The Holly Buddy

2.5cc Model Diesel - Compression Ignition engine.

Firstly I want to dedicate this engine to David Owen. I didn't know David for very long, but his influence on me and my affection for these little engines he instilled will be something I will have for the rest of my life. David gave freely of his time and experience not only to me but anyone who asked for his help.

I would also like to thank Steve Jenkinson who has kindly put my notes and scribbled drawings onto CAD so that anyone who wishes to build this engine will have a set of easy to read plans.

The main aim of designing and making this engine was to try to inspire others to think about designing their own engine. There are a set of parameters that for a sport engine are pretty standard within a fairly small range. These parameters are based around the timing of the 3 main variables if a front rotary engine such as this, or just 2 parameters if a piston port (or sideport) engine. Once these parameters are decided then it is just a matter of supplying the clothing to support them and there is an infinite number of ways that this can be done.

For a first design you want something that will give reasonable power and be relatively easy to start, so go a bit conservative with the parameters. Look at the various engines of the 50s and 60s and see what timing they were running and how they - A) arrange the inlet and inlet timing, B) arrange the transfer porting and its timing and C) arrange the exhaust port and its timing. You don't want to go too big on any of these to start with, but of course you can change them with development and new components. Probably the most critical item of all is the cylinder which incorporates the transfer and exhaust ports, and having made one for the initial build then you can change the whole character of the engine by redesigning it with more overlap, bigger ports etc but retaining the rest of the components. This way you can experiment without having to build a whole new engine.

So what about the Holly Buddy. Well it was designed around a transfer period of 107° and an exhaust period of 122° with the rotary intake at the venturi of 140°. These I believe are quite conservative, but when taken into account that the transfer passages are quite small and finish not that far below the exhaust opening I think they complement one another. It would be quite an interesting engine to make 3 transfer / exhaust passages instead of 2 thereby increasing the flow (but not the speed) of gas through these ports, this is the kind of thing that manufacturers would have done to settle on a design, and it is a pretty simple manner to do this ourselves, it is just time.

The CAD plans that follow are as per the engine built, but you are encouraged to redesign the various components to make the engine truly unique to you. Some of the simple things would be to extend the nose a bit, change the shape of it, reduce the thickness of the flange where it is bolted to the crankcase square, even mill into the crankcase here to recess it a bit – there are many things you can do with this simple piece. Then there is the muff, so long as it holds the cylinder down and has a reasonable surface area on the fins, especially at the top, why not make it tapered or a ball or an elliptical outer shape.

One nice thing you could do is use a bronze bush in the nose instead of letting the shaft run in the alloy. Bronze bushes are very nice and I would make it about 1.5 mm wall thickness and a press fit into the nose. Or even go to a double ball bearing arrangement, but be aware of maintaining the close fit of shaft to tunnel is so important. Whilst on the nose still, I cannot stress enough the seal around the bottom of the venturi, that is why in the design the venturi proper doesn't go all the way through, to maintain that better seal of the parent metal of the nose by not having to mess with it.

As far as materials go, I have noted a few different suggestions, but Google them and see what other materials can do the same job. I have used many times cut-off pieces from a guy making anti-roll bars, beautiful spring steel, but as hard to machine as anything I have ever come across. The 41/40 suggested basically the same strength as chrome-moly but there are other steels that would do a sterling job. You don't want anything that doesn't machine well as you need a fine finish on the shaft and on the bigend pin. Speaking of bigend pin, you can always make this using a pressed in one. You can buy roller bearings and these work a treat, but I have used a good silver steel too. Apparently Harley Davison use pressed in pins. I must admit that I like working with the 12L14 I have noted for the cylinder, it has about 1% lead and machines and works very nicely, just what you want for a cylinder where you have to get an even finish and that all important taper and as a metal, it isn't hard to come by. Make sure you buy a size with enough diameter to this and maybe future jobs.

Now a few notes on the engine itself. Unless you are a manufacturer with access to grinding, then you are going to have to lap the bore and if you follow what I did, linish the piston and contra. I always find that if you can turn the engine freely on first assembly then the piston to bore fit will most likely be too sloppy and compression soft. What you want is firstly roundness in both items, and then you want that slight taper from exhaust to top of bore by about $1/10^{th}$ of a thou. And lastly you want an engine that is tight to turn over. The best engine fit I have found is one that initially doesn't allow the crankshaft to be rotated on first assembly. In this engine the crankpin, gudgeon and conrod are robust and this allows some latitude here. What you want is an engine that allows the piston to just enter the bore above the exhaust and then develops quite some friction. You then, with plenty of oil, turn the engine back and forth by hand and if you are within that nice zone then piston will enter the bore further and further until after a minute or two the shaft rotates fully. Even with a lot of friction the engine will start and run which never ceases to amaze me. When I bought a PAW .06 off David, it was squeaky tight over TDC – this is what you aim for. I can tell you the difference between an easy to start hard compression engine to one that is not so with soft compression on an engine this size is just ½ a thou, so the tolerances are very small. Regards the compression screw or Tommy Bar, it helps to put a small hole in the end so that the centre doesn't try to wander, or put a small dimple in the middle of the contra.

I must admit that I designed the engine in metric, it is so easy to work with, but, I am so used to working in imperial on the lathe that I convert everything to imperial on the plan before I start. Whilst talking about the plan, it helps immensely if you read each component thoroughly before starting each step, try to imagine each step in turn and look closely at the various measurements. Steve and I have tried to remove any pitfalls, one of which I fell into with a measurement but you can still make errors that means a piece and time can be wasted.

I thought of radius-ing the upper square of the crankcase but in the end opted not to, this is something also that would make the engine look different. Also you could make a spinner nut instead of the proprietary one I have shown, I encourage you to find ways of making your engine unique. And if you do stuff something up see if it can be compensated for before discarding it. You would be surprised what lurks inside some engines. On final assembly use a little sealer on the mating surfaces.

