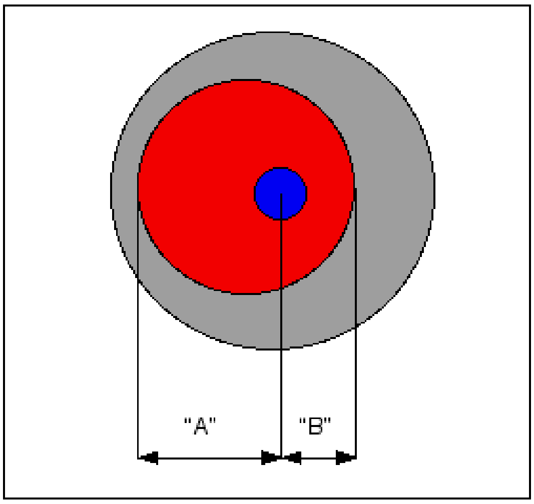
DIY Valve Gear.

In this worked example we will examine a type of valve gear driven by an eccentric and the relationship of the position of the eccentric with relation to the crank. This will be broken up into three sections; The Maths, Design Considerations, and a Design for a loco valve gear.

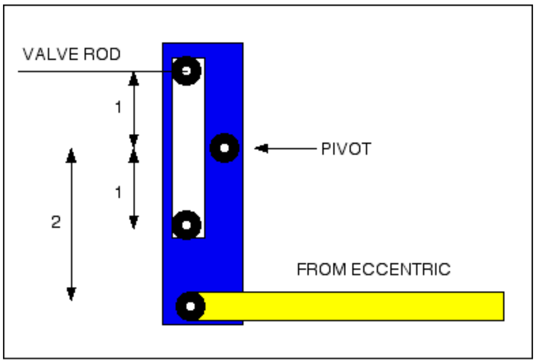
Part 1 -The Maths.

The eccentric provides the forward and backward motion that is transmitted to the valve rod. The difference between them is offset of the eccentric on the crankshaft.



The "Throw" of the eccentric is thus the the length "A" minus "B".

However the leverage needed to operate a valve rod is often higher than that than can be applied directly from the eccentric. This reduction leverage also has the added benefit that it reduces any errors. Let us say that the reduction leverage is 2:1



The slot in the lever enables the gear to be reversed by lowering the connection of the valve rod.

Therefore the movement of the valve rod is half the distance "A" minus "B".

If we assume a 2mm wide slit for the inlets and a 4mm wide slit for the exhaust with a 2mm wide space between them -then the movement of the valve rod has to be 4mm.

Therefore the "throw" of the eccentric has to be 8**mm.**

Part 2 -The Design Constraints.

The **P**rimary **D**esign **C**onstraints (PDC) may listed as follows:

A: Length of stroke.
B: Bore of cylinder.
C: Pressure of steam.
D: Space between chassis rails and axles
E: Reversing

Target application for this motor would be driving the centre axle of an 0-6-0 or similar loco.

<u>Analysis</u>

A: Breaking it down still further -a survey of available driving wheels shows that a normal stroke would be around 25mm. Longer then this would not be useful.

B: A wider bore cylinder would compensate for the short stroke. From a design aspect a "square" engine (i.e. bore+stroke are equal) would provide a better compromise at the expense of using more steam. There should be room for the associated valve gear and steam chest.

C: High pressure steam means thicker pipe work and boiler work. It would therefore be better to design an engine to use lower pressure steam with pipe work and boiler work that could be easily fabricated from common commercial sizes. Since 1.6mm copper is a very common thickness the maximum working pressure of a boiler made with it would be 4 Bar. So, the usable pressure would be lower and it would be reasonable if we take 3 Bar as the maximum pressure fed to our cylinder.

D: This can be defined as an area 50mm wide and 155mm long -assuming an axle separation of 80mm. Into this space we have to squeeze; one double acting cylinder, a central crank shaft , eccentric and reversing gear.

E: This can be done by a screw lift fed from a bevel gear. The slot for the valve rod should follow the curve of the valve rod.

The **S**econdary **D**esign **C**onstraints (SDC) may be listed as follows:

A: Suitable materials.
B: Ease of sourcing.
C: Manufacture.
D: Additional tooling required.

<u>Analysis</u>

A: The common materials used are steel and brass. The problem with brass and steel is water... Normal brass with suffer “De-Zincification” in the presence of ionic water as the zinc dissolves into it. Steel of course rusts... However steam is not an ionic solvent and thus De-Zincification will not occur -thus we **could** use brass for our cylinder. Bronze would be better -but would be more expensive.

