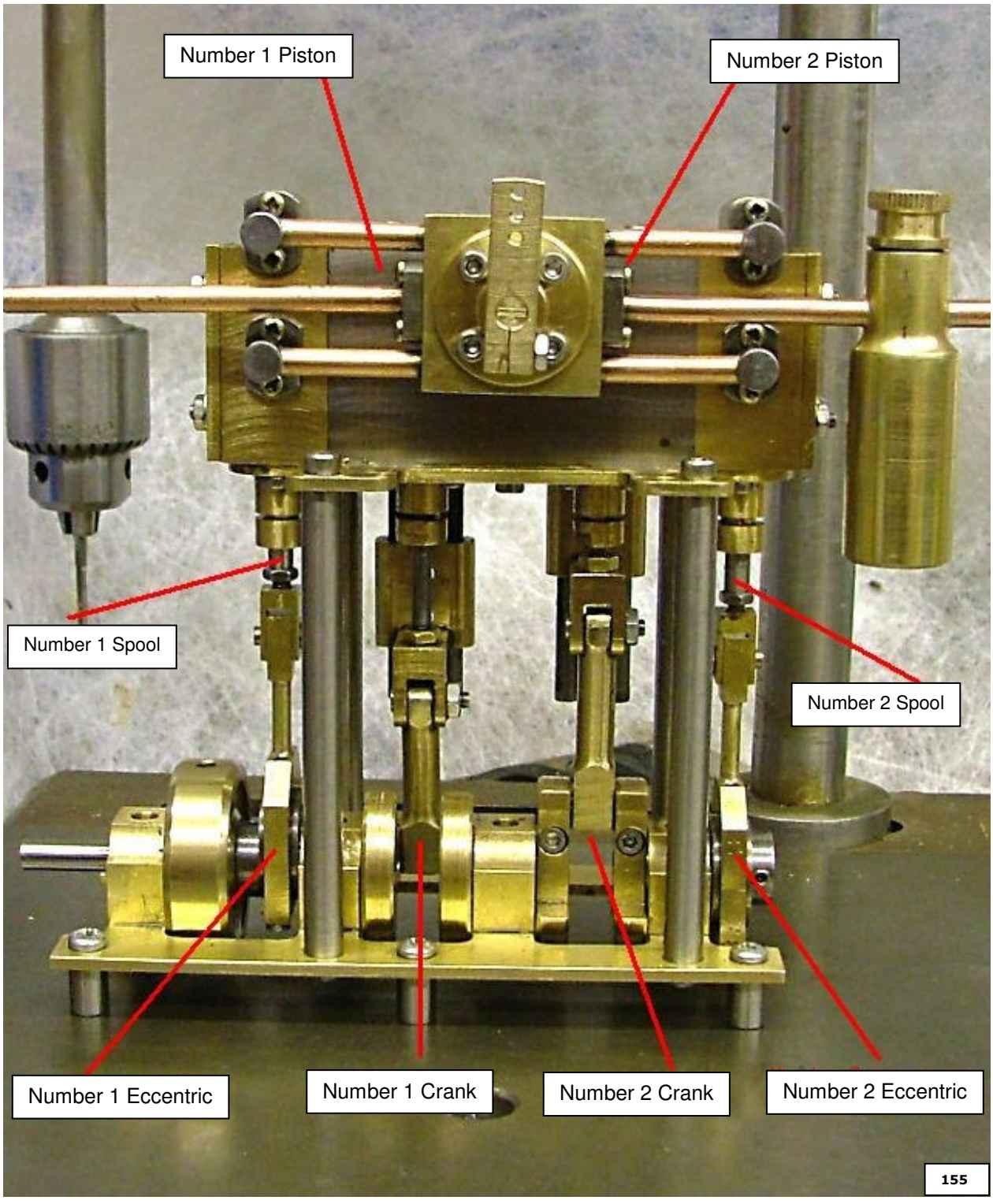
CHAPTER 6

Valve Timing

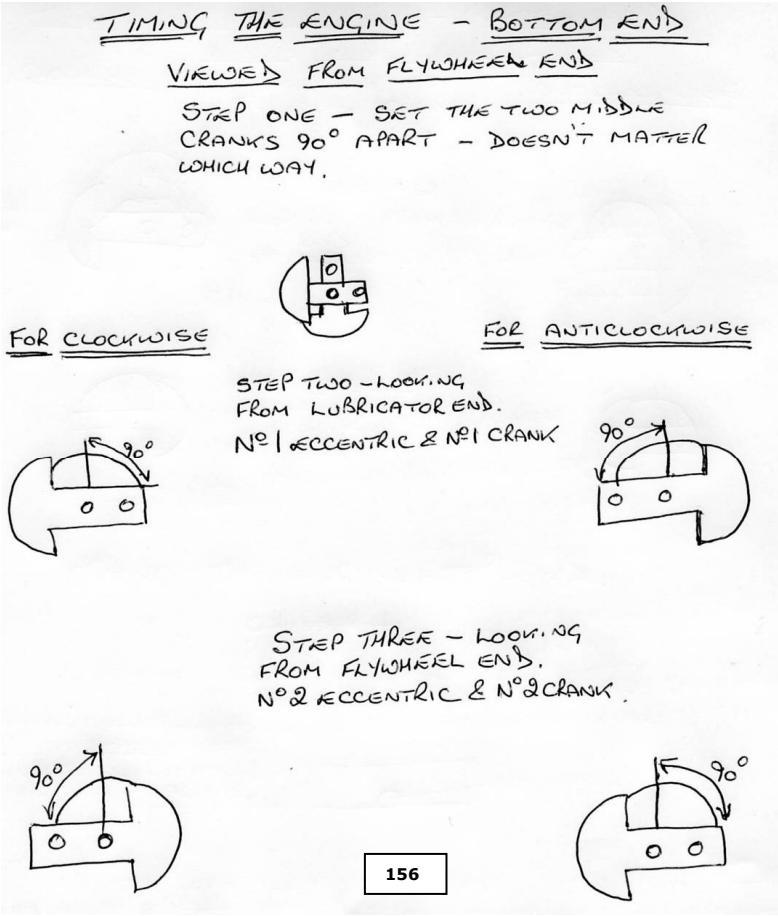
The final bit of the build - getting it to run efficiently. First look at the photo - it shows the position of the parts I will be referring to.



It is easier to set up if the top and bottom are not joined at the start, as it is easier to adjust the crankshaft timing, but can be done with things built up.

First you have to make a decision whether you want the engine timed to run clockwise or anticlockwise as viewed from the flywheel end of the engine. It shouldn't matter; it should run the same in both directions, but due to machining errors it is not always the case. If it doesn't work well one way, try the other. I have given you the view for both on the sketch (Pic 156).

Bottom End



Step 1: To start, set the two cranks either side of the crankshaft centre bearing block at 90 degrees (or very close) to each other and tighten up. These will not be moved again.

Step 2: Viewing from the lubricator end of the engine, set up No 1 crankshaft to a horizontal position as shown in the sketch, depending on direction chosen.

Slacken off the screw in the crank nearest to the eccentric and turn the eccentric until the marked line is at 90 degrees to the crank and lock up the screw.

(You did remember to put the line on like we talked about on page 30, right?)

If you didn't mark the lines on, you will have to use a DTI and find the point of highest lift and mark that.

Step 3: Turn the engine round so you are viewing from the flywheel end and carry out the same procedure on crank 2 and eccentric 2.

That is the bottom end timed. From now on nothing should be moved on the bottom end.

Next we'll time the top end.

Top End

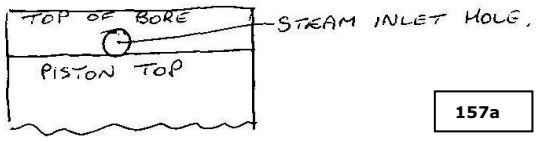
Assemble the top to the bottom. Leave the bore top caps off, and the piston valve end covers, but put screws or nuts on to hold the piston valve block in the operating position.

We will totally complete the Piston 1 and Valve 1 first.

