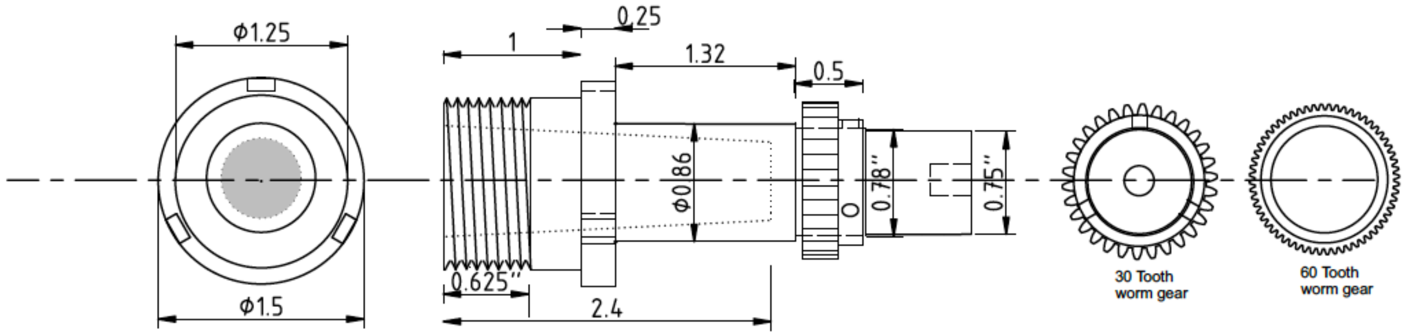
The Rawson Divider Construction

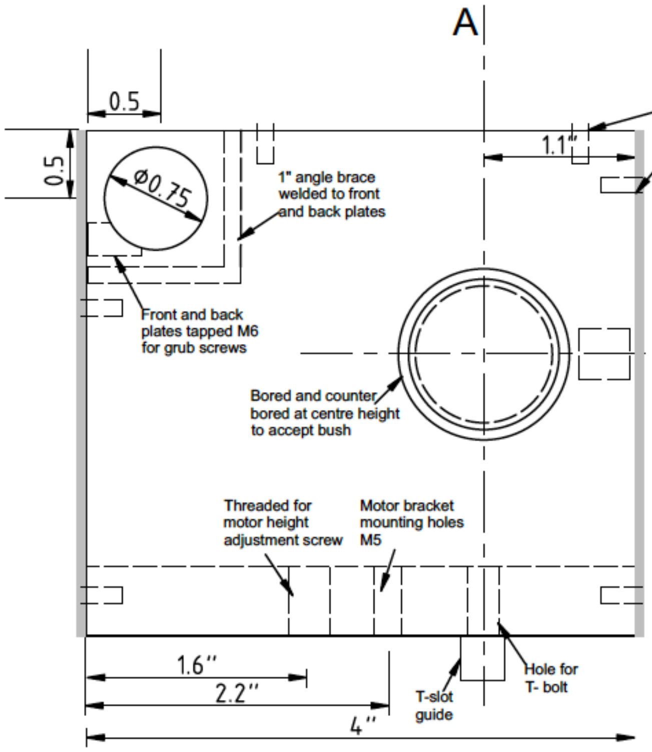
Introduction

The intention of this document is to give as much detail as possible of the prototype build of the Rawson Divider.
It is important to appreciate that, although working, this is a prototype and as such could benefit from modifications in some areas.
The aim was to make the Divider as small as possible given the constraints of the internal electronics and the necessity for rigidity.
The dimensions given on the main drawing page are in inches and represent those of the prototype build. Most of these can be changed to suit availability of component parts. The only critical dimensions are those that match the lathe in use, in this case the Myford ML7.
There must be enough room for the motor and worm gear given the thickness of the base plate. In the case of this prototype, that space is sufficient, but only just.

