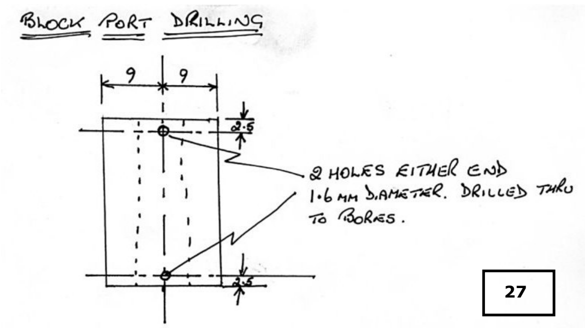
CHAPTER 2

Main Block Mounting Holes

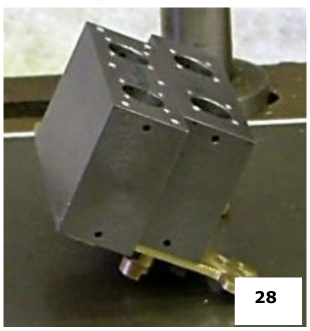
The first thing to do is to get a few more holes into the main block.

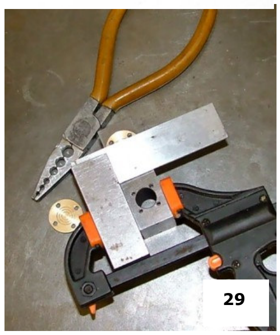


27

If you check the first sketch (Pic 27) it shows the positions of the four ports that are going to be feeding steam to the top and bottom of the pistons. It is fairly deep drilling but if you take it steady there should be no problems.

Pic 28 shows the holes**. DO NOT** deburr the ends of the holes on these, we need them nice and flush.


28


29

First Holes: Top caps and gland seals

I have taken a picture (29) of how to use a square to get your holes looking neat; i.e., square to edges. Once you have them (caps/glands) in the right position, dab a couple of drops of superglue around the edges and let it go off for a bit. (Confirmation: It is the top caps and glands that you stick down while you spot thru with a drill.) Cunning don't you think? And the glue just scrapes off easily afterwards.

30

Anyway, get the drill that you used for drilling the holes in the caps and just spot thru to give you a dimple for your centre drill to pick up on. Tap the caps off and just centre drill all the holes, followed by either a 1.5 or 1.6mm drill to a depth of about 8mm. for the top caps it is not too important, but for the glands I mark the gland and the block to keep them as matched sets.

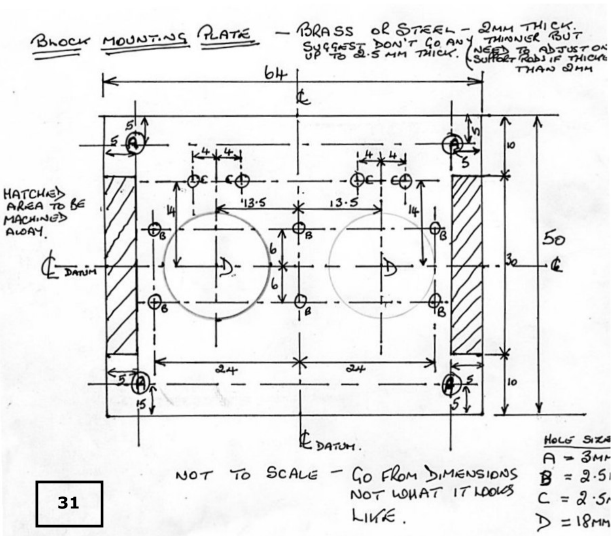
You should now have all the holes in fairly good register (Pic 30). Now 'just' tap them all out with a 2mm tap (or if you are using BA or similar use whatever drill and tap that is required).

Forgot to mention: do one end of the bore first then clean off and proceed to the other end, otherwise you will find it wobbling all over the place as you try to drill.

For tapping small sizes I always use a hand tapping fixture that I made using an old surface plate (this is what I take most of my pictures on), but Arc Eurotrade sell them for about £35+, I have very rarely broken a small tap when using one of these as you have a lot more 'feel'.

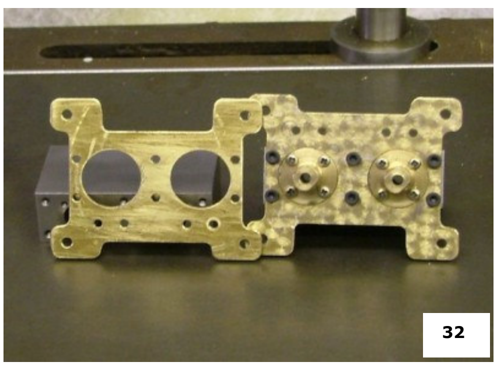
Another tip here: you will notice in Pic 29 a weird set of pliers. Go to the pound shop or market and buy a couple of cheap pairs of electrician’s pliers, hold the jaws slightly apart with a bit of metal shim (Pepsi Max) and drill thru holes, any size you want to hold, I have two pairs - one metric up to 6mm and one imperial up to 1/4"; you will find these are indispensable when you hold shafts when tightening (no marks like mole grips leave), and great when grinding bolts to length.

Second Holes: Block Mounting Plate



Fit the glands to the block, and make the support plate (don't worry if your plate isn't exactly the right thickness, but don't go too thin, as we can fix that when we come to fit the main block to the crankshaft area). Yet another of my grotty sketches (Pic 31), and spoiling you lot as well, I've used a ruler this time, again it is self explanatory except that on the photo (Pic 32), it shows more cut-outs: this is me again, tidying things up and reducing weight. Not necessarily needed - you can do it if you want to. You will also notice I have done a bit of rough engine turning on the plate, this is a very easy way to cover up all the marks and scratches from the plate being kicked around the scrap-mans floor, if you want to polish it go ahead, it will be your engine.

The large holes in the plate are to go around the glands, if you are not up to doing these, no problem.



As long as the six holdown bolts for the plate are there you can make these square, triangle, oval or any other shape that takes your fancy. The reason I did it this way was to accurately locate the mounting plate around the glands while the holes were spotted thru, the plate has to be VERY square to the block for the crosshead to function properly. But again things can be 'made' to work if not quite there, how to do this comes later, don't need to worry about that yet.

Drill and tap the block for the six mounting screws (B on the sketch) 2.5mm by 10 deep, and bolt the plate on.

Note that the plate hold-down holes could in fact be drilled straight into the block using the dimensions on the drawing rather than being spotted thru.