Always turn your engine now in the direction you set the bottom up on. There should be no difference but you never know in this world.

Step 1:

Turning the engine in the direction of rotation set up on the eccentrics, turn crank until piston is at Top Dead Centre (TDC).



157a

Slacken off nut on crosshead and screw the piston rod in the correct direction to bring the top of the piston in line with the bottom of the steam inlet hole. (See Pic 157a)

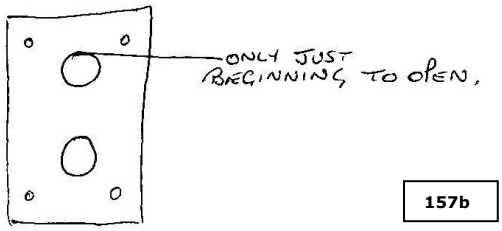
Lock up nut and do another crank rotation to make sure it has held position.

Step 2:

Take off cover plate on the end of the piston valve block.

Slacken off nut at bottom of piston spool valve. Turn engine until piston is at TDC.

Adjust by turning spool until top hole is only just being uncovered at the top. (See Pic 157b)



157b

Tighten up nut. Do another rotation of the crank and recheck.

Step 3: After you have finished the Number 1 end, proceed to the other end and repeat the same procedure for Piston 2 and Valve 2.

You should now have a fully timed engine.

But because we all have different tolerances and fits, no two engines are ever the same. So you might need a little bit of timing tweaking on the piston valves; only minute, opening slightly earlier or later, but at least you can now always set to basic.

Mine was a fair way out all-round when I retimed it today, but my videos show that even being out on that, the engine will still run fairly well. It took me about half an hour to retime mine, and seal the plates.

If I have made any mistakes on here please let me know and I will put it right.

Question – Match Marking and Torque Settings

Hi PD's.... still a brilliant build John & you say.... made from scrap...but that is only a ***SMALL*** *part of the story we PD's have experienced...you have explained relatively simple machining techniques that people like Eddy or myself can understand & produced the results for our own eyes - however I still see years & years of experience behind the concepts & notes {& Bandits mathematics}*

So the only two questions I ask .....

1) after the timing has been set & established...do you provide further match marking... then the engine down to pieces.... spray with Loctite 7471 primer & the reassemble with a Loctite stud lock material?

2) you have used M4 & M tappings & used stainless steel socket head cap screws... are you going to nominate a torque setting for the respective fasteners?

Response – Match Marking and Torque Settings

Glad you have enjoyed the build as much as I have. As you know I have a bit of a problem and doing this has forced me over the last couple of months or so to remain active both physically and mentally. So the build hasn't just been for the people that have been following it but for me as well. That is why I take on projects that last a couple of months; I know that I can get that far before I have to put on my slippers and watch soaps on the box for a few days.

Now for your two questions.

With reference to marking, stripping down and rebuilding. This engine has to be stripped because there are a few things that need to be done, like the flats on the packing glands for the piston valves, but I won't do any more marking, just keep each end of the engine separate.

On rebuild, I always use Hylomar jointing compound for all sealed joints; this acts like a mild threadlock for the holding bolts and screws. For the bits that might be forced to unscrew, the pivot pins on the joints for the eccentric to piston valve spool and the crosshead to conrod joint will get a drop of nutlock on the threads. By using stainless fasteners, you get not only corrosion resistance, but they also have a bit of a 'grab' factor when tightened, so with the low vibration levels on this engine I don't expect to have anything come loose.

That brings me onto the second question about torque loading. Normally for larger sized bolts, a big shifter and white knuckles would do it, but for these small bolts, I don't think it is required and it would just complicate things. In fact, I am having a bit of trouble with this area myself. I am trying to convert to being left handed and I just haven't got the 'feel' yet and am occasionally stripping out the hexagon heads of the screws so maybe I should get a small screwdriver torque wrench.

Tip – Packing Steam Glands

There is one thing I forgot about and that is the packing of steam glands. What I do is unwrap the 'string' into smaller threads, wrap it around the shaft I want to seal, then push it into gland with a thin piece of rod

(the one on the piston valve is a bit tight but can be done). Tighten up the nut until you have a gap of about 1mm between the nut and the gland and you can feel the friction being applied to the shaft. If there's too much friction just undo about 1/4 turn. If it can tighten all the way up, you need to put some more packing in.

