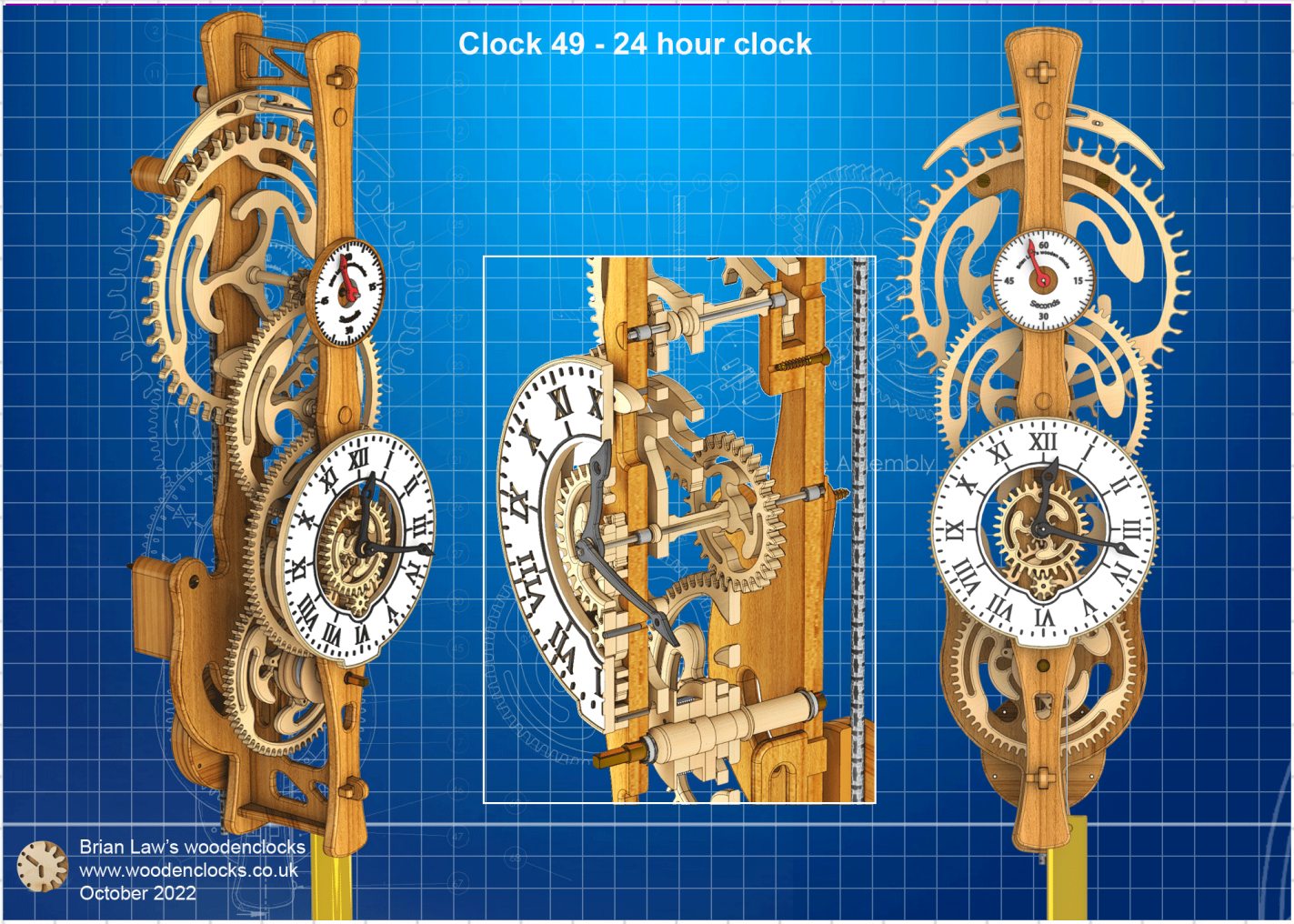
Clock 49 - 24 Hour Clock

Construction instructions for Clock 49



The design of this clock is based around a rather large Escape wheel at the top of a vertically orientated Gear-train. I was aiming for a sort of Dinosaur bones theme but the gears themselves developed along a more Alien line, it all seemed to work so I went for it. The Geartrain has been shortened to avoid making the clock overly long and uses a Half sized pendulum to keep all the movements within the clock itself. The configuration of the Geartrain also allows a Seconds dial to be added to give more balance to the front of the clock. A gravity ratchet has been added to the Drive train to make for quite winding.

The prototype runs for 25 hours with a 800 grm weight and has been running for several weeks now and is keeping good time to within 20 seconds in a 24-hour period. I have actually given up trying to get it to run any better as I am beginning to think its due to temperature fluctuations that have be occuring recently.

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Equipment

The following equipment is desirable:

CNC Router or Laser or Waterjet and if not one of these then a Scroll-saw or a Bandsaw.

Pedestal Drill or simple drill stand with work holding vice. There is a lot of holes to be drilled and cleaned up after CNC machining and fabrication so the drill is pretty much essential. It may be possible to get away with an ordinary electric drill in a stand but a work holding vice is still necessary.

Drill Bits in the following sizes,Ø2 mm Ø2.9mm, Ø3 mm, Ø3.1 mm, Ø3.2, Ø6 mm

Router Cutters Ø 2mm, Ø3 mm and possibly Ø6 mm for cutting out the larger frames.

Hand tools; all the normal things that are used in the workshop, Files, screwdrivers, hammer, pliers etc.

If you want to save a lot of time, then look at a **Sanding disk** and a **Drum sander** but these are really just nice to have.

Consumables
Sandpaper in various grades from rough to fine
Danish oil for finishing.
Gorilla Glue
PVA wood glue
Dry Film Lubricant in a spray can for the gears after everything is finished.