“Tweaking” Tips

Now you have got the holes drilled and tapped we can give you a bit of 'tweaking' power.

On the glands only, reduce the 18mm O.D. by 0.1mm and the same amount on the spigot that fits into the bore. You might find now that the piston is a lot freer in the bore and if not totally concentric with the shaft will allow you to spin it a full 360deg. rather than binding up.

Tighten up when all is running free. If you still can't get a full rotation on the piston, just stick the piston assembly back in the lathe and dress it again with emery cloth on a stick (as previously described) until you get the desired result.

We will get back to the block later, after we have finished the crankshaft, as I have to design the cams for the piston valve and the valve area itself towards the end of the build (God, I hope this engine works, I will have people chasing me round with axes if it doesn't), think positive, how hard can it be, all will come right in the end.

Hopefully next we will be getting the crossheads and pistons into unison, something that moves that you can play with and really impresses the neighbours (I'm talking about the engine bits), plus a start on the crankshaft area.

Engine Turning

What I call engine turning, I use to cover up badly scratched bits that would need a lot of cleaning and polishing otherwise. But it can also be used for decorative effect.

All I use is a piece of dowel or soft metal with the end faced up in the lathe. Then it is mounted into the chuck of your pedestal drill, with the faced end downwards towards the job, put a bit of grinding paste on the faced end and go thru the motions of drilling the plate but in fact all it is doing is scratching a pretty circle.

Move the plate along a bit and repeat, move the plate along a bit and repeat, move the plate along a bit and repeat, move the plate along a bit and repeat, move the plate along a bit and repeat, move the plate along a bit and repeat, move the plate along a bit and repeat, move the plate along a bit and repeat and so on until you have a pattern that takes your fancy.

If you don't like the pattern, start at the beginning and go over the old pattern.

You don't have to use grinding paste, metal polish, a bit of emery stuck on the end, toothpaste, in fact any abrasive material will do, and they all give variation to the depth of pattern.

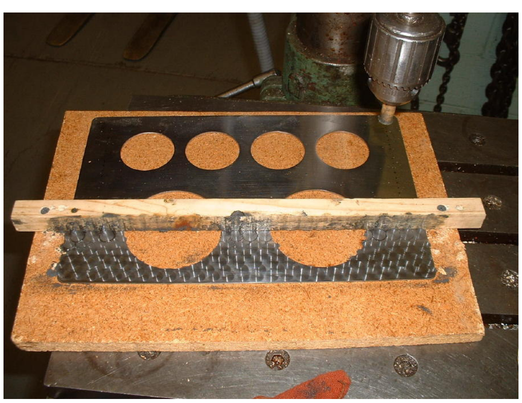
If you mount the job into a cross vice and take your time very regular patterns can be produced using this method.

My ex friend's (now no longer with us) son works for Bentley motors and suggested this for their dashboard; it was taken up and is now standard fitting, but they black anodize afterwards. So if it's good enough for them........

Have a go and play about, soon everything in your boat will be engine turned. I made an oscillator for a model shop owner in Frankfurt, Germany for his collection to put on display in his shop, I did 4mm engine turning on every flat surface of the engine, using metal polish, the result looked spectacular.

For those who would like a bit more info on engine turning, the first link is to a chap who makes a living at it, the second link is another type using what is called a Rose Engine, mainly used by watchmakers and jewellers. http://www.cs.ucr.edu/~eamonn/et/et.htm http://www.rgmwatches.com/engine.html

A

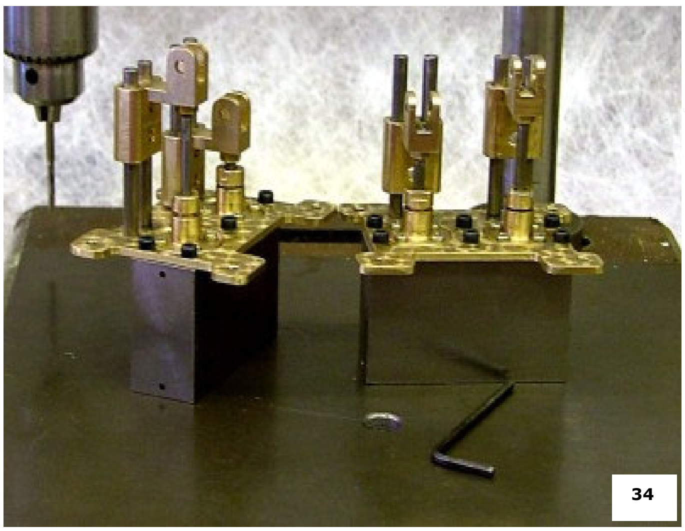


Editor's note: Picture A shows one approach to a set-up for doing simple engine turning. (See Post 12-28-2005, 07:05 at forum http://www.hotrodders.com/forum/take-stab-engine-turning-77222.html)

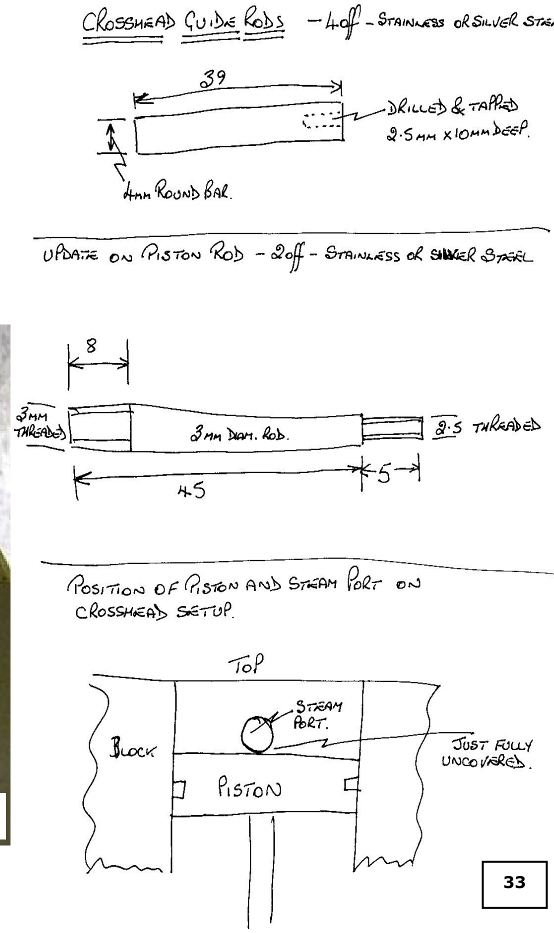
Crosshead Support Bars

Back to the build, very little tonight, just a sketch (Pic 33) showing the crosshead support rods and the now finished to size piston rod, plus how the top of the piston and steam inlet hole should look when setting up.