I would like to add that it is not just yourselves that have learned new things on this post. I have found out how to use my camera a lot more efficiently, plus all the related bits that go with it, like using the computer for graphics manipulation and video. How helpful people on this site are and their willingness to share information, not just with me but with everyone.

One disappointment is the feedback. I was expecting loads of questions, but very little materialized. Either I have explained well enough so questions were not needed, or it was totally above their heads and were afraid to ask because it might make them look silly. As I have said before, there is no such thing as a silly question, just a silly sod for not asking.

There have been a fair few hits on this posting, and looking by the number of times the pictures have been viewed there must be about 50 contemplating building, which is well above my wildest dreams. I was expecting four or five with an interest. Another way to look at is that next year the country will be flooded with far eastern made piston valve steam engines.

Now I have to find something else to make. This one is a none starter for horizontal conversion - it is just too long. Any suggestions will be gratefully accepted, and I do mean that.

I want to do a final video just to show how well the control valve works, but I want to do it outside in a different setting, but every time I try to set it up it starts raining. Maybe later today.

Thanks all, and keep the questions coming.

John & Bandit the Brain

Comment – Finding True Dead Centres

Hi PD's,

I think we all owe John a huge amount of gratitude for this series of posts. What a magnificent effort. It just shows what can be achieved with very small budget and a bit of lateral thinking.

John's design should be easily achievable by others, even with only small/modest machines available. All this really means is that some elements of machining would take a little longer (lighter cuts), or perhaps require a slightly different method of work holding to suit the available equipment.

If I may, I would like to add a few notes regarding timing..... It sure beats building kitchen units....

The biggest problem in all timing is finding the TRUE DEAD CENTRES.

On the surface, this may appear simple, but one thing, in particular, should be taken in to account..... Namely, LOST MOTION, and its effect on angular rotation.

When the piston is being driven down by steam pressure the crosshead is being pushed, and hence the thrust is applied to the crankshaft side of the crosshead small end pin/bearing. Conversely, when the piston is being driven in an upwards direction, by steam pressure from below, then the crosshead is being PULLED, as a result the thrust is now taken by the opposite side of the crosshead pin/bearing. The same applies to the big end/crankpin/ bearing.

Whilst this may only amount to a small dimension (especially in a new engine, and assuming careful machining), it is, however, inevitable in any running bearing, and it creates the LOST MOTION I refer to.

Every time the piston changes direction, some piston motion is used up taking up the slack in the bearings (albeit a very small amount) without any actual motion of the crosshead and/or crankshaft. This is LOST MOTION.