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Materials

For all the wooden Parts

The choice of material to build the clocks from is a very personal one and is down to you to decide. I prefer to use actual timber, Cherry for the frames and Maple for the gears and other parts. I use timber machined to a standard size of 125mm x 6mm, and 125mm X 10mm, and these are fabricated into blanks for the larger components by glueing two strips together.
You can, however, use a high-quality grade of plywood (Marine Ply) or MDF this route is a lot quicker as you can lay out multiple parts on a sheet and have the whole thing cut out in a day, still need to put in the time cleaning up the parts and making all the other bits, but generally speaking, the whole thing can be done a lot thicker. However, on this particular clock, I would advise against using Plywood for the Escape-wheel as the teeth on this part are very thin and can be fragile as they are used to transfer the impact force from the weight to the Pendulum and although this is not a high load it is constantly repeated every second.
You can also use Perspex with which you can create some colourful clocks
Whatever you use, the flat 2D parts are all laid out for you on the Profile cuts sheet, this comes as a DXF file that is 48” square, you can manipulate this in your own CAD program, which you will probably need to do, to be able to feed the files into your CAM program. For all the other parts:-

Ø3mm Drill Rod or Silver Steel 450mm Long for all the shafts and numerous pins.
No 8 or 10 wood screws 63 mm long for wall fixing 4 required
No 8 or 10 wood screws 25 mm long for Pivot support 1 required
Ø28.5 Brass Rod 155 mm long for the weight (800Grams)
Ø6 Brass Rod 35 mm long for the weight hanger
Ø8 Brass Rod 120 mm long for the weight
3 mm thick Plastic sheet for hands and Endstops, ABS or HIPS

Note these are the minimum amount of material necessary to build the clock I used more in the prototype and you may well be advised to buy extra to cover those accidental losses that occur. If I have missed anything here, you will find them in the parts list for the clock anyway.

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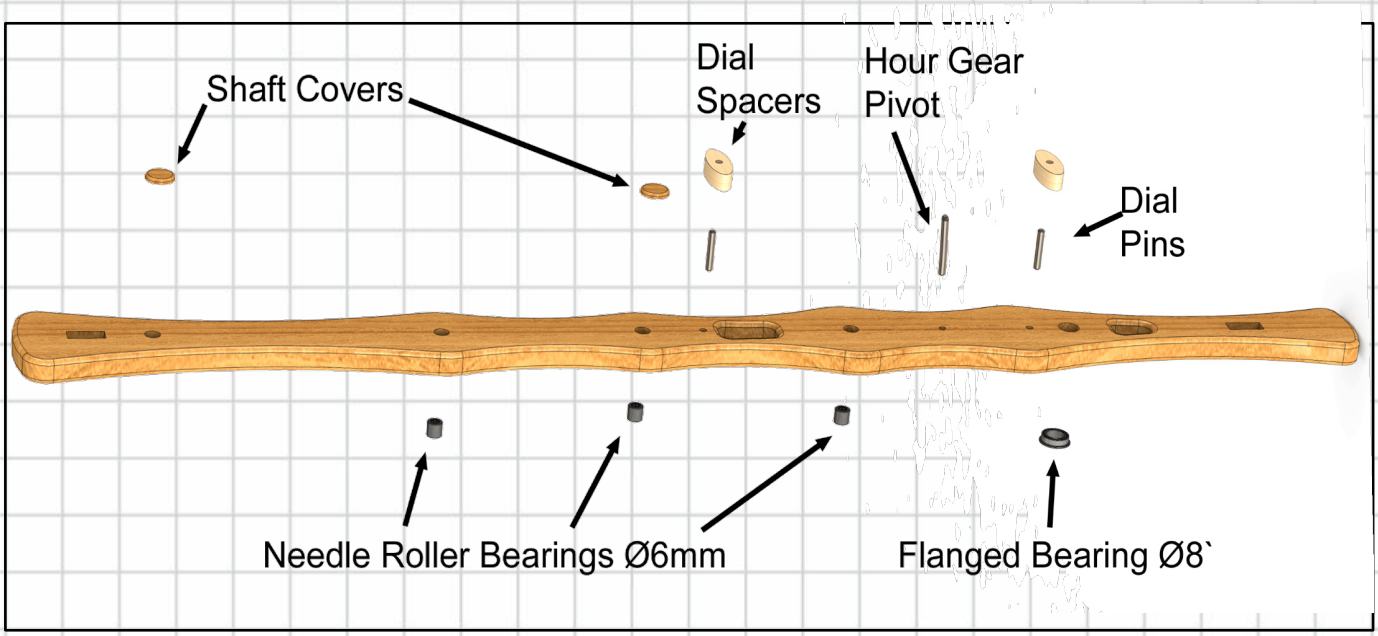
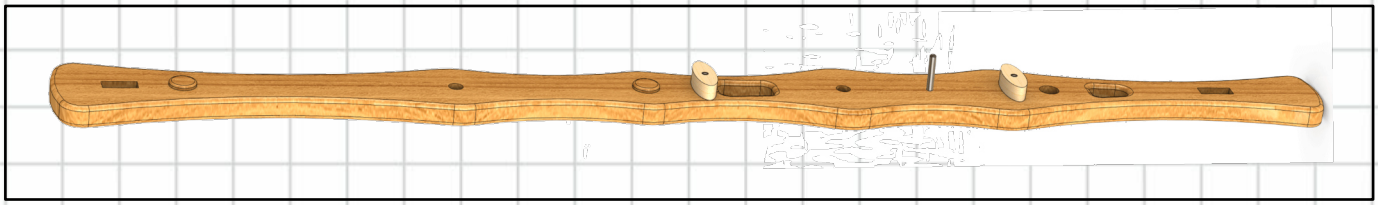
Step 1 Preparation of the Frames



Start by fitting the 3 Needle Roller bearings into their respective holes and then Flanged 8 mm diameter Bearing into its hole in the lower end of the frame. Now fit the 3 pins shown into the Front Frame and the placing the Dial spacers over the two outer pins. Next fit the Shaft covers over the holes they are capping.