Pic 034 shows my two engines with the area totally assembled.



34



33

Building Up

As you assemble put a spot of oil on all parts. Screw out the gland compression screw by about 1mm, and then insert the piston and rod through. Now slacken off the holding screws on the gland and position the gland on the bottom of the block until you can get a free full up/down movement and a full 360 deg. rotation of the piston and rod without it binding, once you have this tighten up the screws and recheck.

Screw on a 3mm nut onto the end of the piston rod and follow it up with a crosshead, screw all the way on. Move the crosshead to a clear area of plate and push it down all the way, the piston should be near the top of the bore.

Lift the crosshead 1mm away from the plate and adjust the screwed-in piston rod until the inlet hole at the top of the bore is only just totally uncovered by the top of the piston (see sketch). Tighten up the locknut (not too tight, they have a tendency to deform things if too tight).

Put one of the crosshead support rods thru the crosshead and screw it to the plate. If the crosshead has locked up, slacken off and adjust until it frees off, then put the other rod thru and do the same. All mine locked up totally solid, so I gave myself a bit of movement by opening out the support rod screw holes to 2.7mm. Do NOT on any account touch the piston rod/gland/crosshead assembly; all adjustment is done on the two rods. It took me about an hour to do the first one and about 10 minutes each for the others.

All adjustments on the rods should be with the crosshead against the plate; it is just a matter of slacken off, turn rod slightly and retighten, try again.

It also helps if after tightening to tap the blocks with a plastic screwdriver handle; nothing heavier unless you get really piddled off - then a 7lb lump hammer comes into its own.

What you want to end up with is the piston being able to go through its full travel without jamming up; slight finger pressure is great but if you have to push a bit it should be ok, we will use the engine itself when completed to sort itself out. I check by putting the piston at the top of its stroke, block the end of the cylinder with my finger and put a bit of air into the steam port on the side, keep your fingers away from the crosshead, it comes out with a bit of force.

After all this by the way, it has to be stripped down at the end to finally seal, but you will have a lot more experience by then and you will be able to do it in minutes.

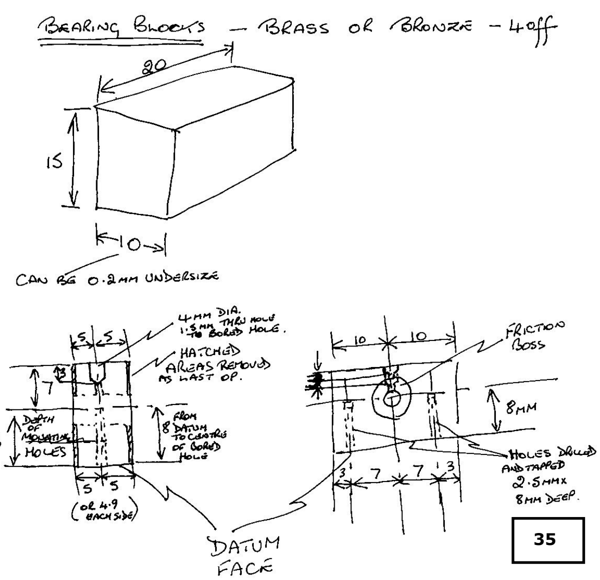
By the way, an engine doesn't come to life until you have some of your own blood on it; just try not to make it too much.

The next time I will be starting on the bottom half of the engine. Some of the bits are common to my last engine so it should progress a little quicker. Going now to my scrap-man box to see what I have to work with.

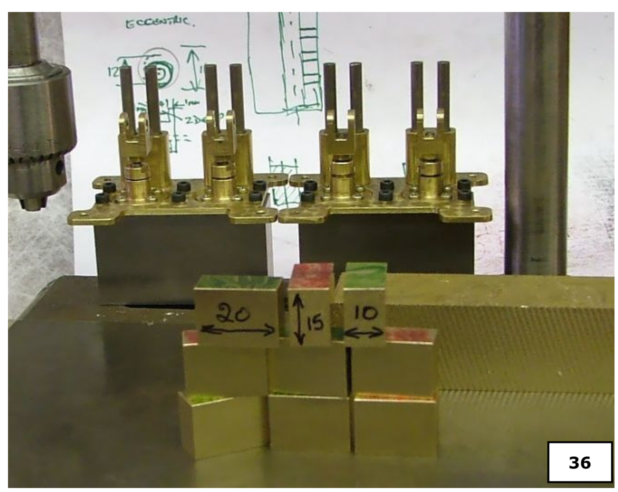
Bearing Blocks

This is just on one subject tonight – **Bearing Blocks**: it has taken me all day almost non-stop to get these made.

There is as usual one of my quickie sketches (Pic 35).



35

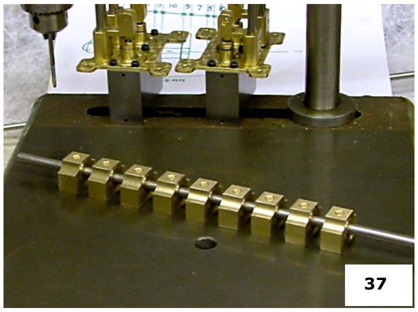


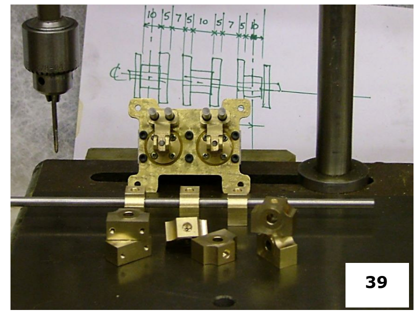
36

Pic 36 show the raw blocks and the piece of metal they were hacked out of is in the background.

You will notice that the blocks have colours on them: the green is on the datum face and red on the opposite end to aid identification. This datum face is critical as will be explained later.

Pic 37 shows a row of blocks all in perfect register with regard to height. Pressure can be put across all the blocks and the shaft still rotates. Pic 38 of the lathe setup shows the last operation on the blocks. Pic 39 shows completed with all operations carried out.





Now the long winded explanations.

The blocks should be made to the sizes stated; in fact the 10mm size could be made maybe 0.2mm undersize: it will allow a bit more freedom when we get to the big end area. It will require four for this engine; I usually make an extra one or two just in case of mistakes, but this time I ended up with all perfect.

