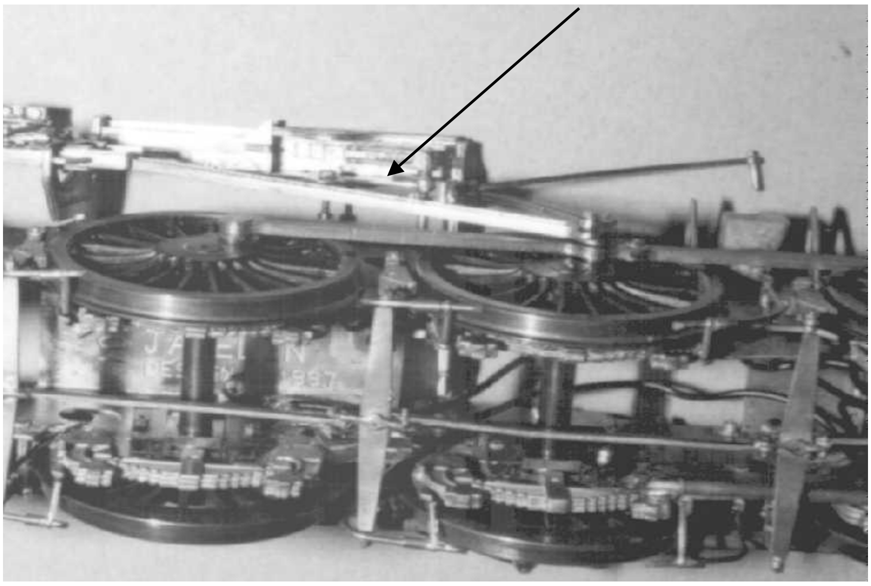
Check the joint for free movement. Initially it may feel tight but as long as it does move this means that you haven't soldered it solid and a few flexes of the joint will displace some of the solder mask and it will become free. A final oiling once it is on the chassis will complete the job. There is no need to remove the solder mask. It is a carbon compound (though it smells like shoe polish to me!) and will help with the lubrication of the joint.



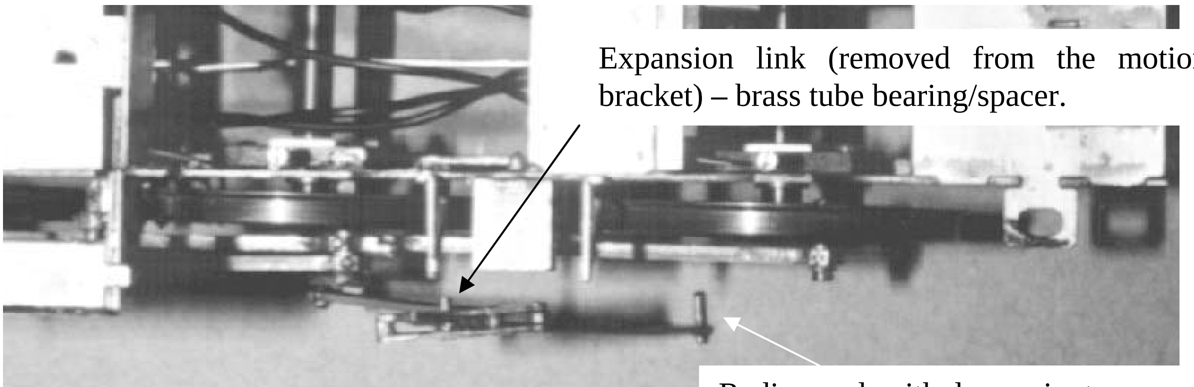
After soldering the joint should be free. A pendulum test will confirm that the joint is correct.

Break points.

As I mentioned earlier there are three main potential break points. The picture below shows two. On the motion bracket of this model I have soldered a 12BA nut onto the inner part (14BA in 4mm). The LMS style of motion bracket particulary lends itself to this approach. A 12BA (14BA) screw passes through this and tightens on to the other side of the bracket where the nut is fixed, It doesn't quite touch the outside part of the bracket. This serves to make the pivot for the expansion link. It may or may not support the radius rod too. However it is often possible, where you are presesented with a fair representatation of the expansion link, to sandwhich it around the radius rod and locate the the rod in forward gear at a small degree of cut-off. The reverser lifting arm serves to hold it in place.



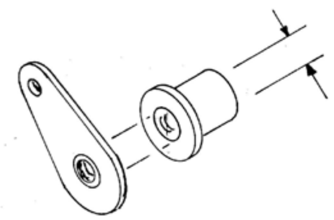
Another break point is at the end of the radius rod. By simply fitting a pin in the end slightly longer than for a fixed joint it can engage with the combination lever with no washer. The slide bar arrangement of the valve chest and valve spindle serves to constrain the combination lever and they do not come apart.



The picture above illustrates the long pin and the arrangement of the expansion link pivot. Here it is a short length of the thin wall brass tube provided by Eileen's Emporium. You will see that it extends towards the inside of the motion bracket. It is spacing the link to the outside of the bracket.

For a time return cranks have been my "bête noir" as they have had a tendency to slip in the wheel. If the joints in the motion are free running then no significant load should be applied to the crank but even so I have had them move. However making the crank as below has proved to be very successful.

It assumes a Slater's crankpin and a etched laminated crank. Shorten the bush to just over the thickness of the connecting rod, too late once assembled! Drill and tap the bush and crank to 10BA.

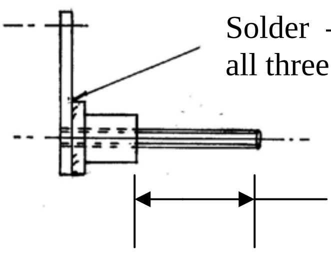


Based on a Slater's crankpin bush. Drill and tap 10BA both bush and return crank.