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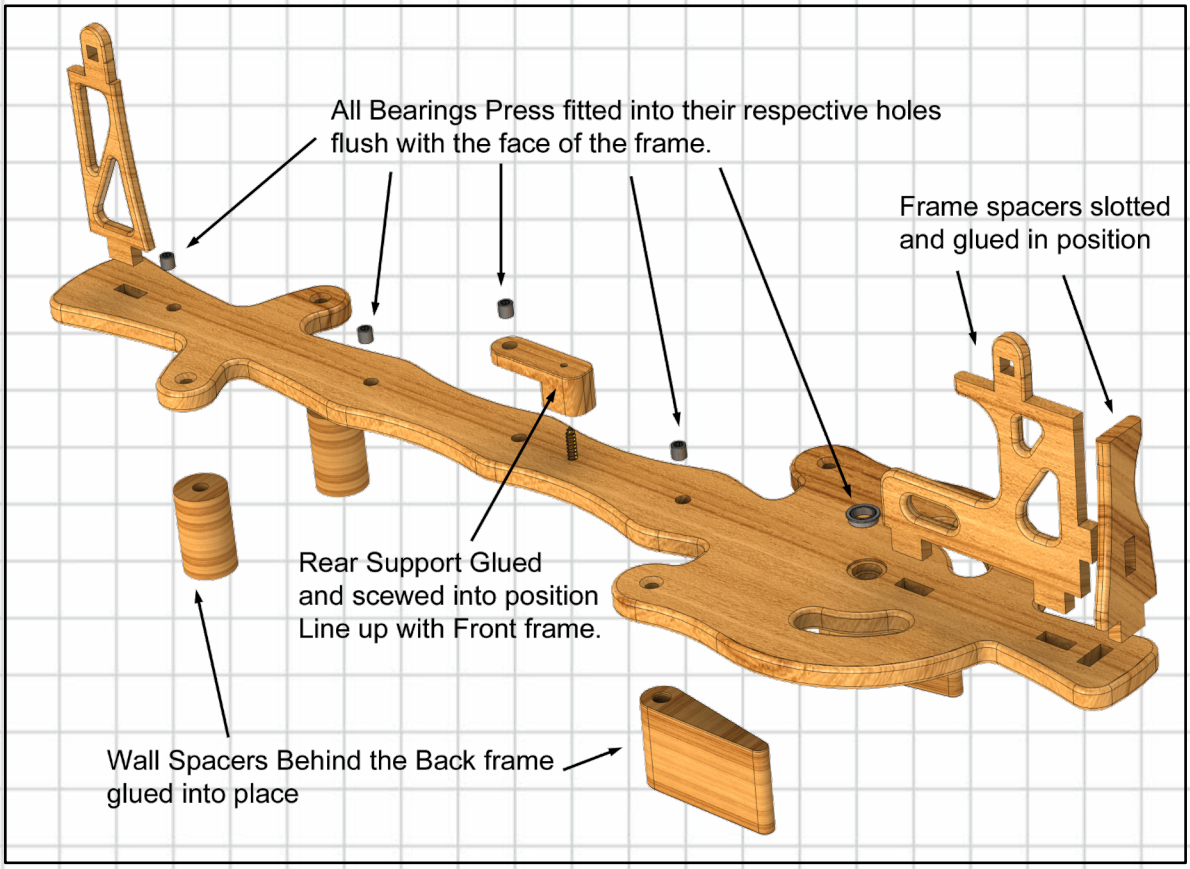
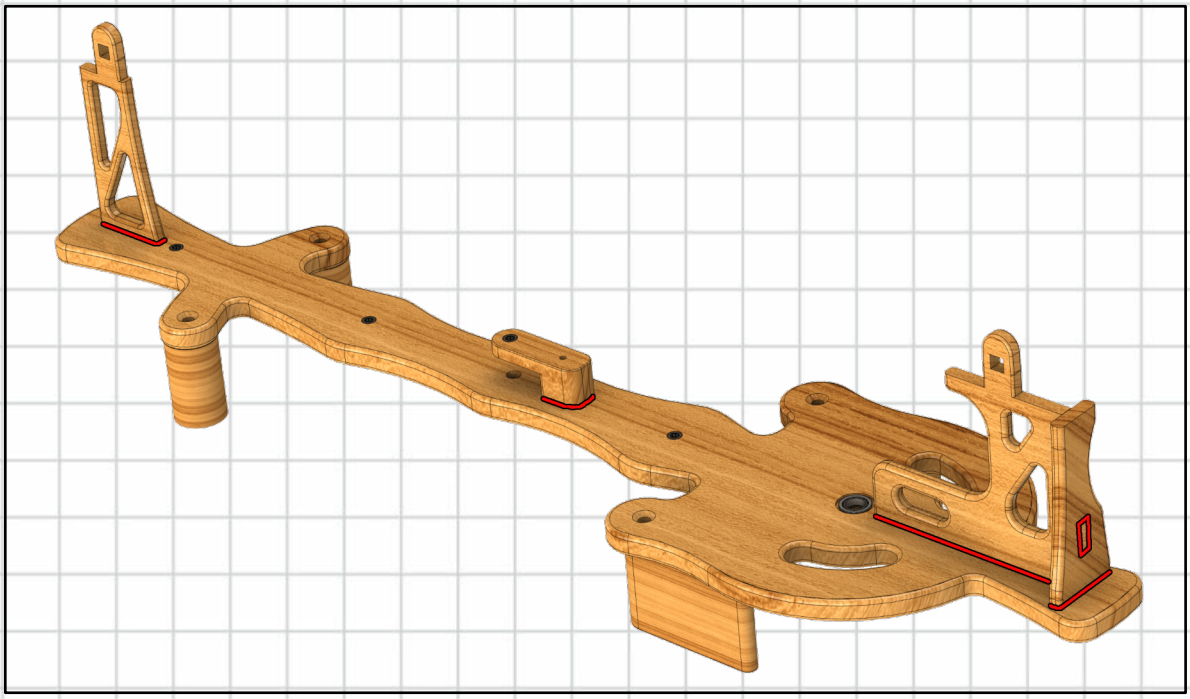
Step 1 Preparation of the Frames