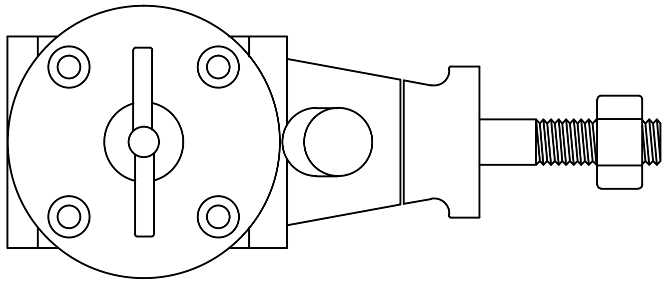
Lastly, I chose to position the cylinder so that the gudgeon pin cannot get into either the bypass or exhaust holes, there is a wall between them that allows this. I once had an engine given to me as a kid where this had happened, and there was no way to get it apart without destroying the conrod.

So there you have it, an insight into my design, hopefully this will inspire others to not only build this one, but to modify the build and then go on the design their own and if you do you then earn the right to call it your "Buddy".. If you haven't built too many engines before, I encourage you to read the HMEM thread on this engine at http://www.homemodelenginemachinist.com/showthread.php?t=26084

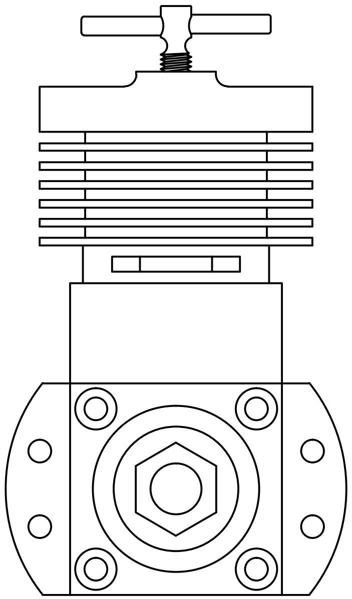
Good luck with it - Ed Holly

3 View Drawing of Engine

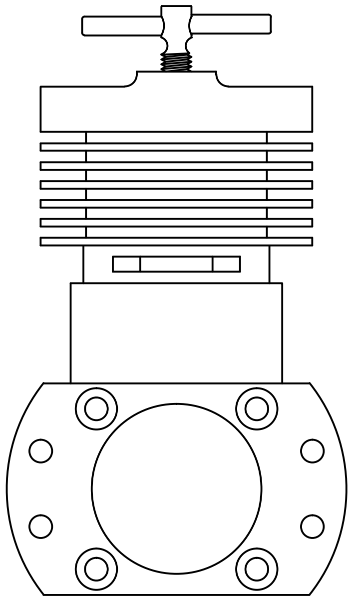
The design and build of
this engine is dedicated to
the memory of the late
David Owen