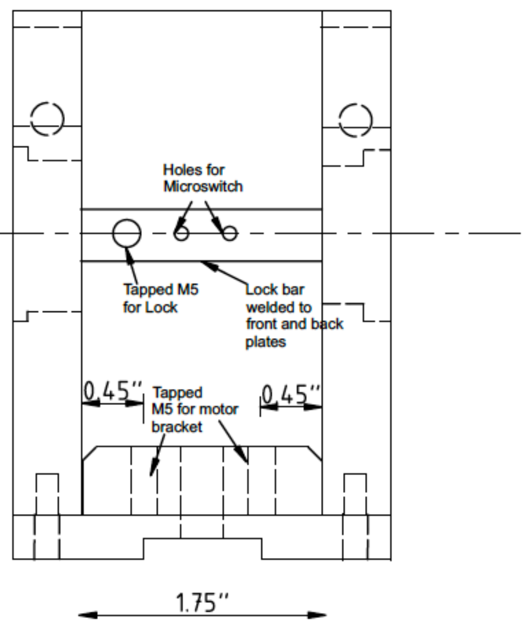
No details of the overarm construction are given in the document.



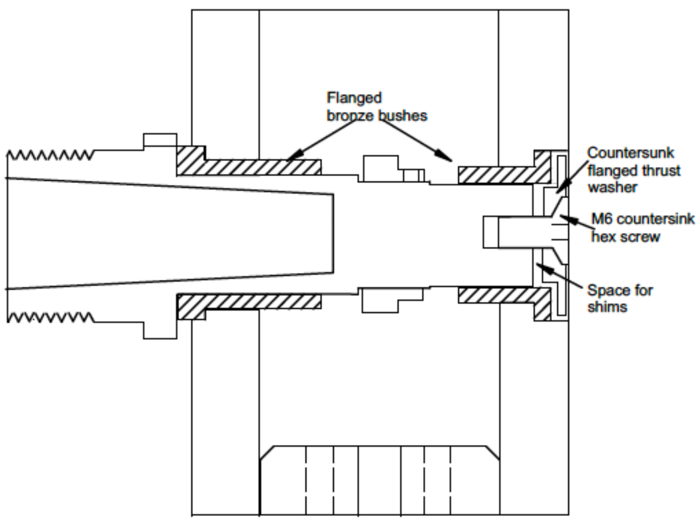
Main shaft and worm gear



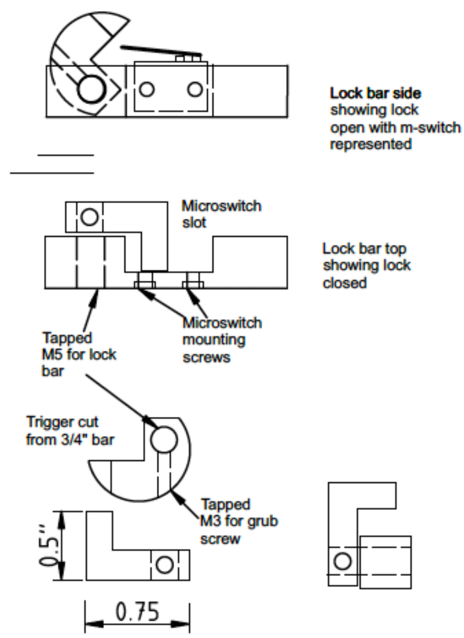
Front View



Side View



Section 'A' Showing Shaft



Lock Mechanism Detail

Main Shaft and Worm Gear

You may notice that I haven't given the overall length of the main shaft. The prototype's ended up at 3.5" because that's what I had available. A bit longer would have meant I could have increased the thickness of the flange on the Myford nose, which has three slots cut in it for a C-spanner. I found this modification necessary for gripping the shaft when mounting collets. A thicker flange could have holes to accept a retaining bar. The lock mechanism isn't man-enough for this and I found, to my cost, that the 60 tooth worm gear can be easily damaged. The design has now been modified to have a 30 tooth worm gear and matching worm. This decision has been helped by the introduction of stepper motors with 400 steps as against the 200 that the prototype first used. With a 400 step motor and 30 tooth worm gear the accuracy remains the same at 108 arc seconds (0.03 deg) per step. But also a 30 tooth gear is less delicate. One is shown mounted on the drawing.
The prototype design includes a No.2 Morse taper in the shaft. This gives the advantage of allowing Myford collets to be used. If this isn't a requirement then there is more flexibility in the shaft diameters and bushing arrangement.