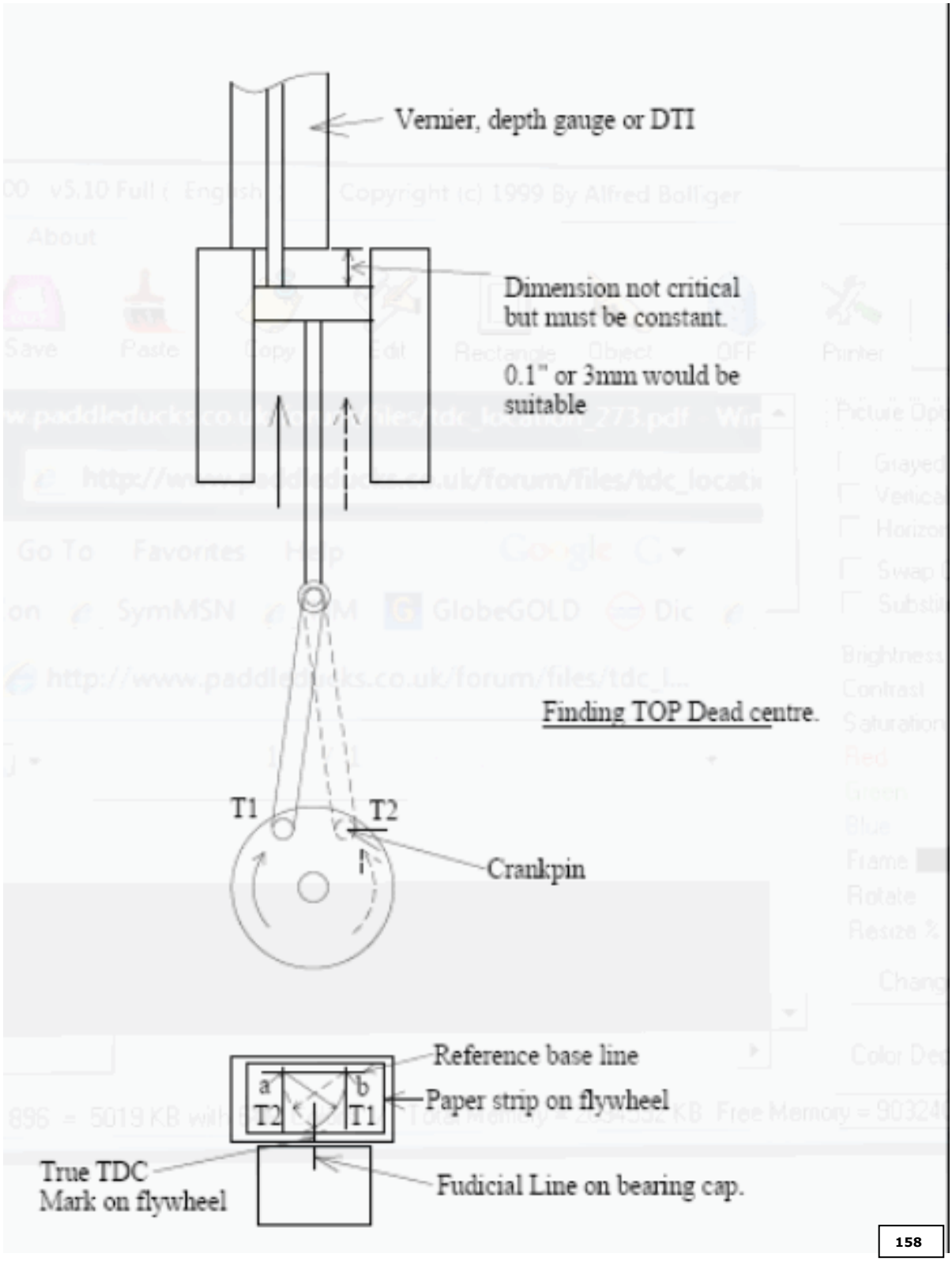
It can, especially where large running clearances are involved (or in a worn/well used engine), make quite a large difference in angular position of the crankshaft when locating the TRUE DEAD CENTRES. I attached a drawing (Pic 158) and some text (Page 81) explaining how to find the true dead centres, taking into account any lost motion.

Once marked up, then it is easy to find the true dead centre positions for the crankshaft rotation. It is well worth performing this task prior to attempting to set the eccentric angles and valve timing.

Incidentally, there will also be some LOST motion in the eccentric/eccentric strap bearing surface and the pin/bearing at the connection with the spool valve..... this must be minimised by close running tolerances, and allowed for in the valve setting.

One final point..... when setting the position of the valve spools (at TDC) it should be just about to open..... any actual open amount will reflect as a non-open amount when the piston is at BDC.... think about it..... which means the crank will need to pass BDC before the lower port opens. For this reason alone, it is important to get the length between the spool lands dead right..... i.e. the same as the distance between the outer edges of the steam ports.

Ok PD's, That's my small contribution... so AGAIN, very well done John and thanks on behalf of all!


Vernier, depth gauge or DTI
Dimension not critical but must be constant.
0.1" or 3mm would be suitable
Finding TOP Dead centre.
T1
T2
Crankpin
Reference base line
a
b
T2
T1
Paper strip on flywheel
True TDC Mark on flywheel
Fudicial Line on bearing cap.