The reason for the coloured marking is now explained. Mark a datum face on every block on a 20mm x 10mm face. This is the face that is always against the fixed jaw of your vice when boring the 5mm thru hole. Everything else on the bottom end of the engine can be tweaked but not the fixed height of the hole unless you have a long 5mm reamer to line ream.

After every block is bored the whole vice area has to be cleaned - a small amount of swarf can throw the height of the hole out completely. I use back stops to aid positioning, thus I just have to position a new block and tighten the vice, no slide movements at all during the hole boring procedure.

If you are lucky you should be able to put a 5mm rod thru all blocks, put them down on a flat surface and apply pressure to the tops of all blocks: the rod should still be able to turn. If not one or more hole heights are incorrect and will have to be sorted before going any further, maybe by putting shims under the low hole blocks: do **NOT** remove metal from the others to get them lower. *(Correction: Before we start with the next thrilling instalment, I made a mistake about the height of the bearing blocks and if you had any that were low you should shim them up. I had forgotten that we have adjustment to cater for this later on, so you can in fact reduce the height of the others to match. The easiest way is to put a rod thru them all and flat down using abrasive paper and a flat plate, something like a piece of glass.)*

Assuming all is OK, we can carry on. Instead of external oil cups, we are going to build them into the blocks. Just drill thru where shown with a 1.5mm drill, and then follow it down with a 4mm drill for a depth of 3mm including the drill tip. Spin the drill or reamer in your fingers you used to bore the hole in the crankshaft hole to deburr the oil hole. Job done.

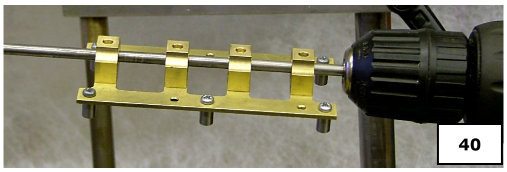
Turn block over and drill and tap 2.5mm the two holes on the datum face. Don't forget to put a small chamfer on these holes otherwise it will throw the height of your crankshaft hole out.

The last job on each block is to machine a small boss on each side. The reason for this boss is to reduce friction, because we are not fitting bearings into this engine. If the crankweb comes into full face contact with the block there would be a lot of friction produced; by using this little boss, friction is reduced to a minimum.

Turning the boss. Get one 5mm bolt and cut the head off. Put cut off bolt into chuck with threads sticking out and tighten up really well. Now just put a block onto the threads and put a nut on and trap the block between the chuck jaws and the nut (look at lathe setup - Pic 038). Bring the lathe tool into contact with the rotating block face until it just touches. Stop the machine and lock the saddle if you can. Wind tool off block and using the topslide, put on a cut of 0.15mm (0.006"), now start machine and cut across the face until it nearly gets to the nut (not critical), now wind out on cross slide and stop machine, turn block around so face just machined is against the chuck. Repeat the process on the other end. Do each block the same; the bosses might not be concentric with the bored hole but it does not matter.

Blocks made, deburr and smile, the critical bit is over. Next will be the baseplate and hopefully crankshaft.

Tip- Lapping Bearing Blocks

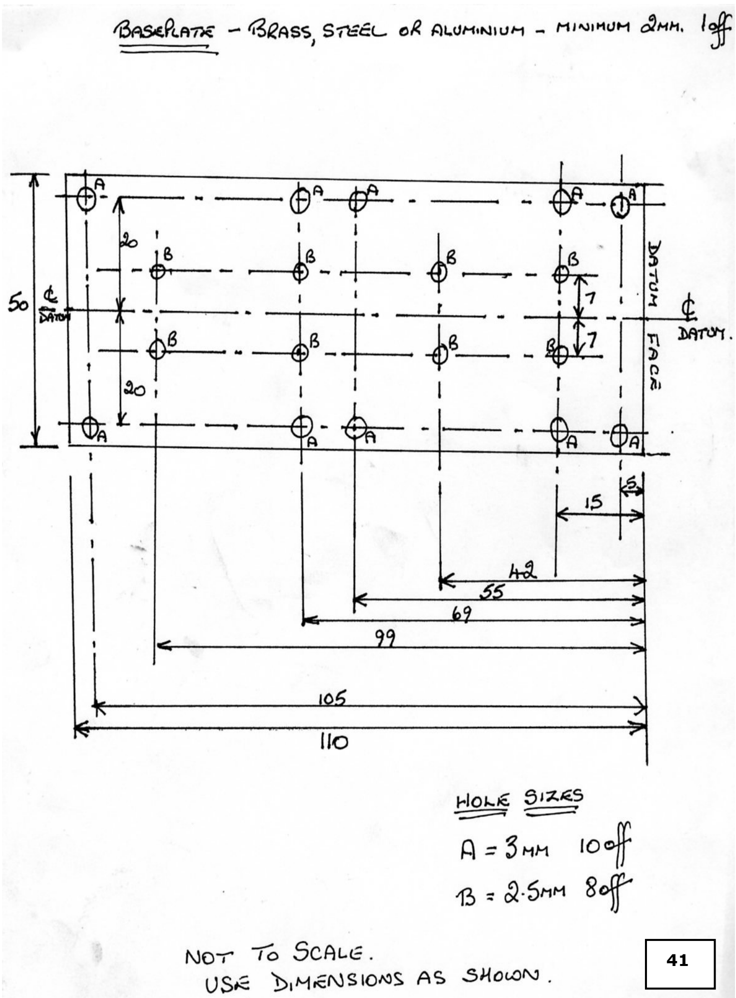


Pic 40 shows how I lap in the bearing blocks. The rod is about 1 1/2 times the length of the bedplate and is the same material as will be used for the crankshaft centre rods, 5mm stainless or silver steel. At this stage the rod is very tight in the bearings. Put a little bit of metal polish or T-Cut in the lubricator pots, hold onto the plate and turn the battery powered drill/screwdriver on (I wouldn't recommend an electric drill, too fast unless you have speed control).

Hold tight to the plate in the beginning, it will try to spin round with the shaft, if too tight hold plate in a vice until the parts start to rotate a bit freer.

As it starts to free off, slide the plate and blocks up and down the shaft. After about 10 minutes of this you should find that the parts now move a lot freer. Clean off everything very well to get rid of all abrasive. Put some 3 in 1 oil or something as thin into the oil cups and spin the shaft, it should be nice and smooth. This shafting can be used for making the crankshaft rods; we have only taken microns off the OD.