Casing

This is a welded fabrication made from 1/2 inch BMS. It is basically a U-shape braced by a piece of 1inch mild steel angle to box off the overarm and a piece of square section steel to form the lock mechanism, I used 3/8 inch (10 mm).

Front View

This shows the holes bored for the front bush and the overarm. The main bush hole should be bored once the case is welded together and fixed to the cross-slide on the lathe. This way centre height will be guaranteed. The size of the hole and the counter bore depend on the bushes available. The only thing to bear in mind is that the front bush flange should be left a little proud to act as a bearing surface for the main shaft flange.
There is a hole shown in the base for a motor height adjustment screw. This was an afterthought on the prototype and didn't work as intended until I fitted a plastic wedge between the motor and the steel angle. This held the back of the motor down so that the adjusting screw could force it to tilt, hence reducing the gap between worm and worm gear. I realise now that the worm fitted on the prototype is too small in diameter, hence the need for height adjustment. The motor bracket mounting holes are such that they align with a plastic motor bracket (see plastic components for details of bracket and wedge).
You can see that the overarm is held in place by two M6 grub screws drilled and tapped in the front and back plates to come out below its centre line.
The front and back plates are also drilled and tapped M3 to accept cover fixings to the sides and top. The side plates are 1.5 mm aluminium and the top plate is a plastic construction and acts as a mount for the electronics.

Section ‘A’ Showing Shaft

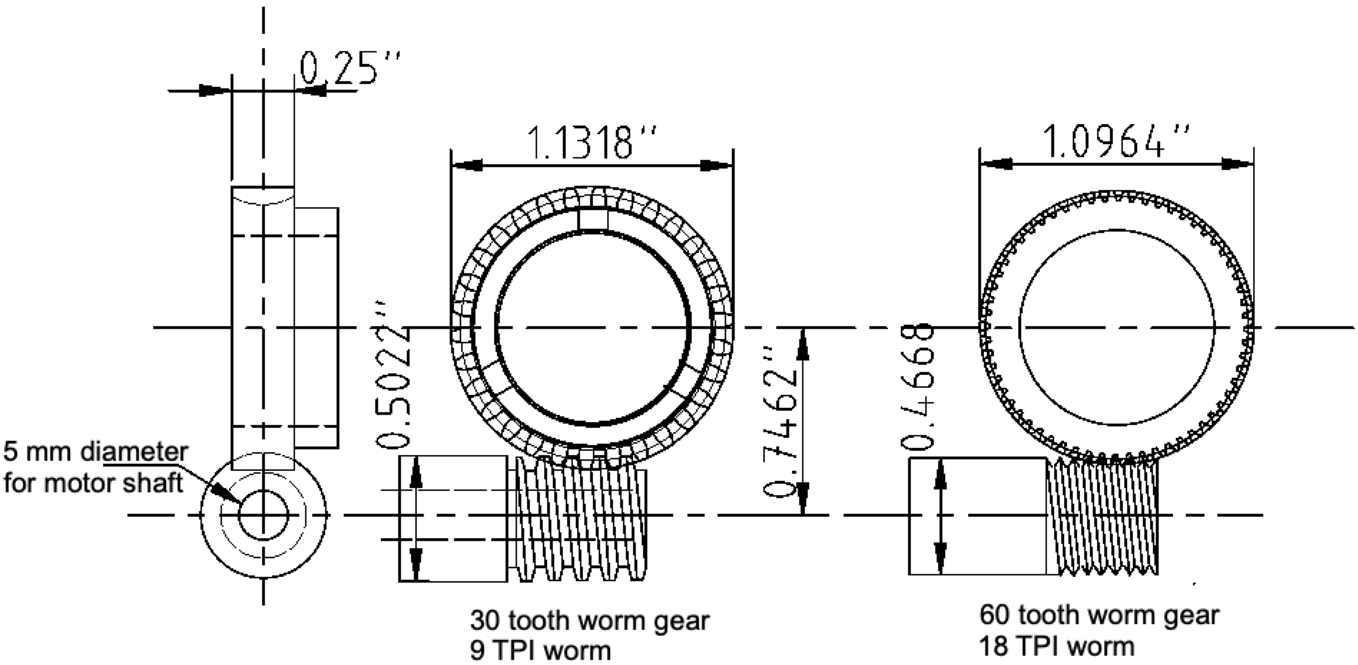
The main purpose of this drawing is to show how the shaft is mounted in front and rear bronze bushes. The bushes used are flanged as shown, and are of different sizes. The shaft’s diameter reduces from front to back in stages to allow the fitting of the worm gear. The bushes I used had internal diameters of 22 mm at the front and 3/4 inch at the rear. This arrangement allows for the end to end loading of the shaft to be adjusted. The front shaft flange bears on the front bush flange which is left proud of the case front plate. The shaft is pulled against the rear bush flange with a flanged thrust washer and screw. There is a gap between the flanged washer and the end of the shaft on the prototype which I shimmed up (with a washer) to allow a little end float. One could make the flanged washer of a length that set the end float. Hopefully the drawing explains it.