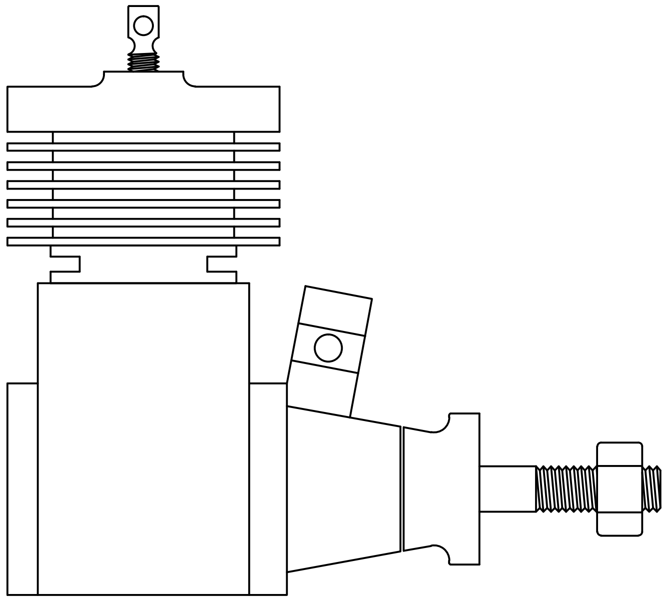
Top view



Front view



Rear view

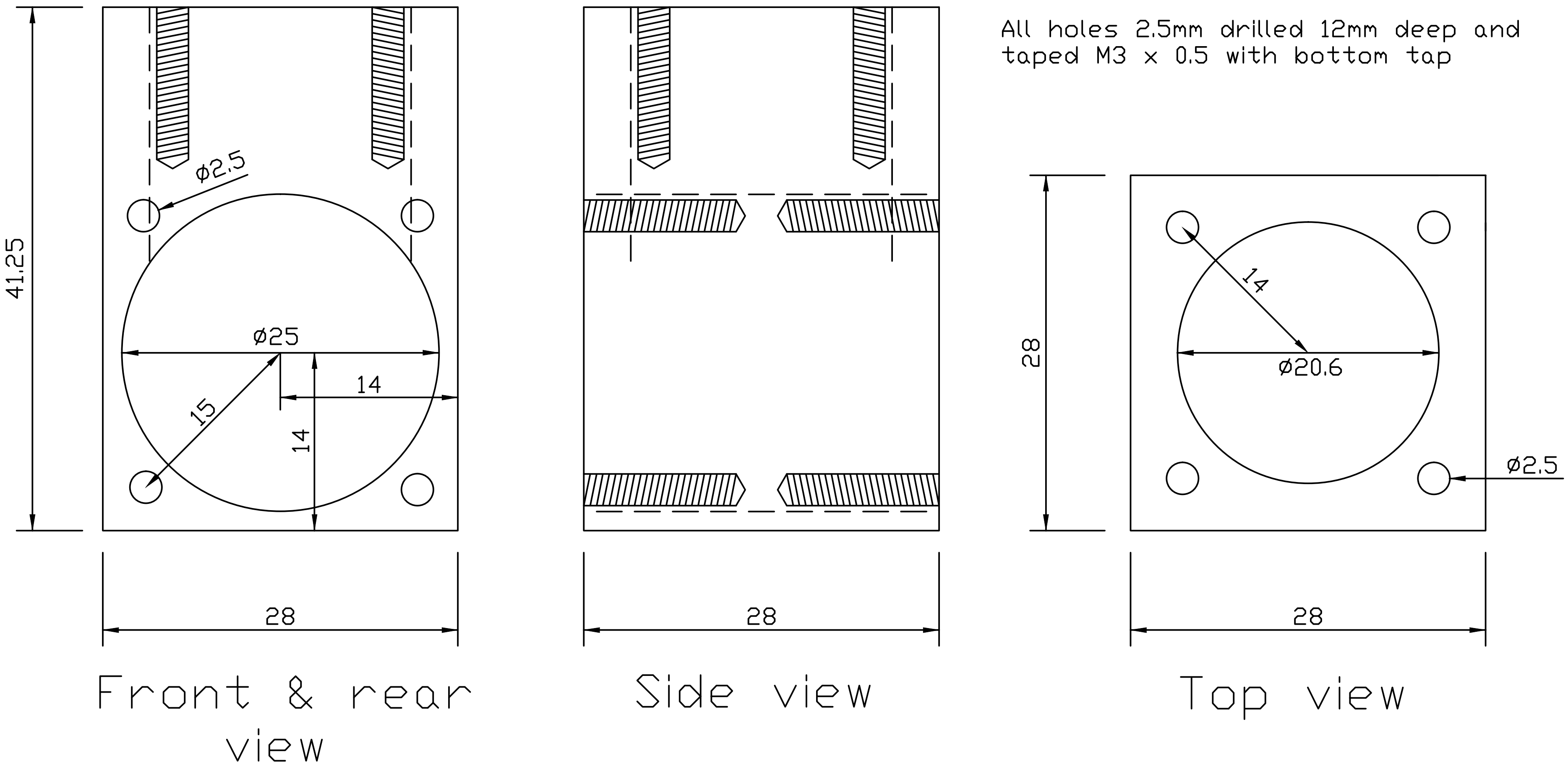


Side view

All drawings 2 x actual size	Materials as stated	Sheet 1 of 9
Holly Buddy 2.5cc diesel engine	Designed by Ed Holly	CAD by Steve Jenkinson