In 4mm scale a 14BA bolt may be more appropriate. The principles in the following notes will need some adjustment in 4mm to suit the crankpin that is employed.

If the crank is made from two half etch components it may be better to make a new inner one in full thickness material.

Fit he bush and crank onto a 10BA bolt, tighten the two together and then solder. The outer half etch part of the crank can then be laminated over the inner on the assembly hiding the end of the screw.

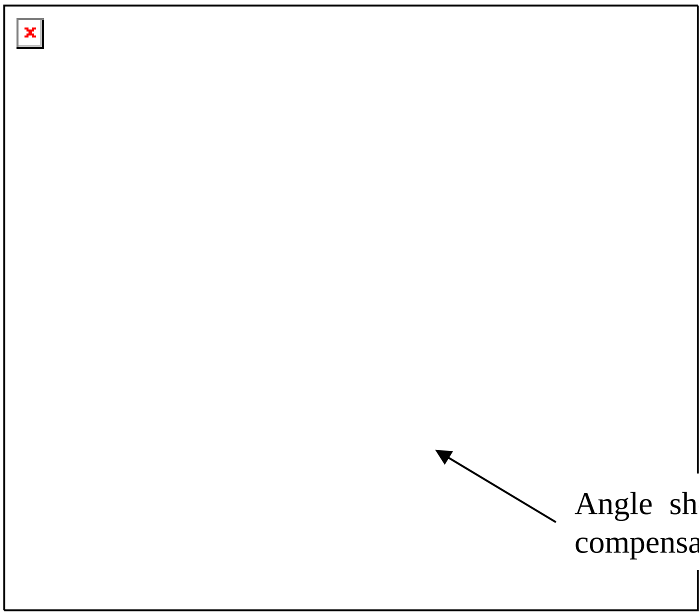


Solder – ensure joint includes all three components.

The length of bolt protruding should be sufficient encompass the coupling rod bush, the wheel and the lock-nut on the back of the wheel.

Tap the wheel 10BA. The plastic centre of a Slater's wheel does not need to have tapping drill to open the crankpin hole provided a first or second tap is used. The joint between the return crank and the eccentric rod can either be a soldered pin or a bolted joint.

The return crank is fitted to the wheel as shown below. The geometry reflects outside admission. Sometimes I have reduced the off-set as there seems to be too much swing in the expansion link – possibly a kit error? It is simply screwed into the wheel and tightened to give the required alignment. This may mean a degree of over tightening but the plastic will be compliant enough to accept it. Complete the installation with a nut tightened down on the back of the wheel and trim any excess thread flush.



Angle shown is 90° 42’ – slightly over 90° to compensate for the slope on the eccentric rod.

Detail from a real works drawing.

A crankpin bush tapped 10BA can also be used in the usual coupling rod positions, a screw passed through from the back of the wheel and tightened into the bush. It is essential there is a washer between the inside of the bush and the wheel otherwise the rod can catch on the edge of the wheel fixing screw. This style of fixing is particularly beneficial where there is limited clearance behind the cross head. A particular feature of LMS locomotives! Additional clearance can be generated by counter-boring the coupling rod to accept the head of the bush. This is easier with milled rods than laminated etched ones. The frictional heat can unsolder laminated ones.

In conclusion I will touch on a riveted joint. To successfully rivet a ball pain hammer is essential. I illustrate one below. The ball end is used to set the rivet.

With a joint is assembled with the rivet it is probably a moot point whether the rivet head is on the inside or outside of the joint.

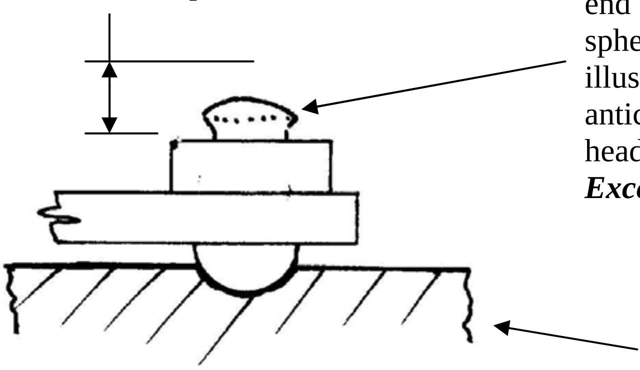
In addition you will need to make a "dolly" or receptacle for the rivet head. A block of steel drilled to accept just the head is suitable. Rounding the hole can be done with a dental burr if needed.

The rivet is trimmed so that about one and a half diameters protrude beyond the components. Sit the head in the dolly and support the components. Strike the rivet with the ball end of the hammer. The edges of the rivet end will deform and start to form a dome. It is easy to steer the head around the rivet to form the head.

Once there is sufficient deformation to prevent the components separating stop. The parts should move freely afterwards. Of course you can rivet the joint tightly if required to suit the application.

About one and a half rivet diameters protrusion to start.

"Set" end of rivet. Striking with ball end of the hammer will result in a near spherical end to the rivet. The illustration shows the rivet part set; anticipate the end will look like the head.
Except if a flat headed 4mm rivet.



"Dolly" to support rivet heads whilst setting.

In some 4mm kits the rivets provided have flat heads. In this case the "dolly" only needs to be a block that can perform as an anvil. The tail will still deform spherically under the influence of the ball pein. This may influence your choice of "side" for the set end.

I hope that these notes provide some help with an issue that can be covered as a one-liner in kit instructions.