Stainless steel does not rust -but is somewhat difficult to work with. This would have to be used for the piston rods -however we could use mild steel for the rest of the construction.

The piston rings and gland seals traditionally would have been made of graphited hemp cord. If we fit a displacement lubricator to the steam supply then we could use modern Flouro Silicone Rubber “O” rings.

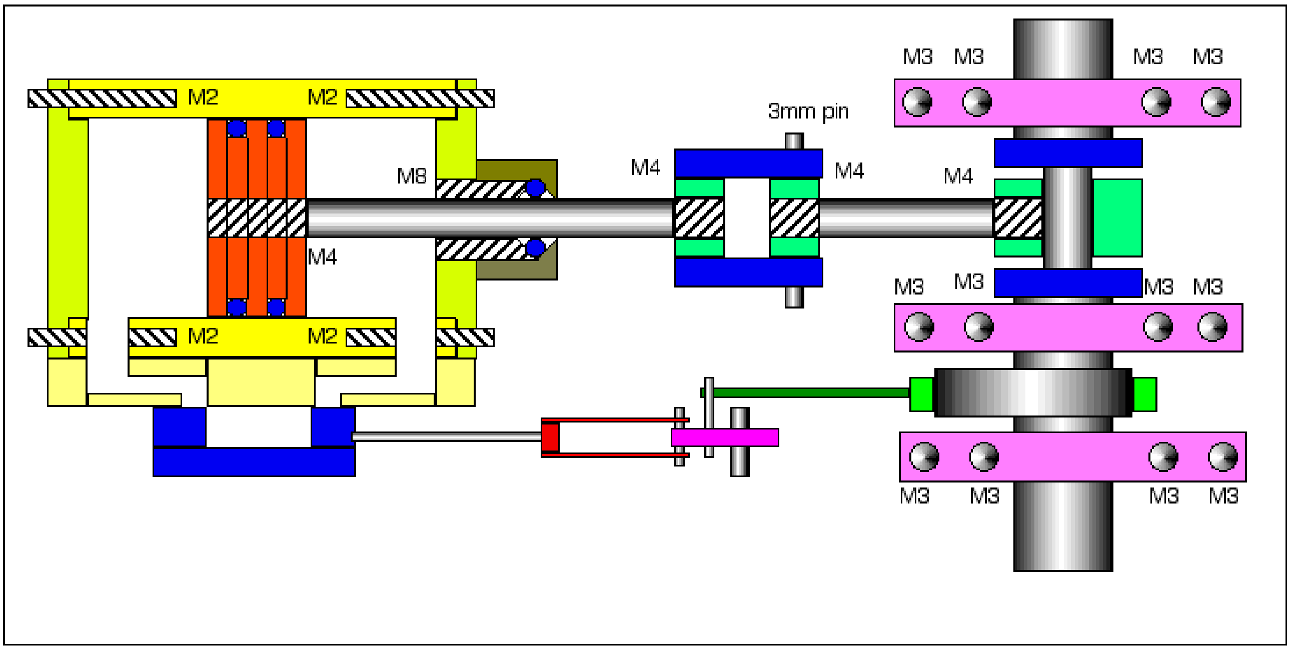
Given the ease of use there is no reason why the engine should not be fitted with ball races -this will save on bushes and reaming.

B: From the results of the PDC(B) and the steam chest means that we can go to fairly large bores, but the available sizes of bar to make the cylinder and piston from -limit this. 28mm is a std size of both brass and bronze bar and 20mm is as well. This would give us a 4mm thick cylinder wall, ample for the job, and it can be drilled for M2 studs to take the end plates of the cylinder. 4mm stainless steel rod is cheap and a commonly held size, 5mm and 10mm mild steel bar will provide the cranks and journal webs. 6mm thick slab steel will provide the bed plate and the pillow blocks for the crank bearings. From PCD(E) the slots will have to be made from brass -both for ease of manufacture and wear.

C: The engine would require the use of a lathe, a milling machine and rotary table.

D: Boring bars, M2 taps/dies, M4 taps/dies, M5 taps/dies, M8 taps/dies etc!

Part 3 -A Design.



The method of transferring the motion from the eccentric to the valve rod has to be compact and rigid. Rather than use a “slip eccentric” the method used here is to use a desmodromic follower. This is a fairly common european pre WW1 method and was used by the M.A.V. & K.P.E.V on several of their shunter designs.