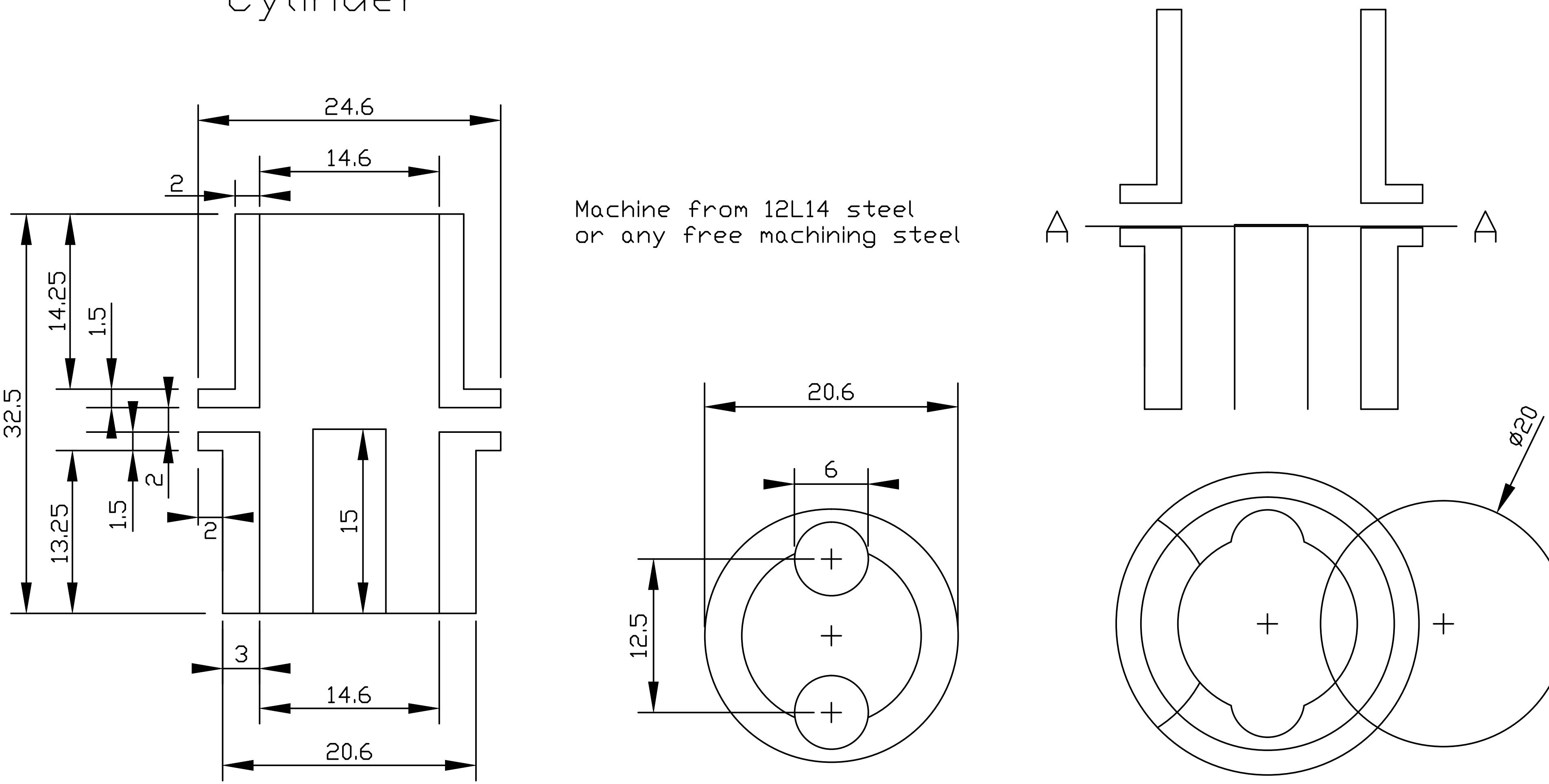
Crankcase from alloy

All holes 2.5mm drilled 12mm deep and taped M3 x 0.5 with bottom tap



All drawings 2 x actual size	Materials as stated	Sheet 2 of 9
Holly Buddy 2.5cc diesel engine	Designed by Ed Holly	CAD by Steve Jenkinson