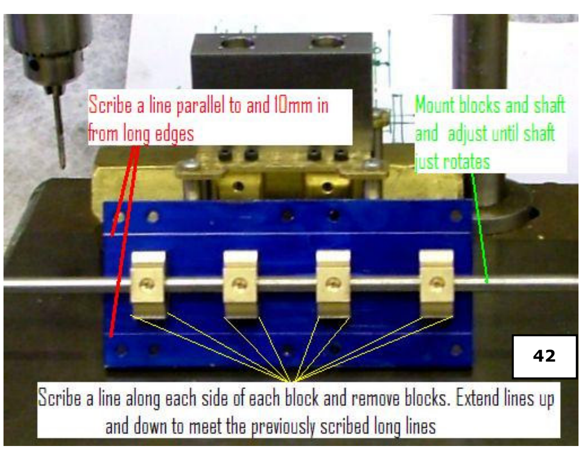
Baseplate

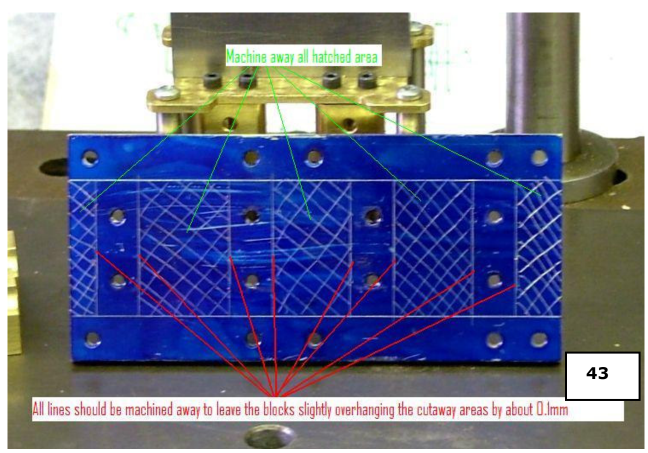


Tonight’s offering is the baseplate**.** I am making mine out of 2mm brass, the same as the top plate, and using standups underneath to give clearance for the crankwebs. This method is a bit flimsy but it is designed to bolt to the boiler and engine support plate, so making it totally rigid. If you wanted a free standing engine you could use thick aluminium plate but a minimum of 12mm thick; you would have to counter-bore underneath to set all the mounting screws in but it should not be a problem.

First off is a sketch (Pic 41). On here, just follow the measurements to make the plate, but please be aware of the datum lines: one is the longitudinal (that’s a big word for a Monday night) centre line; the other is one of the short sides.

All measurements are from these two datum lines.

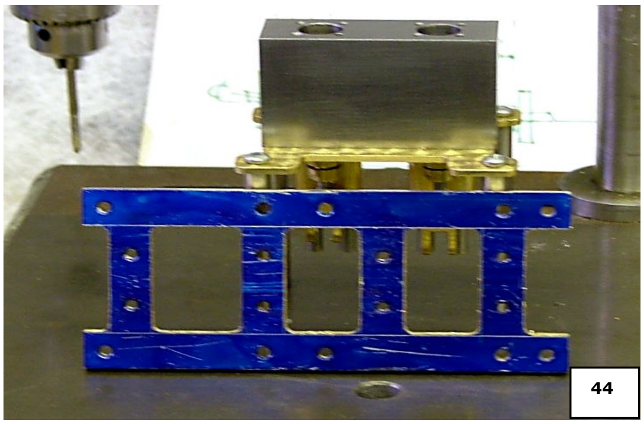


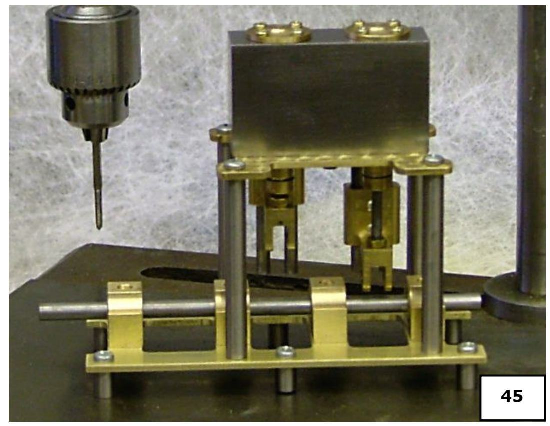


All the photos should be self explanatory, except for the following:

(1) Pic 44 - you will notice the corners of the cutouts are rounded off. I used a 4.5mm cutter but I wouldn't go any larger than 5mm otherwise the crankwebs might foul on the corners.

(2) Pic 45 - simulating an engine build-up. The rods on this are not the right length and will in fact be a bit longer, the feet under the plate are approx what it will be like, they have to raise the plate because that cranks have to protrude thru the plate.





Comment - Boiler

> *Another superb instalment John, and I'm still feeling that this isn't totally beyond my capabilities which is amazing!*
>
> *I realise this is jumping ahead a great deal, but I do hope you'll continue on to include making a boiler, burner, condenser etc, etc, so that we eventually end up with a complete steam plant? And maybe even consider a short discussion on any modifications that would be needed to convert the engine to a horizontal/diagonal type more in keeping with the majority of paddlers?*

With regards to making a boiler, I have built a few in my time, even gas fired ones using the same technology as they use nowadays, but to cut a long story short I don't fancy starting to make boilers again when there are perfectly good boilers to be had at very reasonable prices from the professionals. Besides the fact I have seen some boilers that people have tried to make in their garden sheds using small gas plumbers blowlamps.