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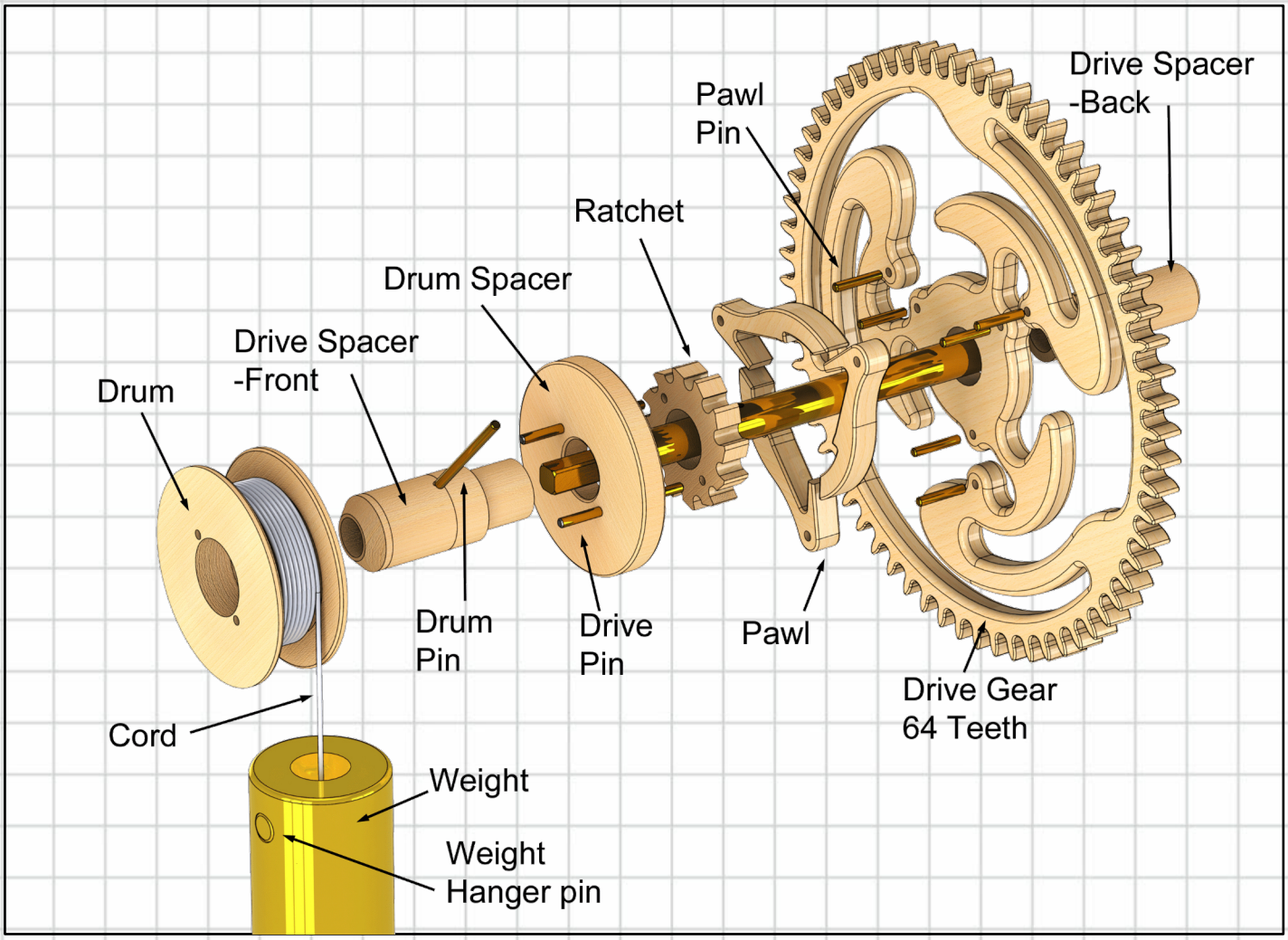
Step 2 Preparation of the Drive assembly



You will need to study the detail drawings to see a description of all of the parts in this sub assembly, it is the most complicated of the sub assemblies used on the clock, Take a special note about the fitting of the Pawl and the orientation of the ratchet.
The cord used to support the main weight is wrapped clockwise around the drum when viewed from the front.