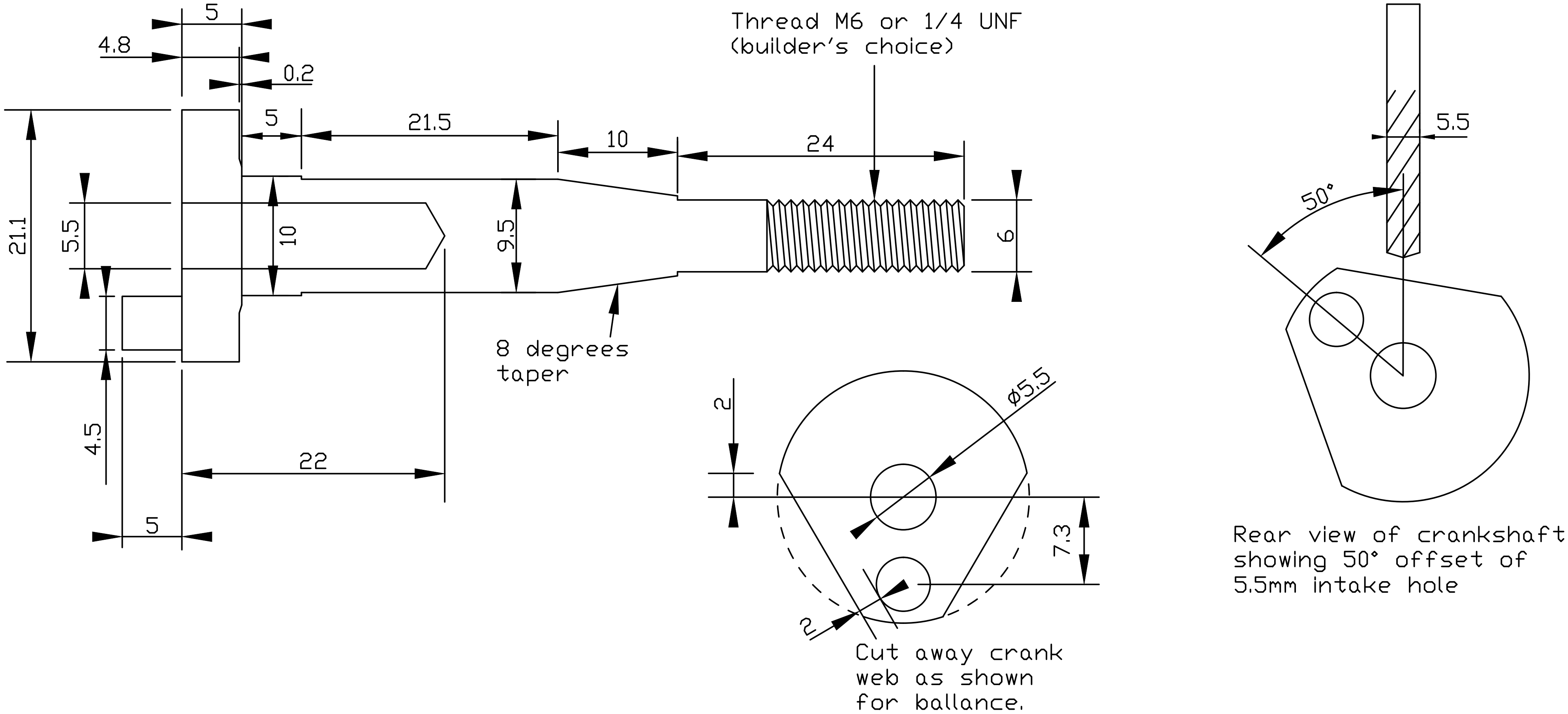
Cylinder



Side view   Bottom view   View through A-A

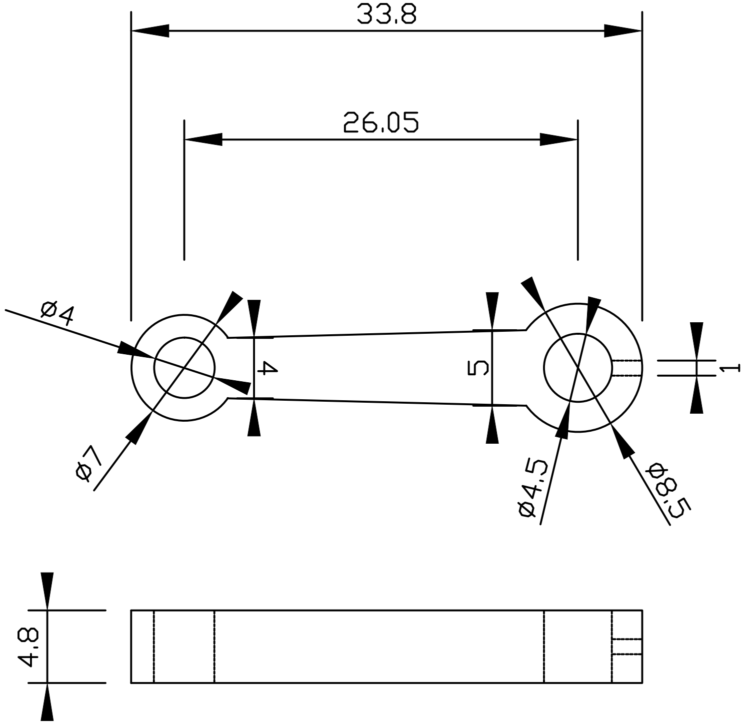
All drawings 2 x actual size	Materials as stated	Sheet 3 of 9
Holly Buddy 2.5cc diesel engine	Designed by Ed Holly	CAD by Steve Jenkinson

Crankshaft   Machine from 41/40 steel



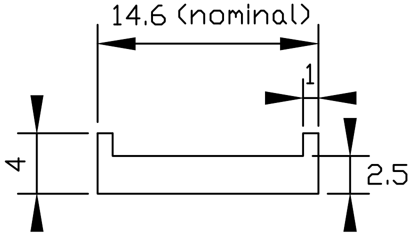
All drawings 2 x actual size	Materials as stated	Sheet 4 of 9
Holly Buddy 2.5cc diesel engine	Designed by Ed Holly	CAD by Steve Jenkinson

Conrod

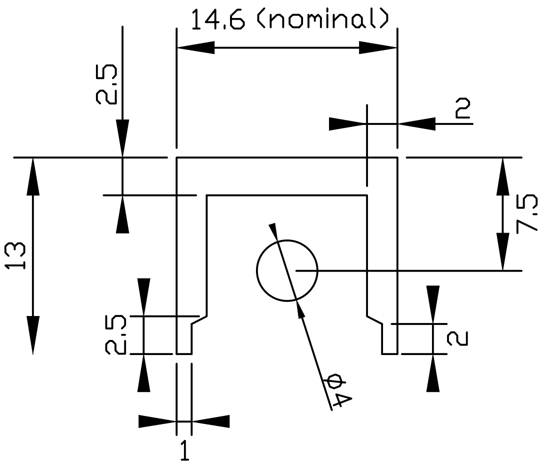


Machine from 6061 or
5031 alloy or similar

Contrapiston

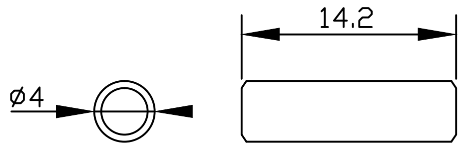


Piston



Piston and contrapiston
from cast iron

Gudgeon pin



Use 4mm drill rod
or 4mm ground rod

Gudgeon must be light
press fit into piston.
Drill 3.8 then 3.9 hole
then ream but not all
the way with 4mm reamer
to achieve this.

All drawings 2 x actual size	Materials as stated	Sheet 5 of 9
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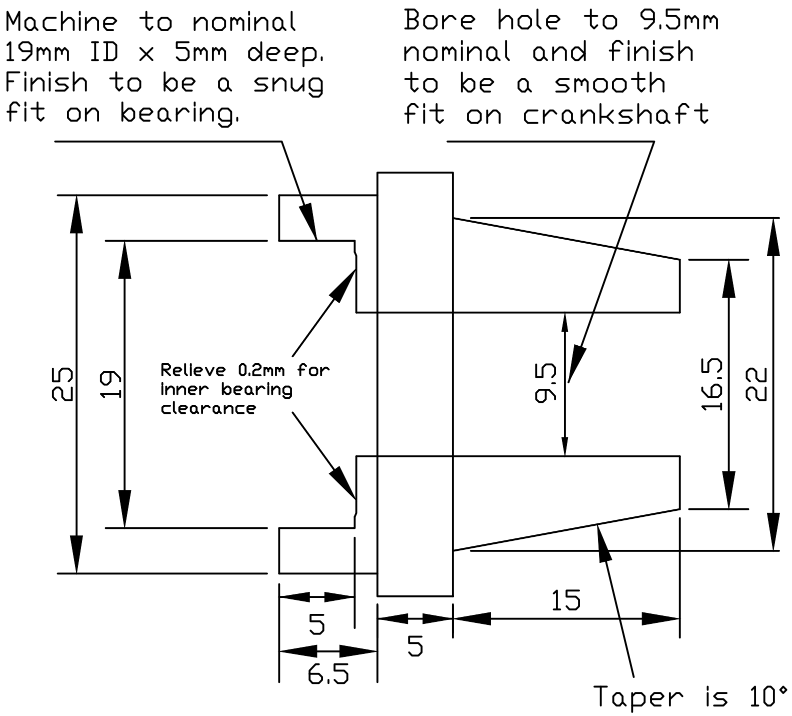
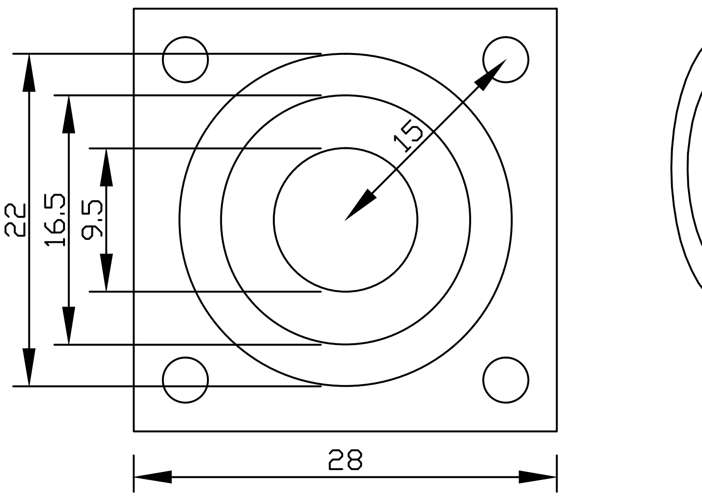
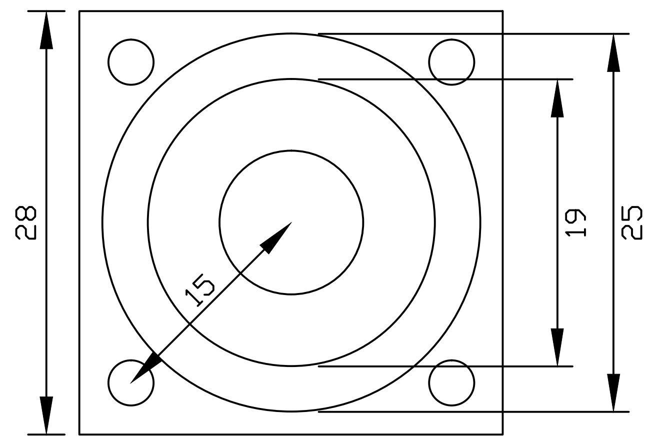
Nose From alloy