158

Tip – Locating Top Dead Centre

Top Dead Centre Location (Refer to Pic 158)

1. Turn crankshaft until piston is somewhere near to required dead centre (TDC).

2. Affix a strip of gummed paper label to the flywheel, this may go all the way round if both dead centres are required, otherwise just make it long enough to accommodate the required marks.

3. Mark a suitable reference base line on the paper strip at a suitable distance from, and parallel to, the rear face of the flywheel.

4. Make a permanent FUDICIAL mark on the top of the bearing cap adjacent to the flywheel, using a suitable scriber.

5. Set vernier, or depth gauge, to a suitable depth (0.1" or 3mm will suffice).

6. Place vernier, or depth gauge, carefully into the bore, with the body resting on the cylinder block top face (as shown on drawing), and turn the crankshaft (as shown by solid arrow on drawing) until the piston just touches the bottom of the gauge.

7. Make a mark on the paper strip adjacent to the FUDICIAL line.

8. Now turn the crankshaft IN THE OPPOSITE DIRECTION (as shown by dotted arrow on drawing) until it again touches the bottom of the gauge, and make a second mark on the paper strip adjacent to the FUDICIAL line. These last 2 marks will be those shown as 'T1' and 'T2' on the drawing.

9. Extend both marks, at 90 deg. to the flywheel front face, until they cross the reference base line (see step 3).

10. Set up a pair of compasses, (or dividers) to a width just a little smaller than the distance between these 2 lines.

11. Using the 2 points marked 'a' and 'b' on the drawing, scribe an arc from each point, as shown.

12. Make a final mark on the paper strip, where these 2 arcs cross each other, and extend this onto the edge of the flywheel with a suitable scriber, and add TDC lettering, if space permits, for the cylinder being timed. egg, TDC 1.

13. This Mark is the TRUE TOP DEAD CENTRE.

14. Align this mark with the FUDICIAL line and the piston is at TRUE TOP DEAD CENTRE.

15. If required, the same procedure can be used to find the true BTC, just set the depth gauge to a suitable distance from the bottom of the bore.

16. Repeat all above for the other cylinders.

17. If using a DTI (dial test indicator) rather than a vernier/depth gauge then, in step 6, turn the crank to get a suitable reading on the dial (and make a note of it) or better still, zero the dial, and make the first mark on the paper strip. Then for step 8, just turn crankshaft until dial again reads the same and make second mark. The biggest problem with using a DTI is finding a suitable place/method of firmly anchoring the DTI base/carrier to the engine cylinder block whilst the above steps are performed.

Comment – Lack of Comments

I have to agree with everyone else's comments - An absolutely superb series of posts by John which just goes to show that even idiots like me have the ability to make their own steam engine with the guidance given in this series.

I think the reason for the lack of comments is twofold, firstly everything has been explained extremely well, and secondly, a lot of questions would probably only come about when you actually started to make the unit. It's one thing reading a series like this; it's another thing entirely to take it as the basis of making your own engine - Only then would a lot of questions really start to become apparent.

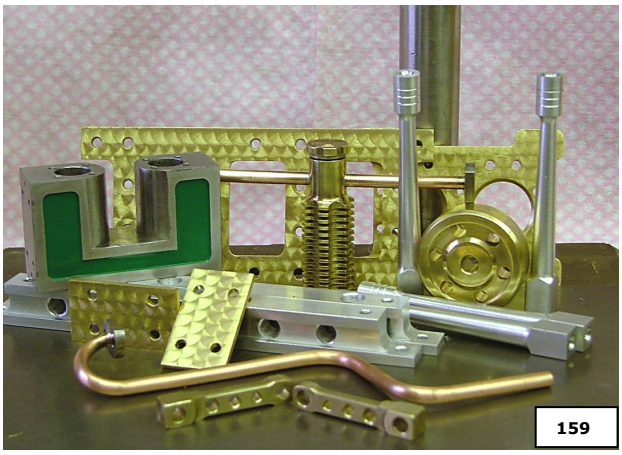
I still hope to have a go at something like this, but having just parted with almost £5000 for a car, it may be while before I can afford to start building up the required machinery, etc. Though as a secondary point, it is good to know that you don't need to spend anywhere near as much as I had first thought! You need to buy good quality yes, but you can get away with not having some machines by using some of Johns techniques and a bit of lateral thinking.