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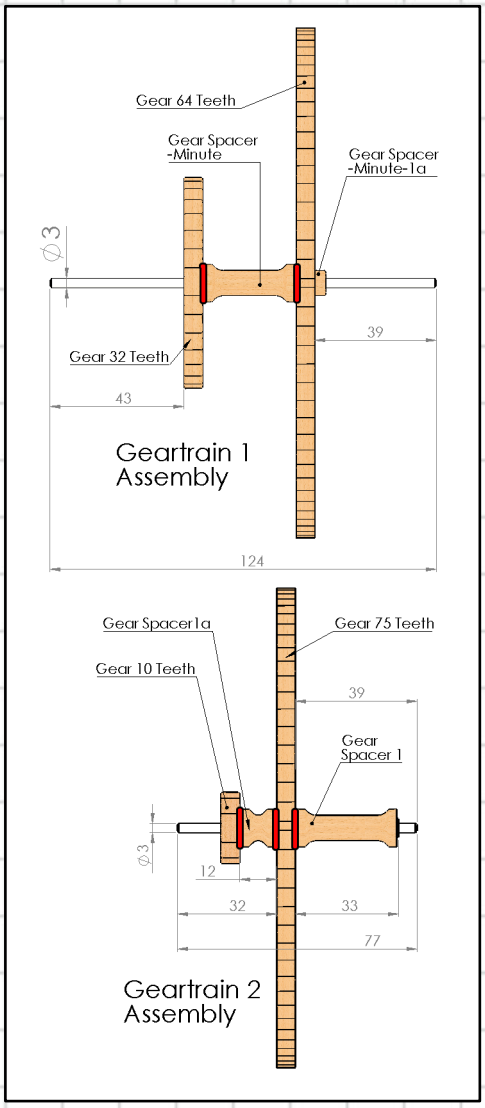
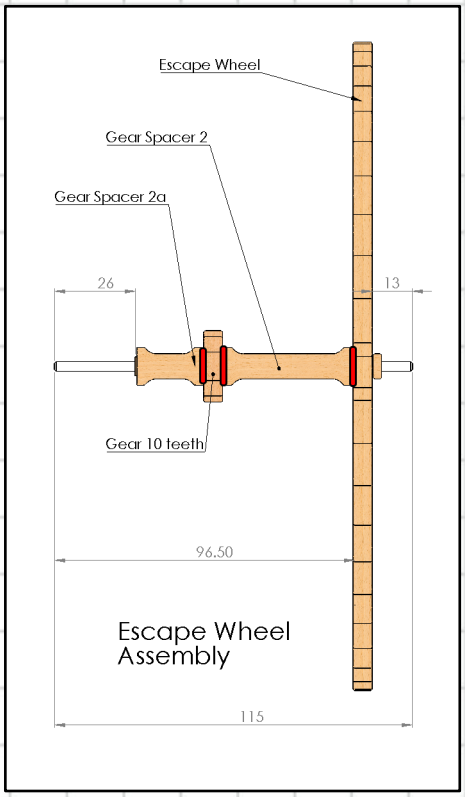
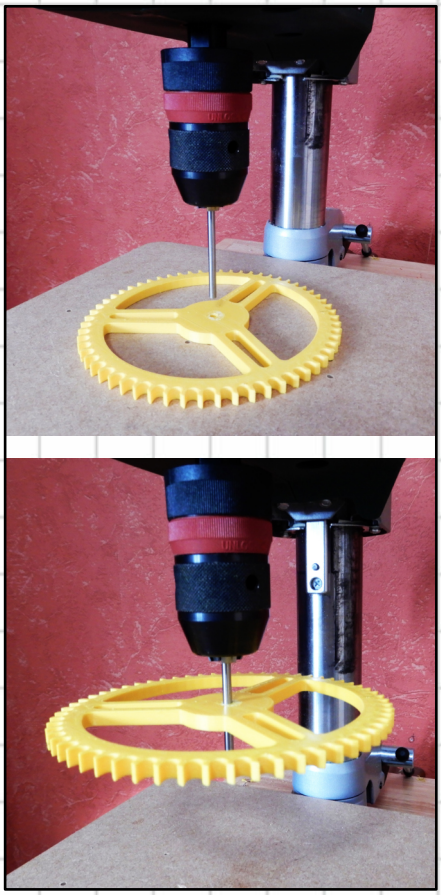
Step 3 Preparation of the Drive train sub assemblies







The Drive train sub assemblies shown above are all very similar and require to be assembled in the same manner. I recommend you use a drill press to do this as I have done, as it ensures that the gears are all mounted square to the shaft,.They should all be a **fixed** on the shaft. Make sure where shown in red to glue all gears and spacers together so there is no relative movement between the parts.

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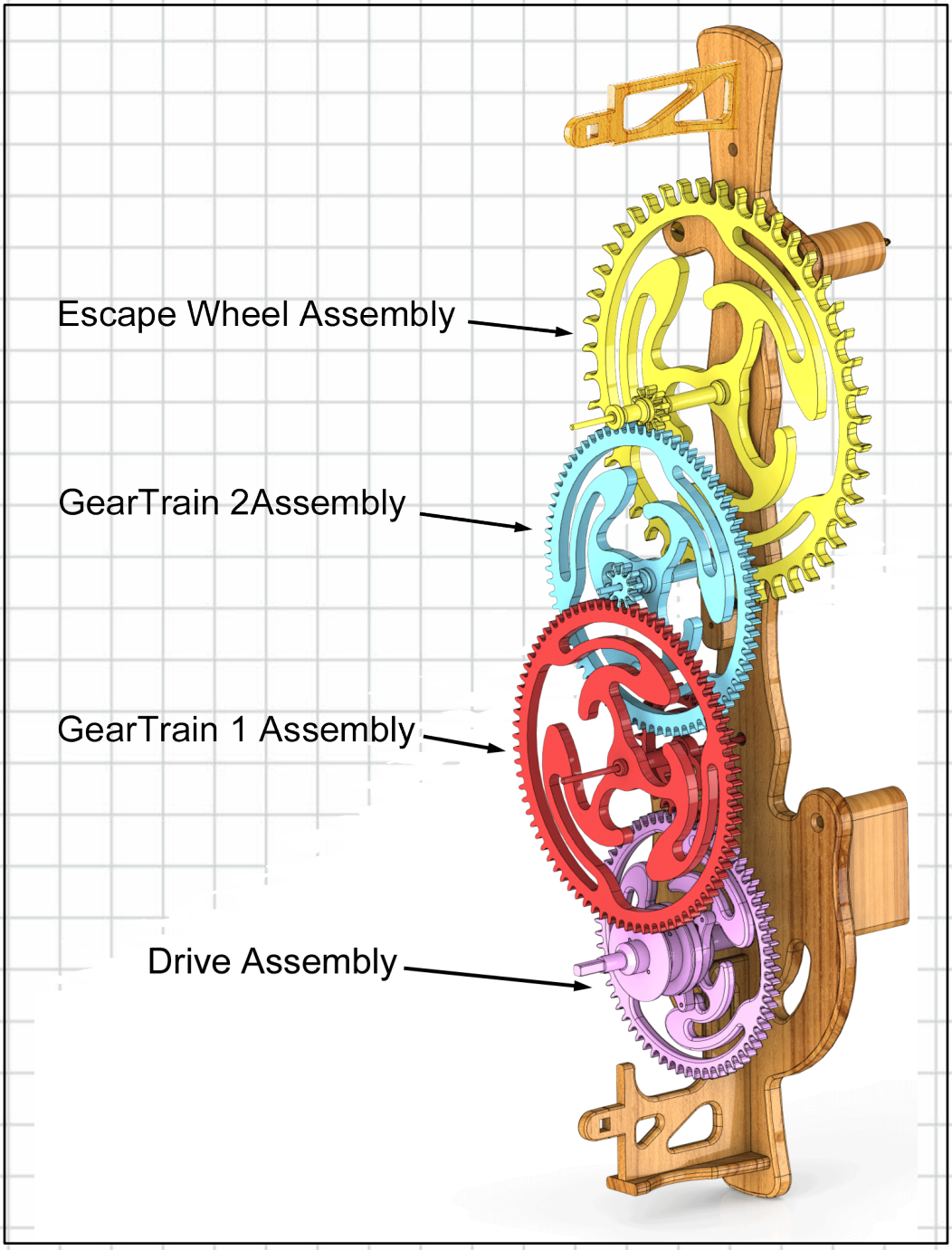
Step 5 Fitting the Gear trains