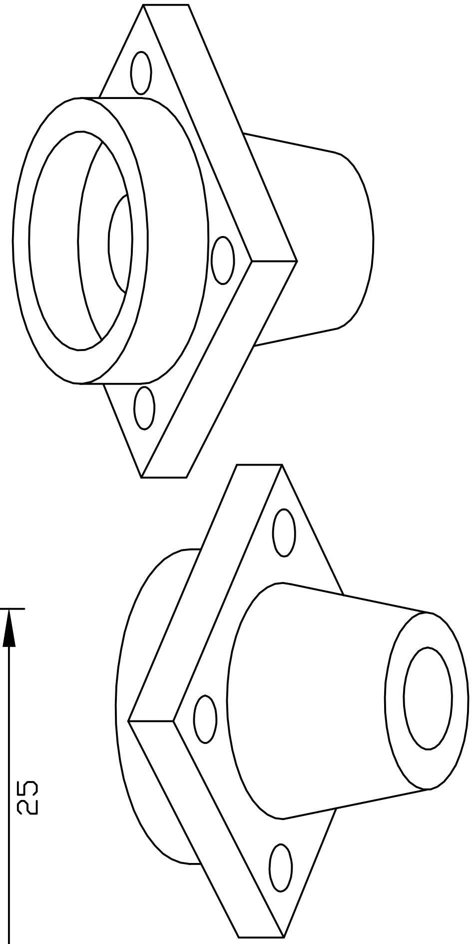
Side view

Front view





Rear view



Isometric projection

All drawings 2 x actual size	Materials as stated	Sheet 6 of 9
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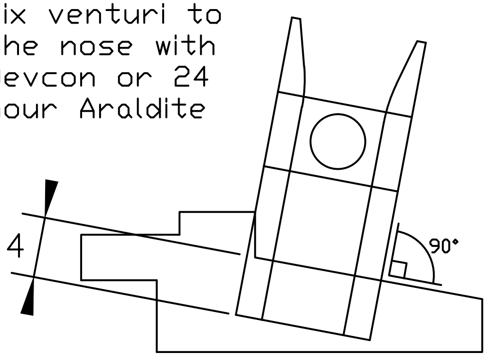
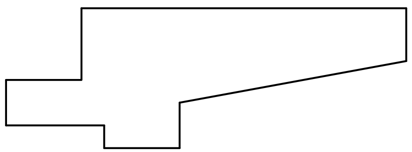
Venturi and Prop Driver From alloy