Lock Mechanism

I explored many different approaches to a mechanism that could both lock the shaft and operate a switch. I think there must be a better way but given the constraints I haven’t come up with it.
The one built and shown relies on the TPI of a 5 mm thread. The trigger mechanism only has room for a quarter turn of the locking lever. But locking the shaft with a 5 mm screw has its limitations. I’m sure that a fatter coarser thread would do a better job, and this should be considered when making the locking bar, trigger and lever. I originally made the trigger from plastic but it was impossible to fix it firmly to the lever. The steel one involves a bit of sawing and filing (or milling) to get it right, but accommodates a 3 mm grub screw for gripping the lever. I haven’t given details of the lever as it’s simply a threaded rod with a handle on the end (ball turned for the experts). The lever is screwed through the lock bar and the trigger and then tightened against the shaft. The trigger is then brought down onto the microswitch to activate it and locked in position with the grub screw. If all goes well the shaft should rotate freely when the lever is pulled back. In my case the front bush had to be drilled to allow the lever to pass through to the shaft.

Worm Drive

The original worm gear was made from phosphor bronze with the worm from free cutting steel. These had 60 teeth and 18 TPI respectively. As mentioned previously the worm was made too small due to a calculation error and necessitated raising the motor. The ideal dimensions are shown below.



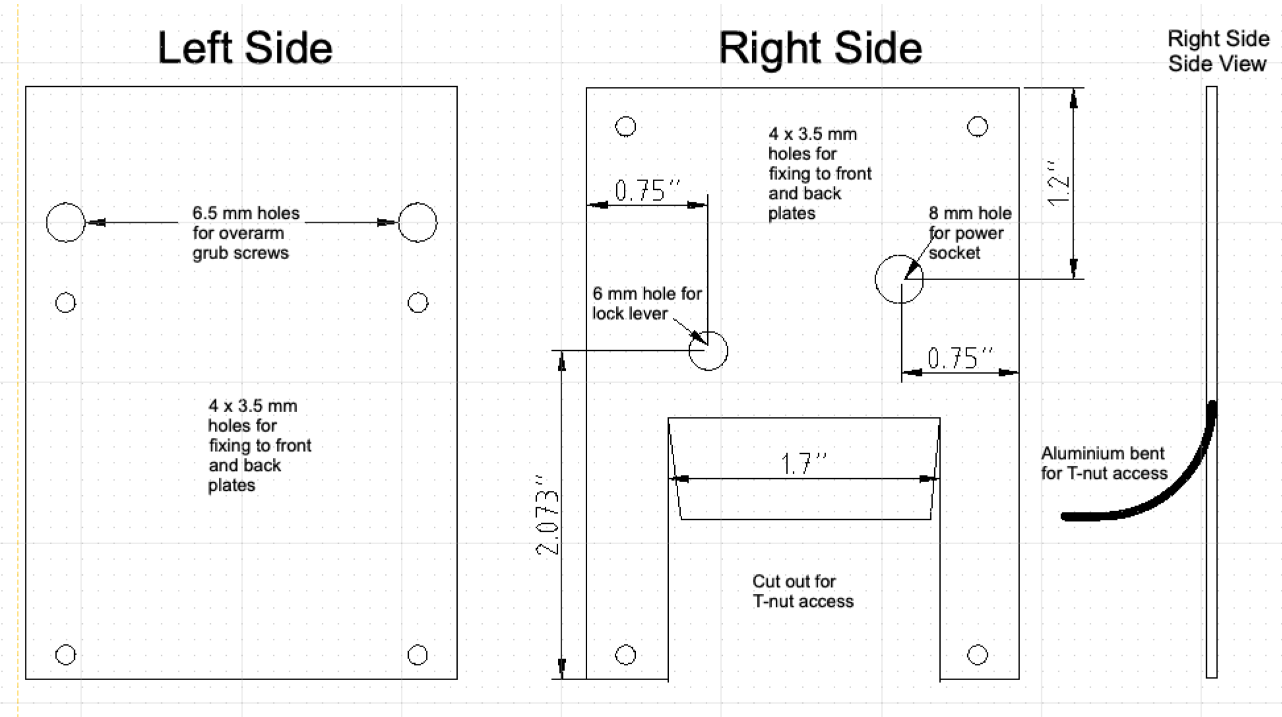
The drawing shows a 30 tooth worm gear requiring a 9 TPI worm, in detail, with the original 60 tooth arrangement and its dimensions specified.

