

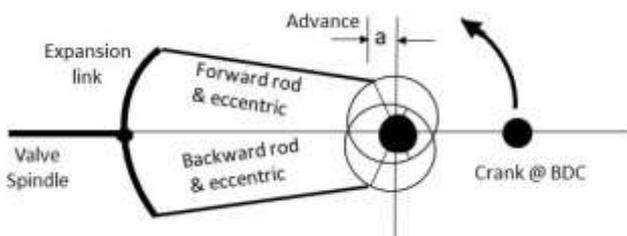


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“Eccentric but not nuts”

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After building engines with Joy and Walschaert's valve gears I finally came to models that carried the Stephenson and Allan Link Motions. Setting link motion is pretty straight forward when done properly but having seen the difficulties experienced by many builders it is worthwhile having a look at the different approaches that can be taken. First a quick recap of link motions, they come in three varieties: Stephenson, Allan and Gooch. The first was almost universal in this country in the 19th century being used on thousands of inside cylinder locomotives, thereafter on some outside cylinder Edwardian locomotives with inside valves as well as on all the GWR 2-cylinder standard engines.



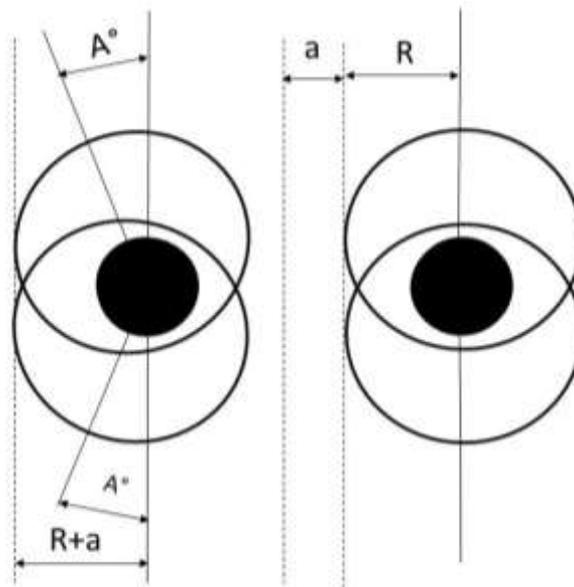
The Straight Link version due to Allan found occasional use, and the Gooch motion appeared on Broad Gauge engines. They all employ two eccentrics, one each for forwards and backwards motion, driving opposite ends

of a slotted link from which a die block transfers the combined movement to the valve spindle as shown in the diagram.

Valve setting is the same irrespective of the version used. It would be convenient if the valve movements for fore gear and back gear were 180° apart but valves are made wider than the ports in order to provide for Lap, so each eccentric has to be advanced a few degrees beyond 90° to move the valve by the distance of the Lap at dead centres. In practice a bit more advance is provided to give “Lead”. This is marked as “Lap + Lead” in the diagram showing the Stephenson layout for outside admission valves. For inside admission (usual with piston valves), or where there is a reversal of motion through a rocker, the crank would be at Front Dead Centre. It appears relatively simple but in fact design is rather complicated as small changes in the suspension point of the link have a big impact on the equality of events at each end of the cylinder. Luckily the average modeller does not become involved with the details, but he does have to set the gear properly if his model is to run smoothly and “notch-up”.

So how do we set valves when using link motion? There are different ways but the trial-and-error process usually mentioned in 5” or 3½” G construction series is the worst; unfortunately, if a builder starts down this path it is usually too late to change course once the model has progressed. The correct method is surprisingly simple and, as we might expect, it is the way it was done in such places as Crewe and Swindon: why wouldn't the professionals do things the easy way? The Drawing Office designs the valve gear and issues the drawings to the Works where the parts are manufactured and then assembled according to the drawings. This means that eccentrics are

made to the specified throw to obtain the correct travel and they are fitted to the crankshaft at the specified angle with respect to the cranks using keyways cut in axles in accordance with the drawings. The only part of the whole process that needs “setting” arises from the variability of the distance between the crank axle and the cylinders, when setting full size valves $\frac{1}{32}$ ” is significant and variations in horns and cylinder location may exceed this.



Advance Eccentrics by “a”

After erecting the gear as per the drawings this error was dealt with by equalising the valve travel about the centreline of the ports, a task that involved taking rods to the smithy to have them shortened or lengthened, but for our engines adjustment is trivial as they usually have threaded valve spindles. If the thought of keying eccentrics to the axle puts you off (not my cup of tea either) our eccentrics can be fixed by drilling and pinning. The whole process is reduced to making pairs of eccentrics fixed together at 180° minus twice the angle of advance, then holding the assembled pair on the axle perpendicular to the crank, or to the centreline of the valve gear for inclined valves, (remembering that at Back DC they lean forwards for outside admission), finally squeezing in a tiny spot of Loctite for a temporary fit. After re-checking the angle (and handing) if things don't look right the assembly can be freed off using heat to break the bond and another attempt made. When everything looks OK holes are drilled into the axle and the eccentrics are pinned.

The only actual setting required after assembly is just the same as on full size engines but easier: centralising the valve to give equal movements either side of the ports, in our case by adjusting a threaded spindle.

This is really simple and a lot more accurate than fiddling with eccentrics and straps on a part



assembled engine. There is but one problem: does your drawing office provide fully dimensioned drawings including the setting angle of the eccentrics? Well I was lucky as I began with Don Young engines and Don had worked at Doncaster so he showed the necessary details, thereafter I became my own Chief Draughtsman so it was all down to me. I've had a glance at the plans of a few models using link motion and some designers show the setting of the eccentrics while others don't. Designs by Martin Evans vary with some

having indications on the drawing, others mentioning it in the text, some not at all. The GWR 4-4-0s of K Wilson do not have the setting angle on the drawing but there is a reference to it amongst the rambling text. Neville Evans clearly indicated the angle for his HR designs and stated it in the text for his GWR engines.

So what do you do if you already have loose eccentrics on the axle? Put bluntly: you will suffer! If you know the correct setting but have not actually trusted yourself to fix eccentrics, matters are not too bad, you can get the axle out and mount it between centres to fix the eccentrics individually (rather than fitting the pre-assembled pair). With the crank on the centre line of motion put a temporary vertical "fence" (a square) against the eccentric grooves so that both eccentrics are on the vertical centreline of the axle "up-down", then move the fence forward a distance equal to the Advance so that the eccentrics lean forward by the same amount. How much? Either the distance specified or one calculated from the stated angle as "Eccentric throw x sine of the Angle", e.g. for a 10° advance with $\frac{3}{8}$ " eccentric throw the distance of advance is $0.375 \times 0.174 = 0.065$ ". If you do not have a specified advance angle try giving your cylinder and valve gear drawings to an expert to calculate it for you, failing that you will join the group doing things the hard way: by trial-and-error.

This involves temporarily setting the eccentrics to some likely angle using grub screws and noting the extreme positions of the valve during one revolution in mid-gear and then centralising the valve to give equal displacements about the ports. Next, in full forward gear, different settings of the forward eccentric are tried until the required lead is obtained at each end. The real bind is taking off the straps each time to get at the grub screws and avoiding dimpling the axles so much that the screws keep slipping into the dips. This is repeated in back gear for the other eccentric. Returning to fore gear things will need adjusting due to having moved the other eccentric, then of course it will need doing again in back gear. Repeat sufficient times for things to settle down and then pin to axle. Now do it all over again on the other side of the engine. I would like to find an easier way but no such luck. Can you imagine doing this on a big engine? So you see how smart the big boys were at Crewe, Swindon, and the other works