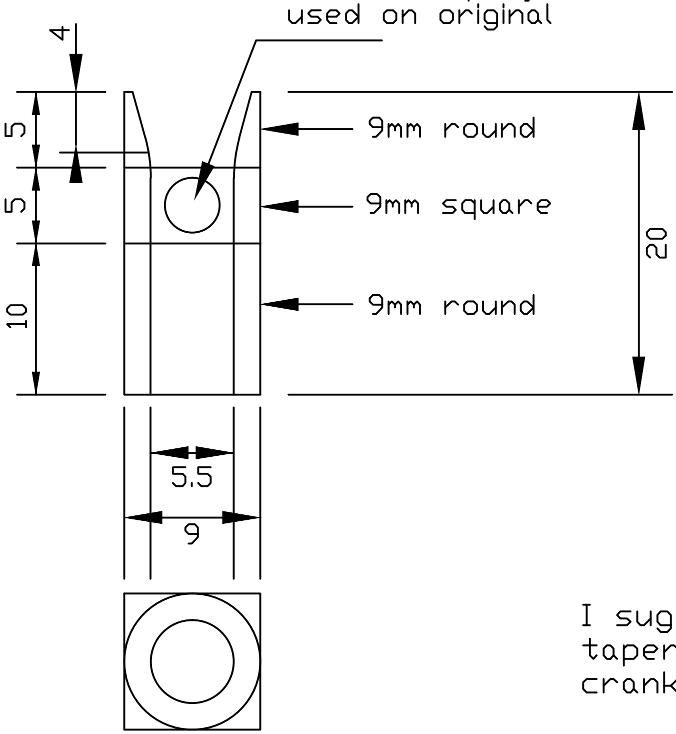
Venturi





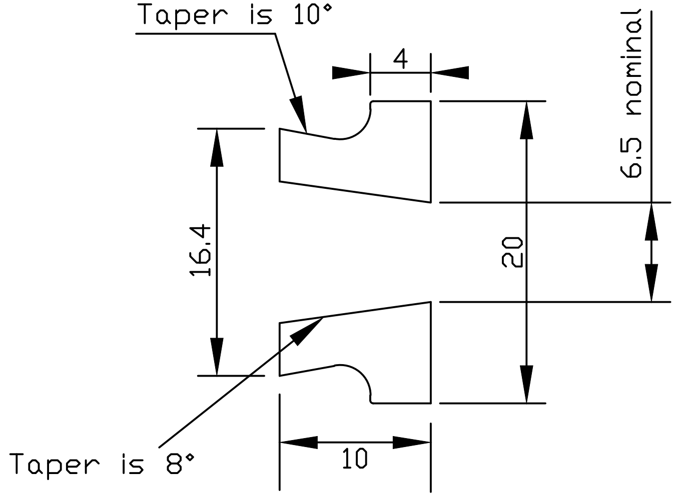
Section through nose

Side view



End view

Prop Driver



I suggest machining the prop driver taper immediately after making the crankshaft for perfect mating

All drawings 2 x actual size	Materials as stated	Sheet 7 of 9
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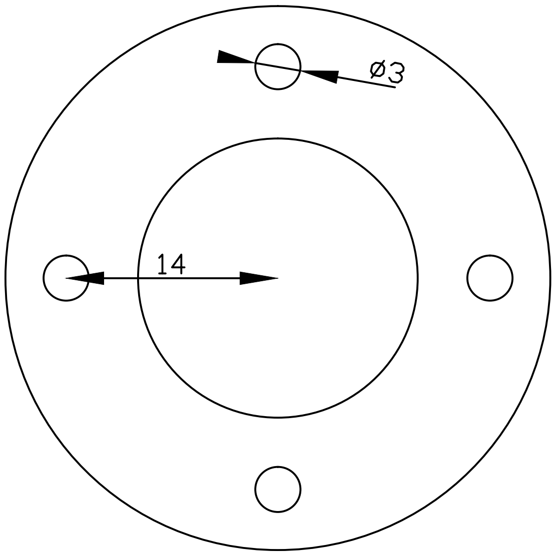
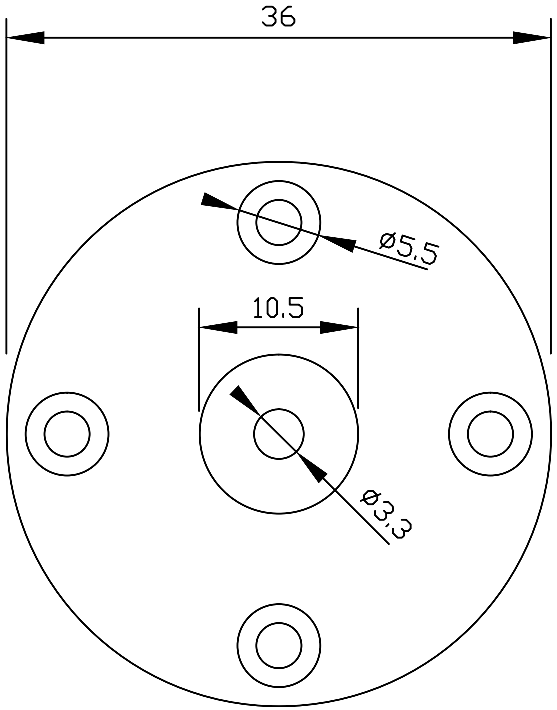
Cylinder Muff   From Alloy