This shows the improved depth of engagement of the 30 tooth gear with Acme profile.

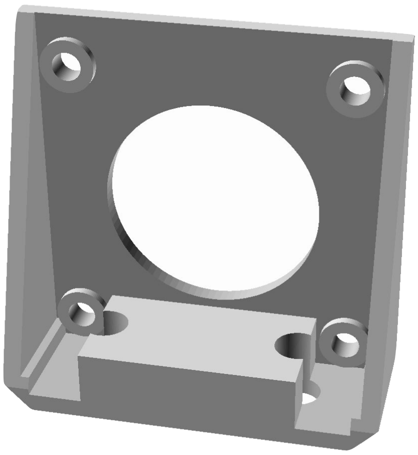
NB. These dimensions are calculated from the space between motor centre and lathe centre height assuming a 0.5 inch thick base on the case. This gives the 0.7462 inch mounting distance for the worm and worm gear. If these dimensions are followed accurately the motor will not require any height adjustment or wedge, but the gears must run concentrically, there is little room for error.
There are many different ways to cut the worm and worm gear. For the prototype I made a fly cutter for the worm gear and a matching form tool for the worm. The worm gear was offset for cutting to match the helix angle of the worm (6 deg for 30 tooth, 3 deg for 60 tooth).

Aluminium Side Plates

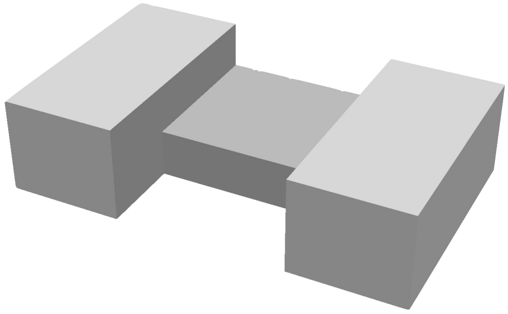
The casing is closed off with two aluminium side plates.
The left hand side is straight forward, as shown below, whereas the right hand plate is a little more complicated. This needs a cut-out to give access to the T-nut fastening but also needs to offer protection for the worm drive. This is achieved, as shown, by cutting and bending the aluminium. This side also gives access to the lock lever. It is important to make this lever so that the threaded rod can attach to the lever-arm after the side plate is fitted. If the lever arm and threaded rod are one piece it will be very difficult (if not impossible) to set the trigger for the lock. There is also a hole for the 12volt supply socket which must be mounted as shown if it is to avoid fouling the electronics.
The mounting holes shown for the cover plates need to be positioned so as to mate up with those formed in the front and back plates on the main casing.