Once again, my sincere thanks to John and to everyone else that contributed to such an unusual and well presented thread.

Custom Engine

Here at last is my final video. http://www.youtube.com/watch?v=gTuET23TkaI

I said before that the control valve was not as good as I expected. I have now changed my mind on that one. Being outside without all the compressor noise in the background I was able to hear the speed changes on the engine rather than having to rely on visual changes, and it does now come up to my ideal for a fairly easily made control valve, with no leakage.



And that brings me to this weeks little project.

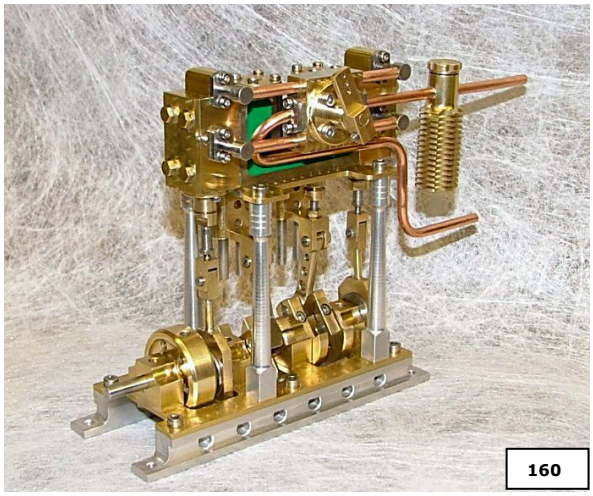
You must remember by now that I built one of these steam engines in parallel to the prototype. Well I have finished doing all the custom parts, and now on the picture you can get an idea of what I will be doing.

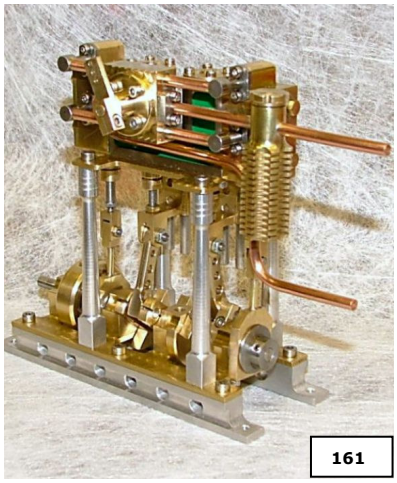
To keep D…. happy I have taper turned the columns, plus you will notice the lovely pink background, I know that he is going thru a Barbie phase so I thought it would cheer him up.

The cylinder block has been machined to simulate separate cylinders and the relief that is machined in the side has been painted in Ford Modeena Green, which I think is the perfect complimentary colour for this engine, besides the fact it was the only gloss spray can I had in my workshop. The engine turning took over five hours to do to get the holographic effect I was after.

The next post will be the custom engine assembled.

Hopefully this is the final part in the build saga of this engine. As you know, I built two in parallel, and the second one I decided to give it a bit of a 'lift' from the basic design and hopefully if anyone ever decides to make this engine, it will give them a few ideas to make it different. The first four are different views of the engine and the last (Pic 165) shows the two together.