Load each of the Gear and Escape Wheel sub assemblies into the Back frame in the sequence, it is best to do this with the clock laying down on its back. Fit the Escape wheel first using the shaft to hold it in place. Next place Gear train2, followed straight the way with Gear train 1

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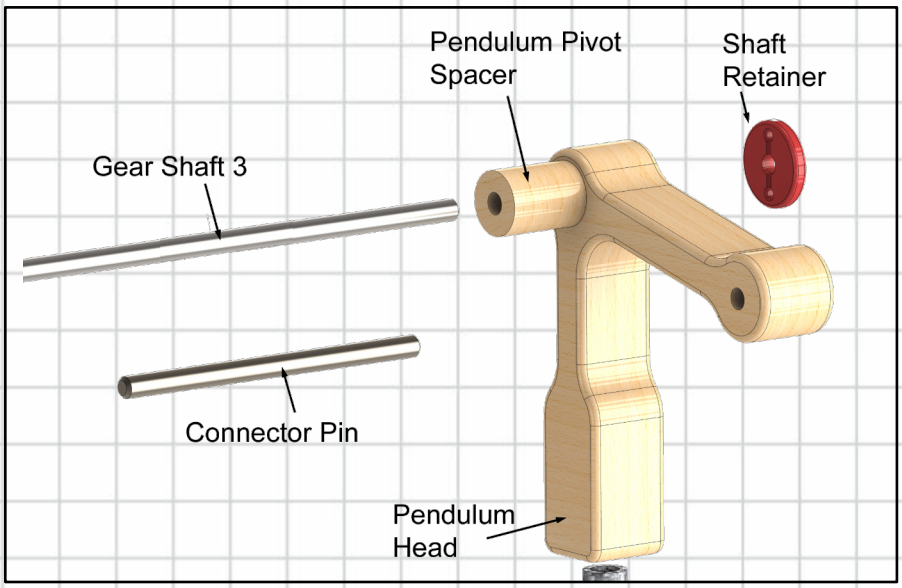
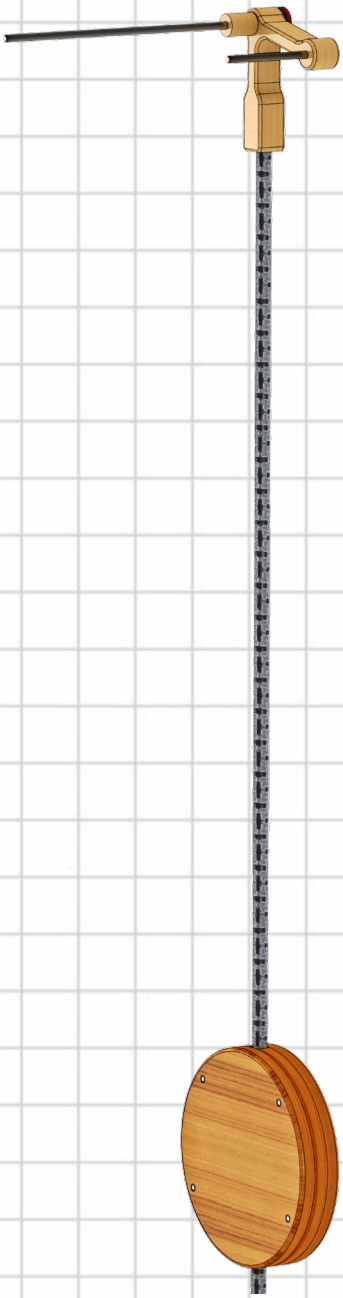
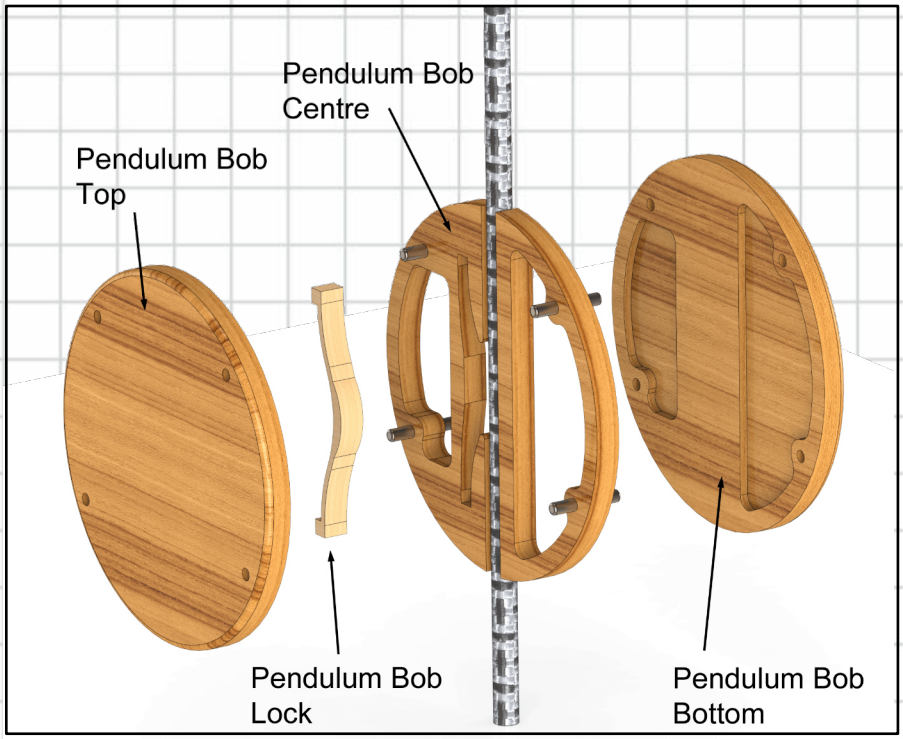
Step 6 Preparation of the Pendulum sub assembly





First glue the Pendulum Pivot and the Pendulum Head together and then slide onto the Gear Shaft 3 letting it protrude through the back of the Pendulum Head sufficient so that the Shaft retainer can be fitted. Now press the Connector pin onto the other hole ensuring it is a tight fit. The Pendulum rod is the pushed into the bottom hole and glued in place.