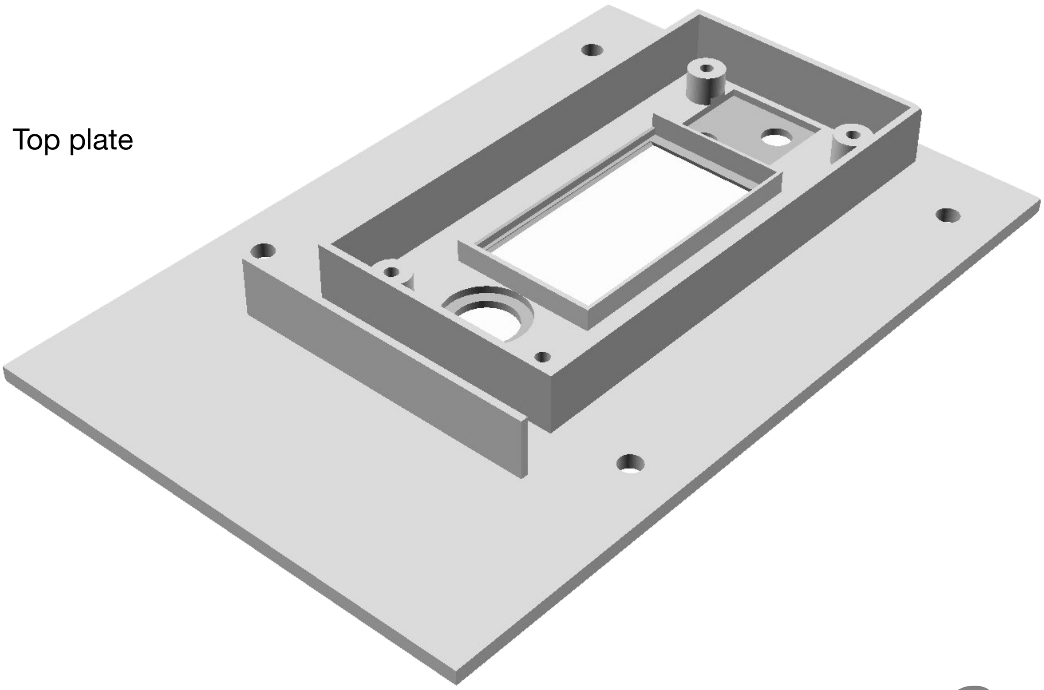
Plastic Components



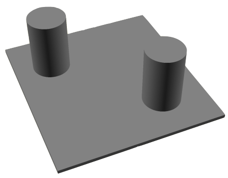
Moto Bracket



Wedge

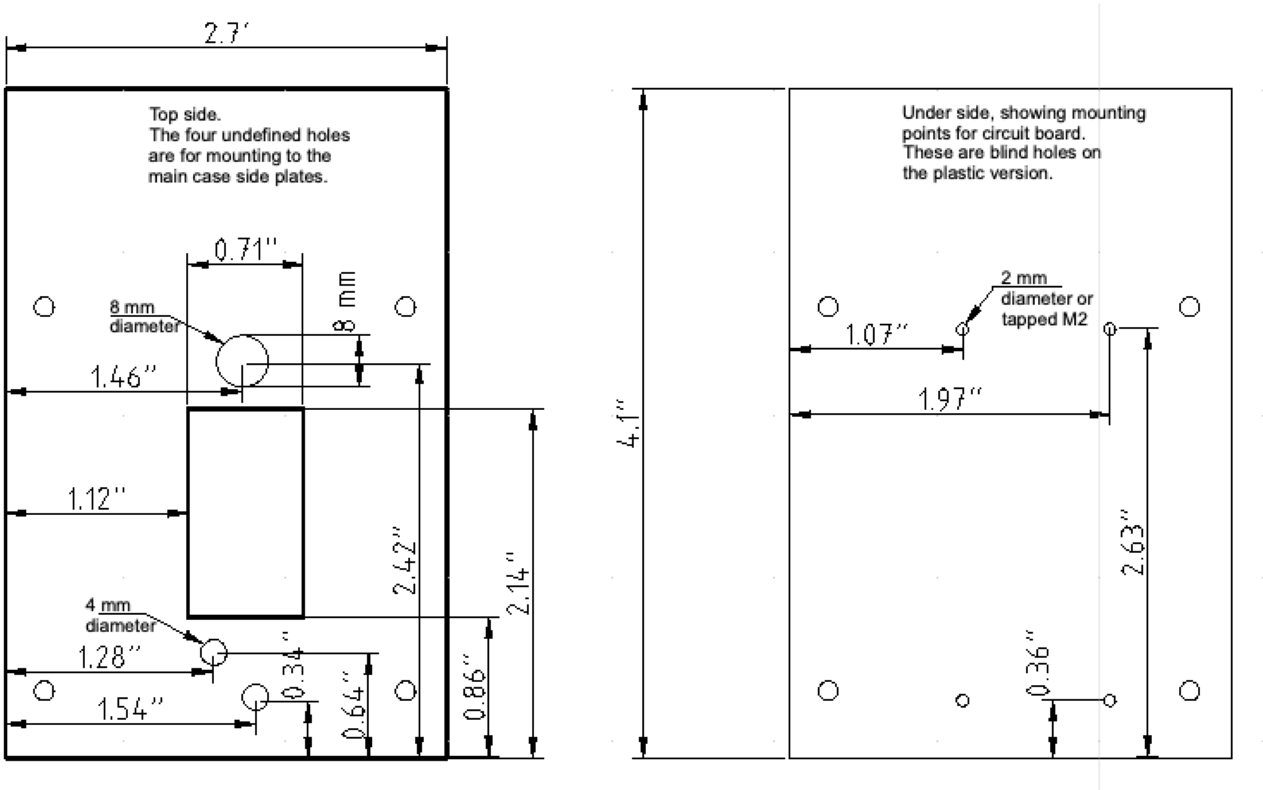


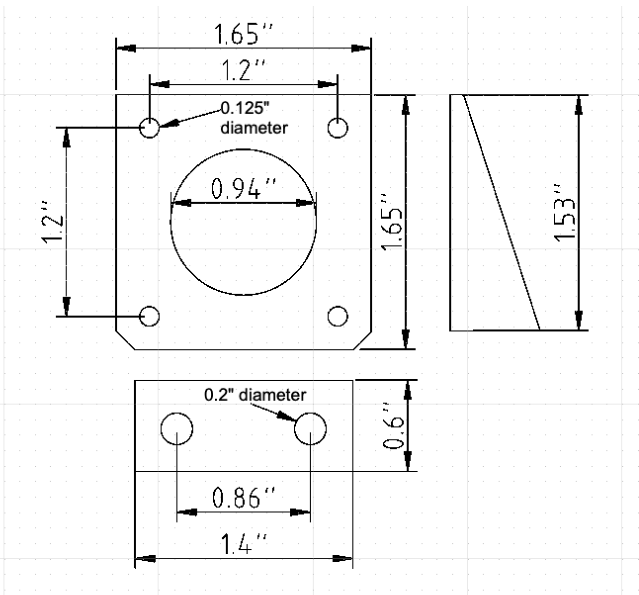
Top plate



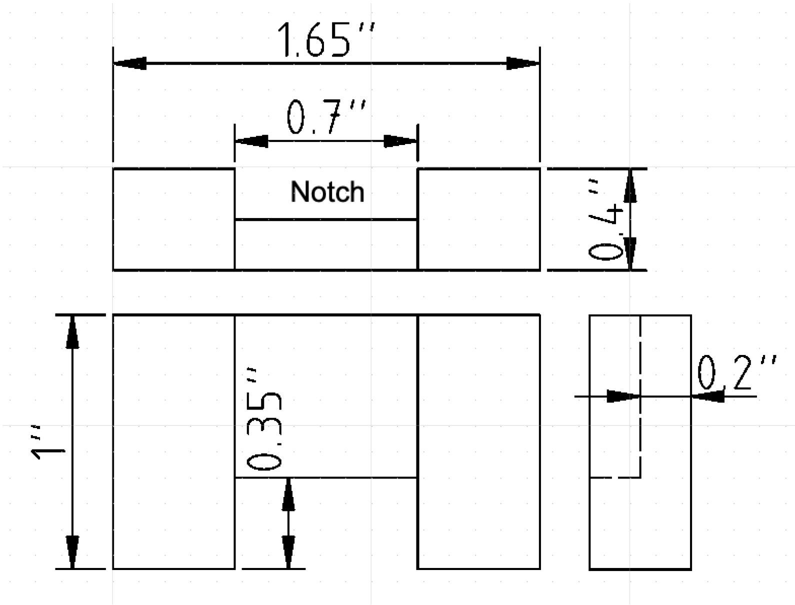
Button extender

If you prefer an aluminium top plate in place of the plastic one I used, here is a drawing showing the dimensions in inches. These are converted from the millimetres used in the plastic version. The top side is the important one for the cutout positions and hole sizes. The under side shows the position of the circuit board mounting holes. The plates length dimension allows for overlapping of the side plates.
If this is to be modified particular attention should be paid to the relative distance of the circuit mounting points and the outside edges. In the prototype it’s a snug fit. The buttons will need some form of extender if plastic isn’t used.