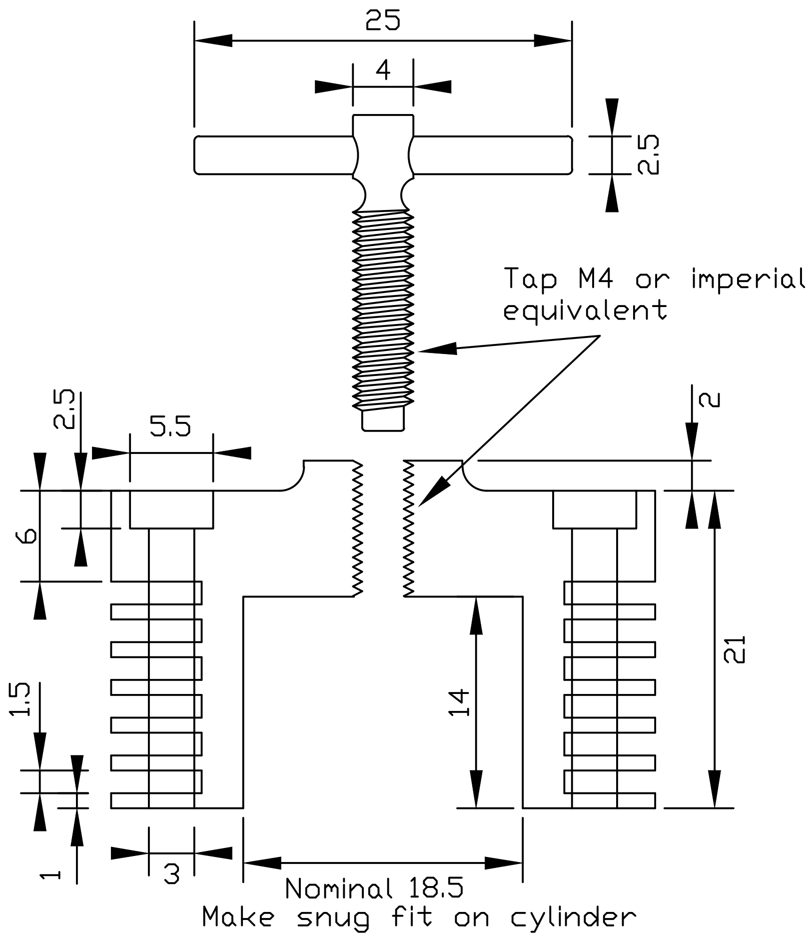
Tommy Bar Steel



Bottom view



Top view



Side view

All drawings 2 x actual size	Materials as stated	Sheet 8 of 9
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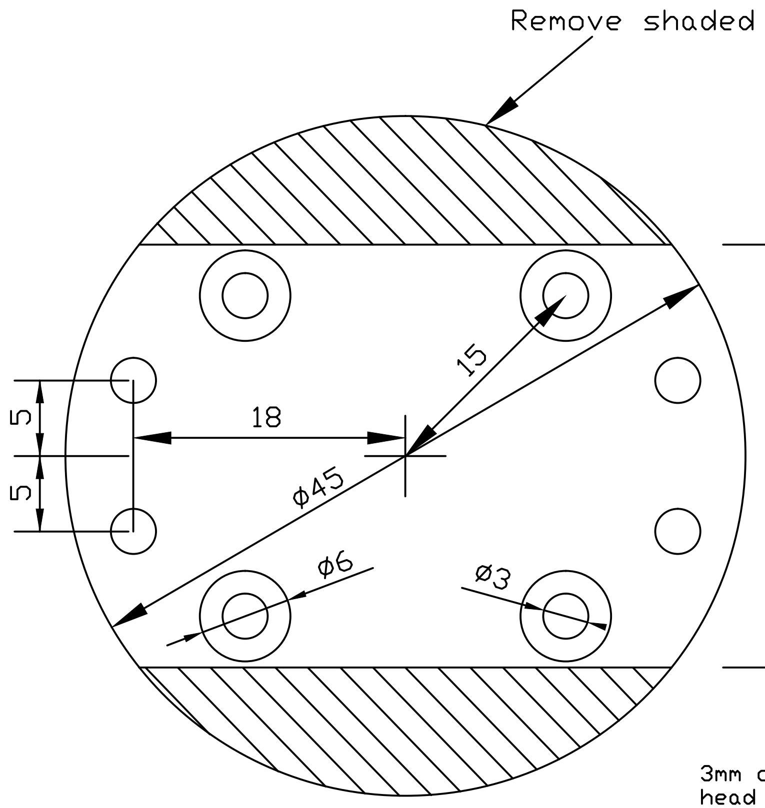
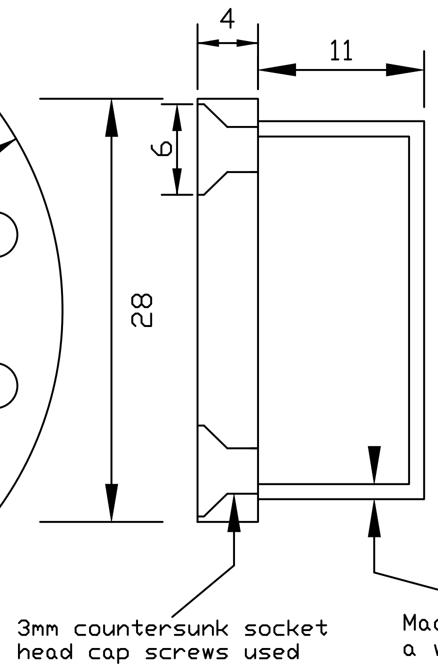
Backplate / Engine Mount

From Alloy

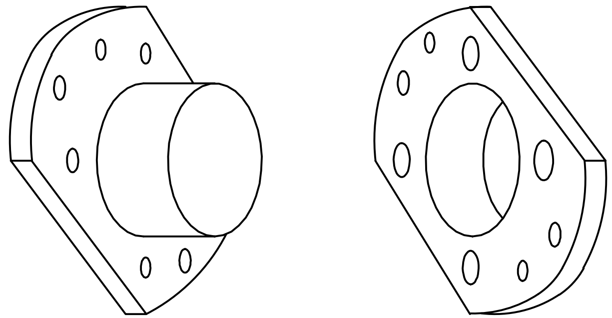


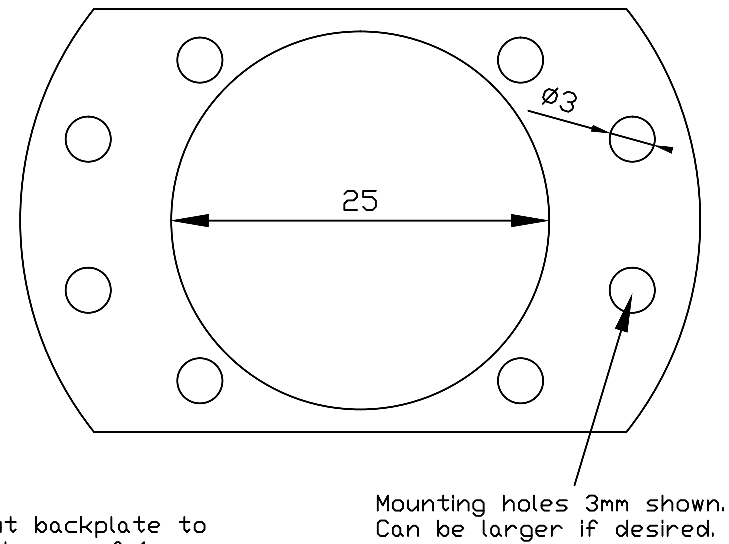
Rear view



Side view

Isometric projection





Front view

All drawings 2 x actual size	Materials as stated	Sheet 9 of 9
Holly Buddy 2.5cc diesel engine	Designed by Ed Holly	CAD by Steve Jenkinson