160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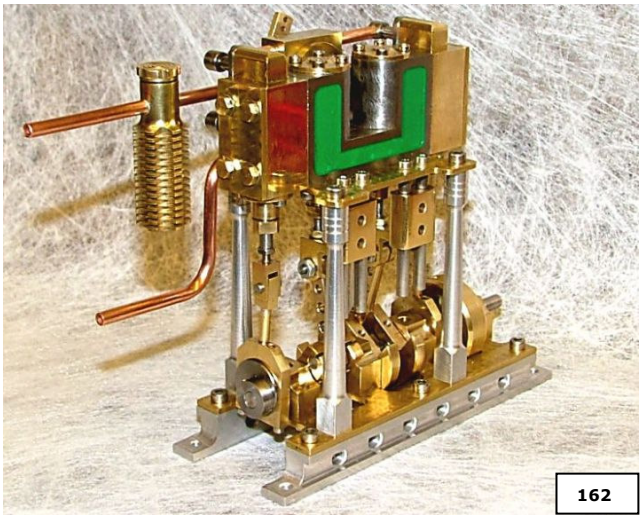
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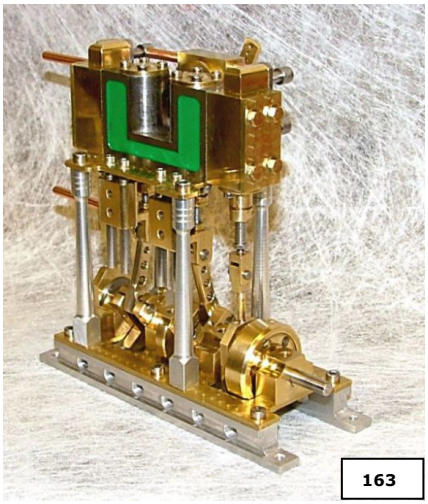
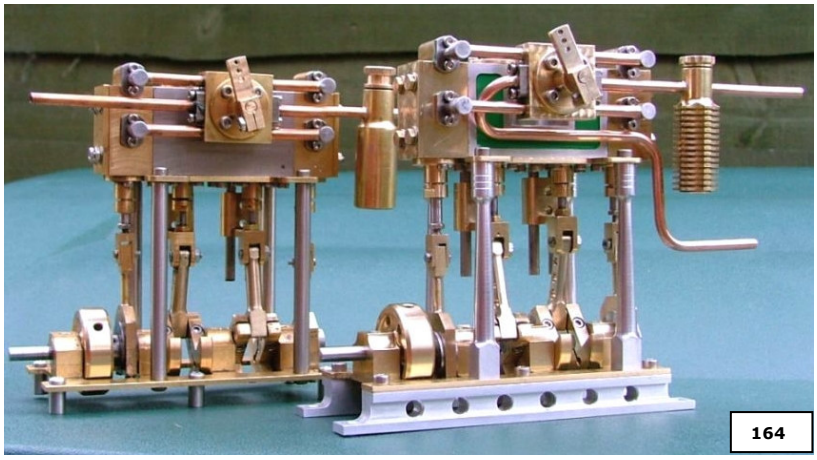

163


164

Question – Milling the Custom Block

I want to know how you milled the centre out of the block and made it round on the inside??

Answer

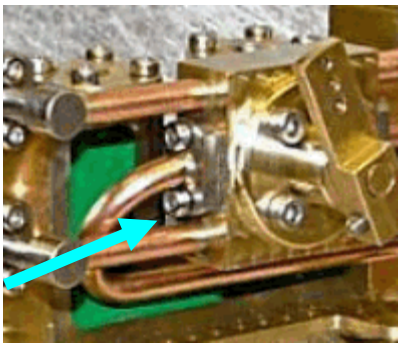
You must know that cats have very rough tongues. Well I coated where I wanted the metal removed with double cream and gave it to the cat to lick on.

Back in the real world, I mounted each cylinder bore in turn on a mandrel mounted on my rotary table, and machined away an arc using the same centreline as the bore, taking care I didn't break into the mounting holes coming from underneath the block.

Question – Tightening Bolts

How did you tighten this SHCS [socket head cap screw] ....an answer of a...'bald headed woman or a ball headed Allen key is not acceptable'!

Answer



With a long series ball-ended Allen key

It is a bit of an optical effect but the flange on the u-tube is offset to allow the u- tube to miss the pipe below it.

If I hadn't have done that way, it would have meant a very complicated silver soldering and port drilling exercise to keep the pressure and exhaust separate, which would have entailed using a 5/8" dia., six fluted, 90 tooth, square section, unique left/right cutting, brass plated plug tap, which I have misplaced somewhere, so I had to take the easy way out and offset the flange.

~ The End ~

Good luck with your own build.

JOHN "BOGSTANDARD"

AUGUST, 2007

Attachment: Appendix 1 – Design Sketches