Here are dimensions taken from the motor bracket. They don’t attempt to imply a design in metal. The mounting holes shown at 0.86” apart would benefit from being closer together as they were very close to the motor mounting screws. Notice the raised block on the plastic version to alleviate this problem. The main case bottom plate will, of course, have to reflect any change. The chamfer was designed to clear the weld.

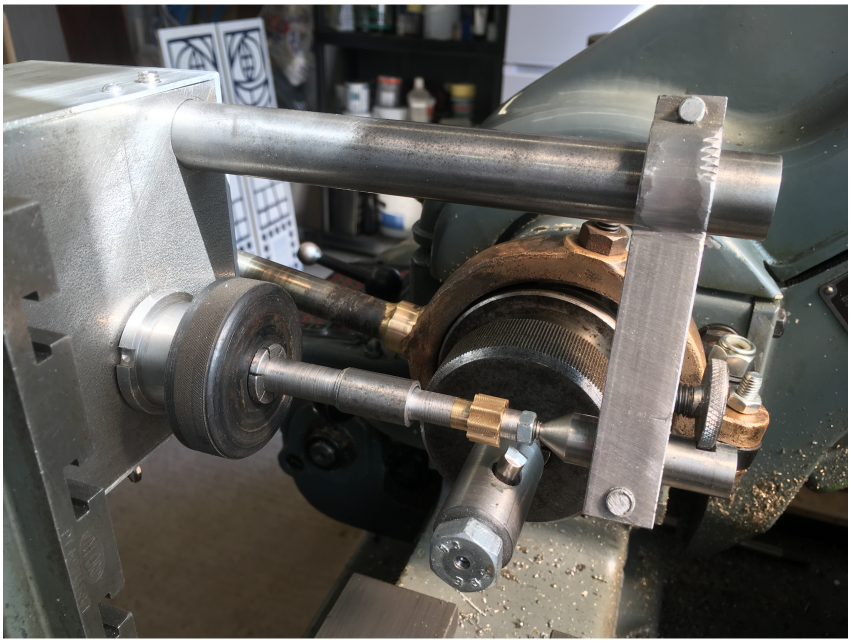


Here are dimensions taken from the plastic wedge. The notch is necessary to allow the motor wires to pass through. The thickness of the wedge (0.4”) is governed by the welded position of the steel angle, and must be made to slip between the top of the motor and the angle. This wedge was made as an afterthought and may be better integrated into the overall design. It could be used as a brace between the front and back plates, particularly if the construction is bolted rather than welded.

Photographs

30 tooth phosphor bronze worm gear and steel worm cut with an Acme profile.

30 tooth and 60 tooth worm gears compared. The 18 TPI worm was made too small, it should be similar diameter to the 9 TPI worm.
Although the 30 tooth gear looks larger in this photo, it is only very slightly bigger, but shows a much better tooth engagement. The profile on the 18 TPI worm is quasi Acme whereas the 9 TPI version is correct. Also note the difference in helix angle.



The Divider being used to fly cut a 9 tooth brass gear. Note the use of a home made Myford collet nose and collet, and the C-spanner notch in the nose flange.