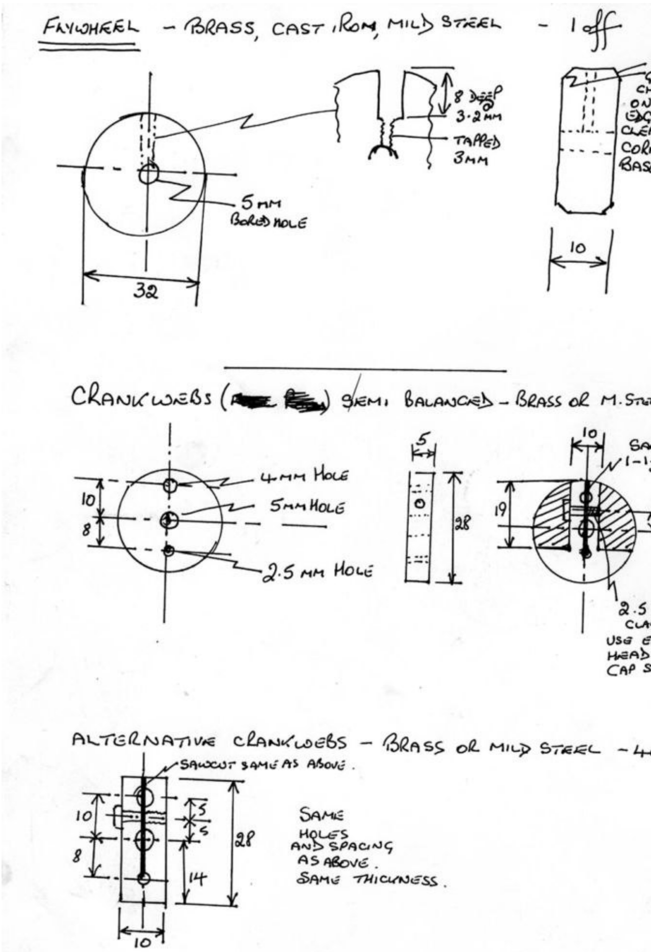
I am not saying that it can't be done, and again I have seen some great ones, but the thought of me giving free reign to someone to attempt to make a boiler to my specifications, I'm very sorry but NO, I just couldn't bear the thought if someone was injured. Leave it to the professionals. I saw a chap once pressure testing the thing he called a boiler; he had it weighted down with a brick in a bucket of water and it was directly connected to his compressor, he was standing over it to see if there were any bubbles, you couldn't see my a*** for dust.

I am already looking at turning one of my engines into a horizontal, but it looks like it will be a bit more difficult than my oscillators.

The main problem is the pipework - if I can get it compact enough I will give it a go. I don't think it will look very pretty, in fact downright ugly (just like the ones we are building here), but as I said at the start of this project, it is a design and make as I go along and I don't even consider aesthetics, just make it simple and make it work, that even a beginner has a chance of completing. In fact it might be easier to design a purpose made horizontal, I will get some fag packets together and see what materializes.

With regards to a lathe, don't blame me; it was your suggestion in the first place. But for the cost of a small lathe and all the related bits is less than the cost of a moderate kit, it does open up a whole new world in the term 'modelling'.

Crankwebs Part 1 – Blanks (and Flywheel)



46

As usual there is a sketch (Pic 46) for items to be made. The flywheel can be made as is or like I have done, put a recess in each side for cosmetic effect.

There are two drawings for the crankwebs, one semi balanced and the other a lot easier to make but not as nice cosmetically.

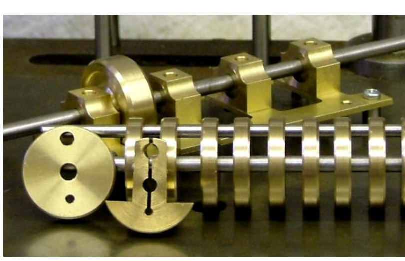
47

Pic 47 shows the rough blanks for cranks and flywheel and the scrapman’s bar end that they came from.

48

Pic 48 is the blanks ready for precision drilling. The distance between the crankpin (5mm) and the big end pin (4mm) is critical and should be drilled using machine cross slide for the setting. The distance isn't critical, but they must ALL be the same.

Pic 49 shows what you should be aiming for: all ten of my discs slide easily onto the two different diameter rods; I must stress again THEY HAVE TO BE EXACT for this design crankshaft to work. The 2.5mm hole is not critical.



49

Also shown is what the finished semi balanced crankweb will be like. I should get them finished tomorrow.

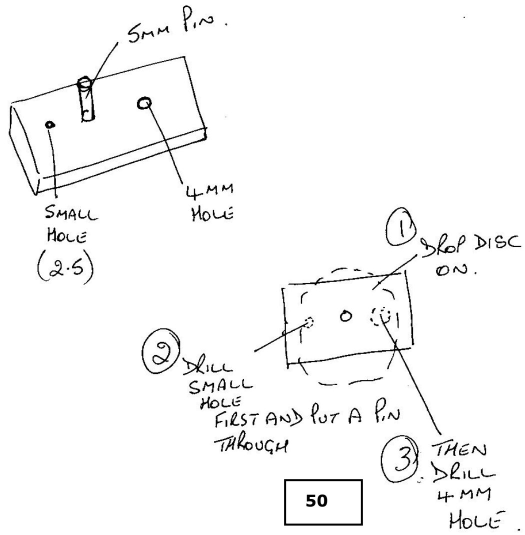
Next hopefully is building up the crankshaft

Comment - Crankweb Fabrication & Jig

> *Hmmm... The first bit that has really worried me!*
>
> *It looks like a fraction off with the drilling and either it won't fit together at all, or it will lock up as tight as a ducks whatsit!*
>
> *Would it be better to drill all the holes in one solid block and then part it off into the separate bits that are needed?*

At last, now we are getting there - you are starting to think like a model engineer. Problem solving is about 90% of the job when tackling something like this. It should be "How am I going to make it?" for every part that is not self explanatory. This is the satisfaction I get from making things out of all sorts of materials.

The only problem with your idea is getting the hole to drill perfectly straight when going so deep. Its about time people started to worry about making things shown here and ask the question, I have already done it so I can supply the answer, if you don't have the same machinery that I have, I can come up with another way for it to be done. There are lots of ways to solve most of the problems. Making a little jig is the usual way to do it. .



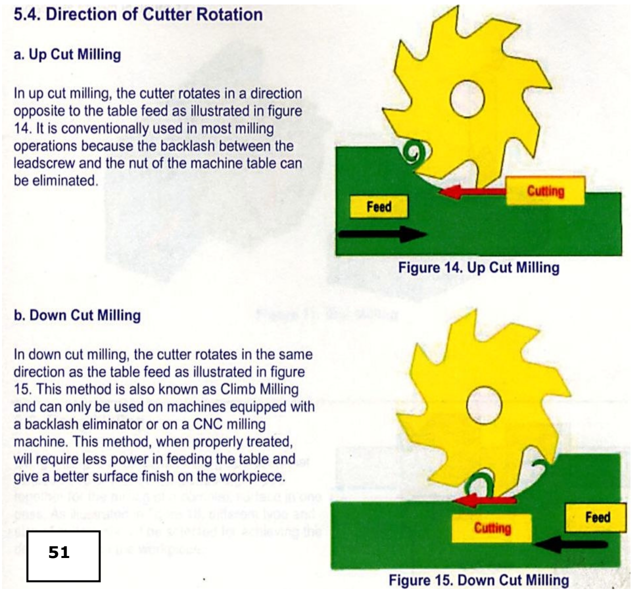
50

The easy way is to make a jig out of steel (see Pic 50) and follow the instructions.