Fix the Top and the Centre parts together using the 4 pins, then lay the Ball bearing into the pockets to get ottal wheight around 150 grams. Fit the lock in position and fit the top part, then slide onto the pendulum Rod.

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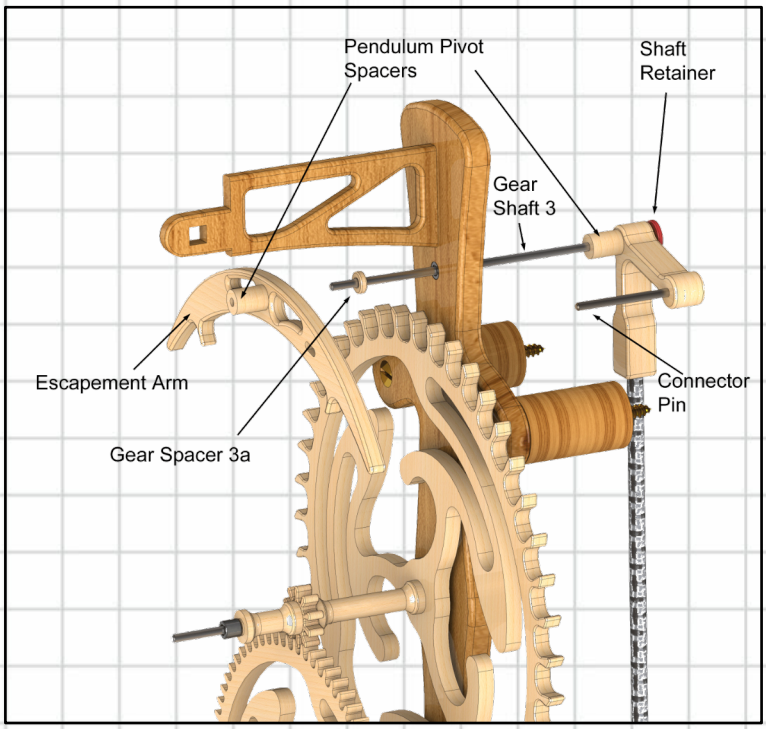
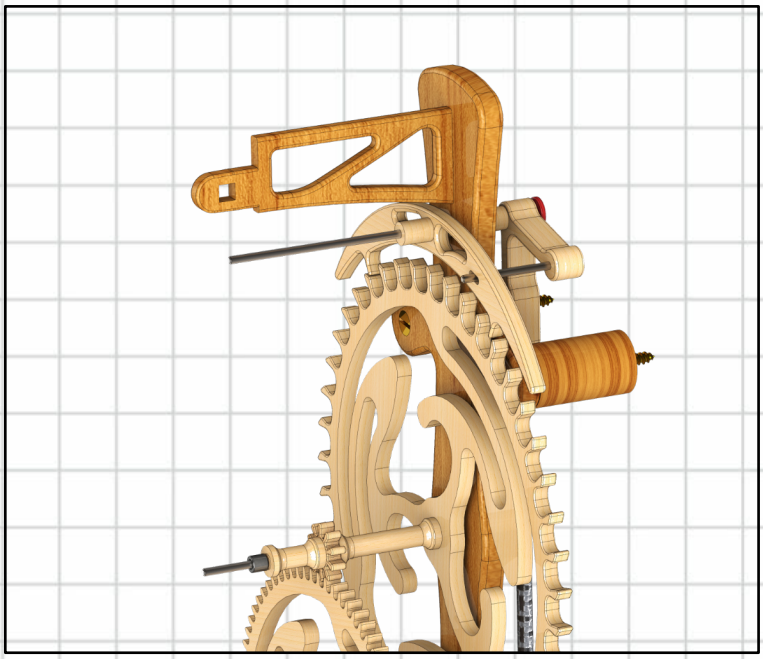
Step 7 Fit the Escapement Arm



Glue the Pendulum Pivot Spacer to the Escape arm making sure to keep the two parts properly aligned whilst the glue dries, by sliding a shaft in place between the two of them.When dry drill through with the 3.1 mm diameter drill to remove any excess glue

Slide the Gear Spacer 3a onto the Shaft

.Now slide the Escapement Arm onto the protruding shaft and secure with the endstop shown below.