The way I do it is to set stops for the part to sit against in the vice, and after the first one as long as you do not move any machine settings it is just a matter of dropping the next piece in and drill and so on, I drilled all ten of mine after the initial setup in less than 15 minutes (I deburred each part after it was drilled, and blew away the swarf before the next one). The small hole is drilled later, that isn't critical: it’s only a pivot point for the metal to distort around.

I think from now on for difficult bits I will take a photo of my setup, but most of the difficult bits have now been done. Ah well, we'll get it right one day.

Milling Caution


5.4. Direction of Cutter Rotation

a. Up Cut Milling

In up cut milling, the cutter rotates in a direction opposite to the table feed as illustrated in figure 14. It is conventionally used in most milling operations because the backlash between the leadscrew and the nut of the machine table can be eliminated.

Figure 14. Up Cut Milling

b. Down Cut Milling

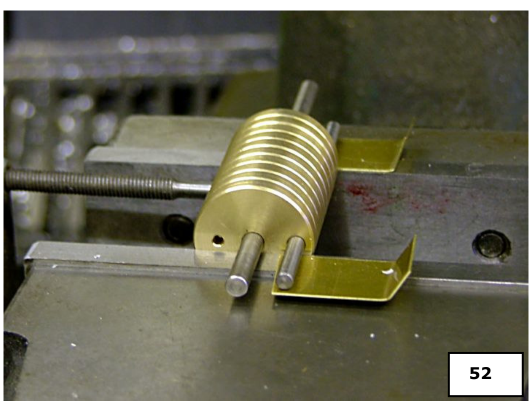
In down cut milling, the cutter rotates in the same direction as the table feed as illustrated in figure 15. This method is also known as Climb Milling and can only be used on machines equipped with a backlash eliminator or on a CNC milling machine. This method, when properly treated, will require less power in feeding the table and give a better surface finish on the workpiece.

Figure 15. Down Cut Milling

Due to the normal types of machines, either lathes with a vertical slide or the general purpose milling machines (like mine and 99% of most people) you should NOT be doing any CLIMB MILLING unless you really want a new facial feature that looks decidedly like the job you have in your vice, and maybe the cutter as well.

You only do a cut one way: CUT, rewind back, put on new feed, CUT. Slower but safer. DOWN CUT or CLIMB MILLING should only be done by experts with the correct type of machinery, and this is one of the main reasons amateurs like ourselves (and I have done it) have ruined a perfectly good job because we put the cut on the wrong way.
You should only be doing CONVENTIONAL or UP CUT Milling. Pic 51 is a copy out of a machine manual that explains it very well, if you can't understand it, just ask.

Crankwebs Part 2 - Shaping



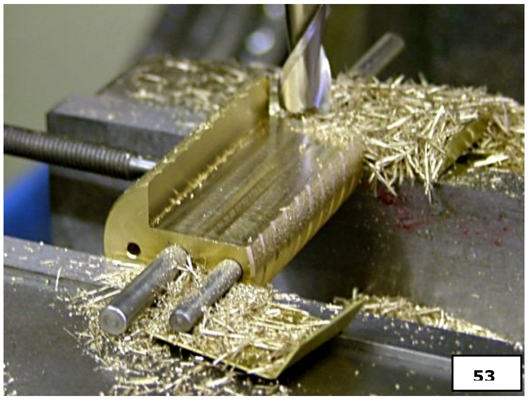
Pic 52 shows all my crankwebs mounted in the vice. The cunning bit is the bits of brass you see there. We are going to use the accurately drilled holes to our advantage.

There are two different sizes, 5mm and 4mm. If we get the centres at the same height it will be just an easy machining job. To do this by the way, when your vice jaws are tightened together they should be in line with each other and also the tops of the jaws need to run parallel with the end of the cutter in your chuck. Whenever I invest in a new vice the first thing I do is grind the tops of the jaws parallel to the base, for just this sort of job.

If we subtract 4 from 5 this gives us 1; half it and we get 0.5mm. Now search high and low to get some material to use as shims, anything solid, metal, plasticard, even shim stock if need be, of 0.5mm thick.

Put the job into the vice like shown on the Pic 52 and slip the shims under either side of the 4mm rod, push down and tighten the jaws. This now ensures that all machining is now parallel to the hole centres. This trick can be used anywhere you want to machine parallel to two hole centres.

You will also notice I am using a back stop again, this allows me to reposition the job after the first side is cut and use the same settings again, it all saves time, and they are so easy to make. I have even superglued a piece of metal to the inside of my vice jaws to act as a back stop when the diameter of my backstop rod was too large.



Pic 53 shows the first side machined: flip over and machine the other side, using the same setup.

Pic 54 is the finished job. Ten crankwebs machined in less than 30 minutes.

Pic 55 uses the same setup for using a slitting saw to put the slot in, but two things here, after you have tightened up, remove the rods otherwise you end up with half round section, and don't try to do more than one at a time, it is by leaving the rods in for strength we can get away with it for milling the webs.

You don't have to use a slitting saw: a bandsaw or hacksaw will do the job, it isn't critical, but my way makes the bits look pretty.

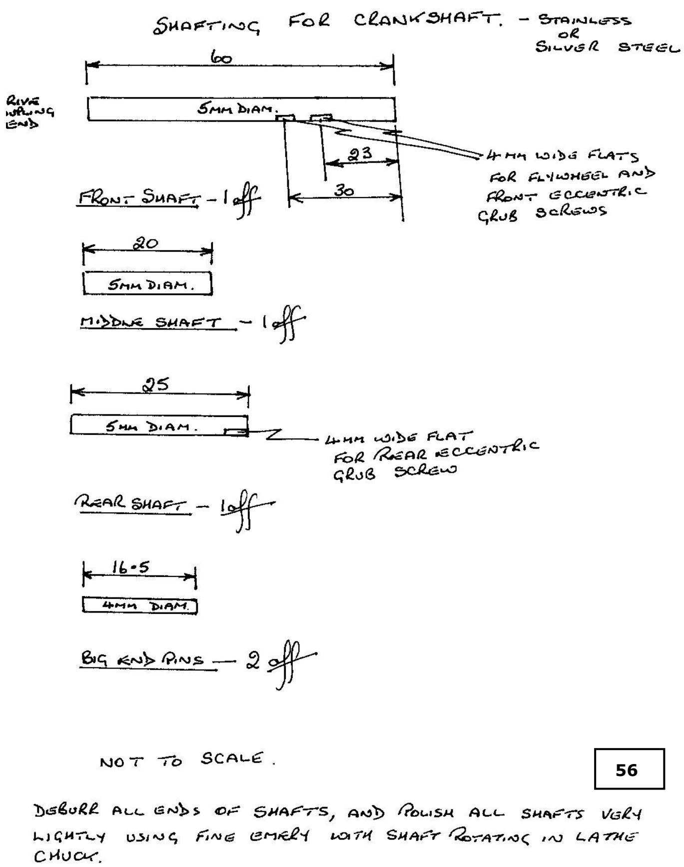
Tomorrow we will get all the crankshaft completed and we will see if my calculations are right and it rotates.

Crankwebs Part 3 - Crankshaft Assembly

Hi All, Back again. But not getting any feedback to see if anyone is still interested.

Who was the idiot who suggested building a composite crankshaft made up of thirteen separate parts (5 shafts, four webs and four cap screws)??

Assembled it all: like trying to juggle with half a dozen kittens. Tightened it all up and the damned thing rotated perfectly, no fiddling, filing, nothing. So assembled the second one, exactly the same. So nothing else to do but carry on. I knew something would go right eventually.



56

The sketch (Pic 56) shows the different shafts required for the crankshaft, do not go over length on any of these, if anything slightly shorter (approx 0.1mm). It doesn't matter on the 60mm long one; this can be any length you like as it is the one that connects to your prop shaft.

When built there should be no shafting protruding anywhere into free space on the webs. The flats on the shafts are to allow grub screws to be fitted and the bruising to the shaft that they cause does not interfere with disassembly of the parts because the damage is on the flat rather than on the periphery of the shaft.


57

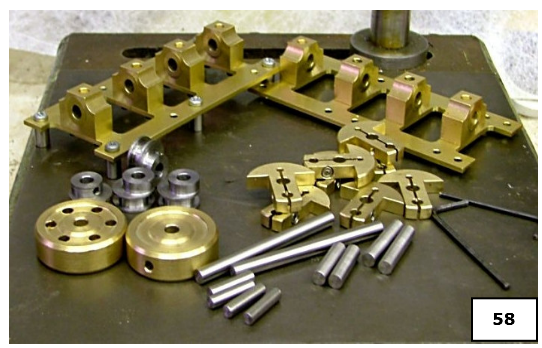
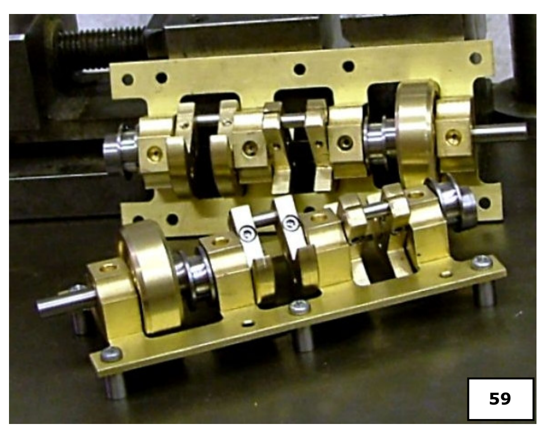

58

Photo 57 shows another way for machining the webs. I made a small shaft with about 5mm either end protruding out of the webs, these sticky out bits were turned down to 4mm (the same as the smaller shaft) and extended slightly inside the web. This method cannot be used where the shaft has to be removed for machining (cutting the slot) because the vice jaws prevent it from sliding out.

Pic 58 shows all the bits for crankshaft assembly (my flats are not machined yet).

Pic 59 is the built up crankshafts, looking like they are ready for business.


59

My next job will be to make the bits to join the top and bottom together, namely the connecting rods, their screws and the support columns. Have got a bit of work to do on this yet as I need to keep the height to a minimum, so it will be conrods first then make columns to fit.

Comment – Crank Positioning

> *When I look at the electronic pages of steam engines by Daniel Bourard I see crank positioning referenced as degrees, minutes & seconds & naturally the same for the eccentrics JMC [even after spending 610 EURO] will not release any working detail on this issue*
>
> *So is this positioning a BLACK art or what & how do you achieve it ?*

I think you are confusing your very well made and complicated slide valve engine with this simple piston valve design. The timing is almost exactly like an oscillator where each crank is at 90 deg apart (this gives it it's self starting properties), as for the port timing, Sandy explained this to me on a previous post about piston valve timing and basically the ports start to open 90 deg before the piston crank, at least I think that is what I mean. I wouldn't even know where to start on timing yours, maybe Sandy can help.

Did some prelim work this afternoon on the conrods, made a couple out of plasticard to get the right stroke so hopefully tomorrow top and bottom will be connected.

Comment – Crankshaft Construction

> *This method of crankshaft construction is quite common on small model engines, Saito use a similar system, as do I on some of my engines. It certainly is easier, cheaper and a lot quicker than turning the darn thing from a solid billet, however, it does have limitations.*
>
> *The other point about this type of construction is the more simple method of making the crankshaft bearing blocks, which can, as yours are, be simple bored blocks. A fully turned crankshaft would need to be mounted in split bearing housings, possibly with split shell bearings as well, which are much more complicated to make and accuracy levels necessary are that much tighter.*
> *With this method, it is also possible to use ball races on all bearings, which would not be possible with a solid turned shaft, at least not for the centre bearing/s. On larger engines it would be possible to use split roller bearings on the inner journals, however, for these small engines such items are not readily available. (at least not at a practical cost)*

Comment – Valve Timing

> *Valve timing..... The inlet port should begin to open when the piston is at top dead centre, or just leaving it.... with a simple piston valve, as John is using, this means that the crown (high point) of the eccentric must be ahead of (lead) it's associated crank pin by 90 degrees. This angle is quite critical and therefore must be accurately set.*
>
> *The crank timing of 90 degrees between cylinders, which is not overly critical, +/- a couple of degrees would not cause any real problems, has nothing to do with the valve timing, this is, as you say, to enable the engine to be self starting.... however, this is only true when using double acting cylinders. (You would need 4 single acting cylinders, each set at 90 degrees to each other, to achieve the same effect)*
>
> *D..... your JMC also has 90 degree crank spacing, however, since it also uses Stephenson link valve gear with 2 eccentrics per cylinder and probably also employs some valve lap and/or lead, then the eccentric angles will not be at 90 degrees, but would be set at some angle as dictated by the valve gear type and the lap/lead requirements. The next instalment of Steam and Steam engines will be dealing with just this subject, so hang on just a bit longer and you will be able to read all about it.*