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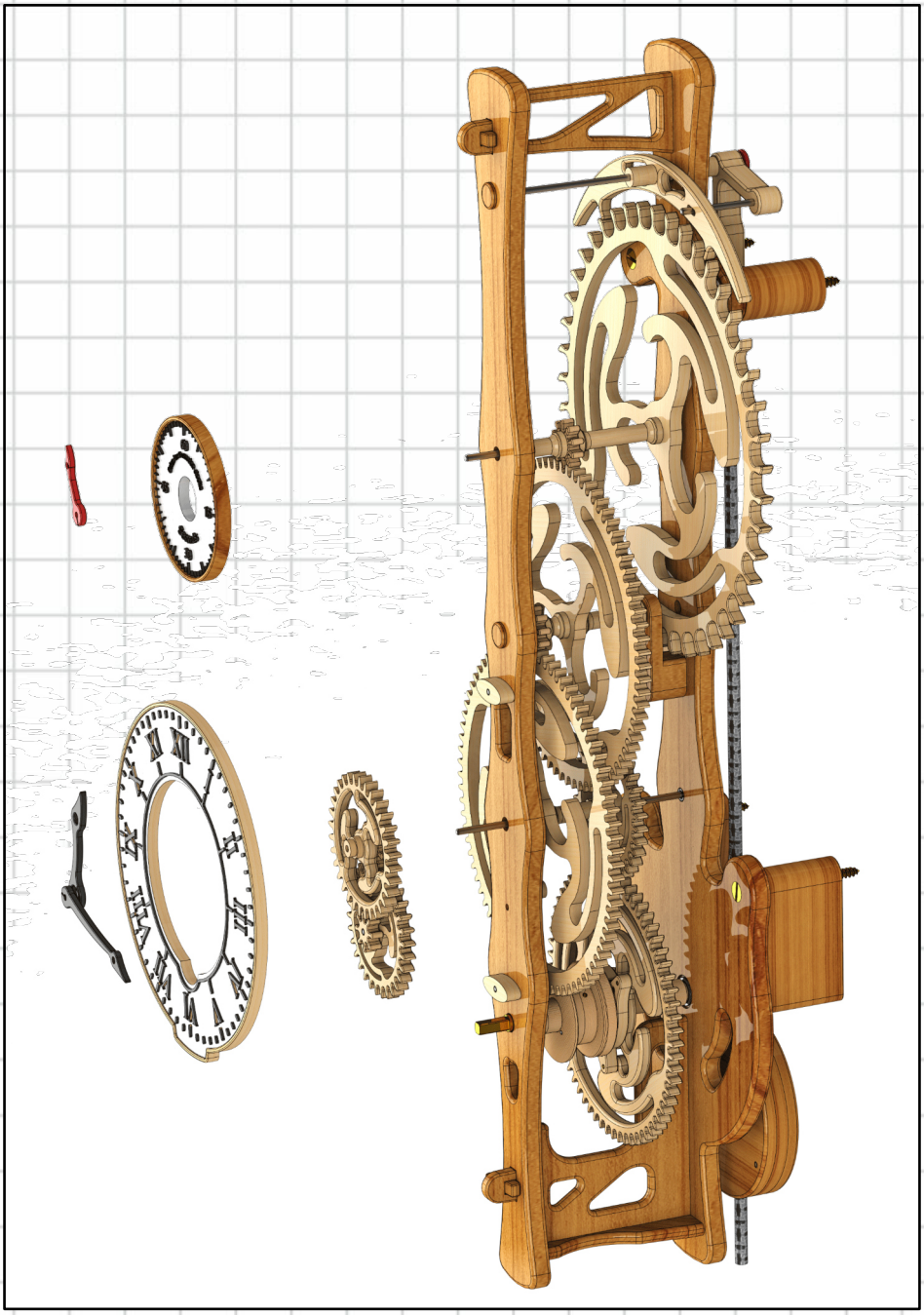
Step 6 Fit the Front Frame



Fit the front frame by fitting over the2 protruding Frame Spacers and engaging the the protruding gear shafts. Secure in position with the 2 Wedges.
To fit the Hour gears push the 10 toothed gear onto the minute shaft, this should be a tight fit so it can transmit the drive through to the next gear in the chain. The slot cut across the hole is to give it some flexibility so you ca push it on and Pull it off if needed. Now glue the 8 tooth and the 30 toothed gears together and fit on the short shaft below the Minute shaft. Should be free to run.
Now fit and glue the Hour tube into the 32 toothed gear and make sure it can can run freely on the Minute shaft.Now fit the Hands and the Dial to its oritruding pins.

Finally glue the seconds dial to the fron frame and fit the seconds hand..

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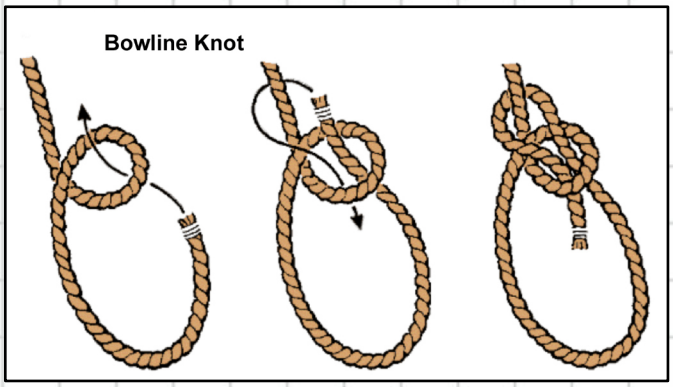
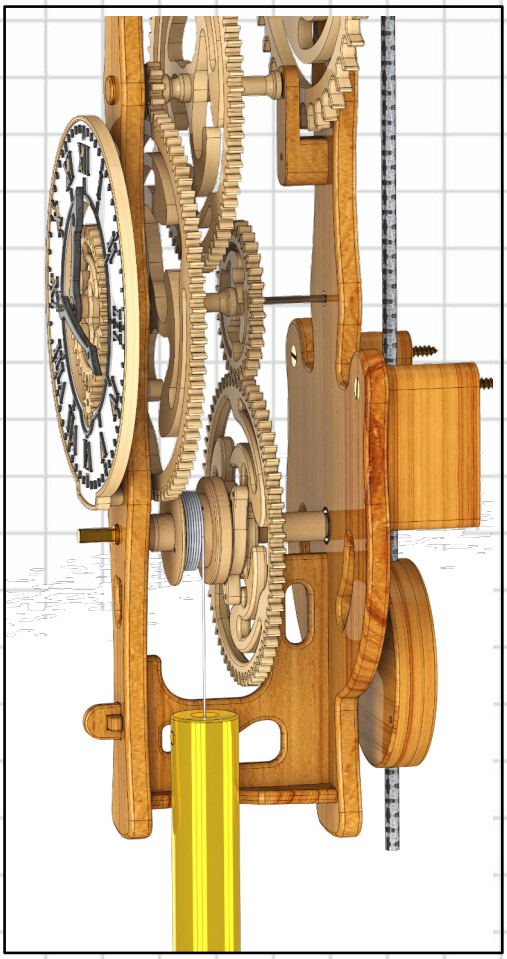
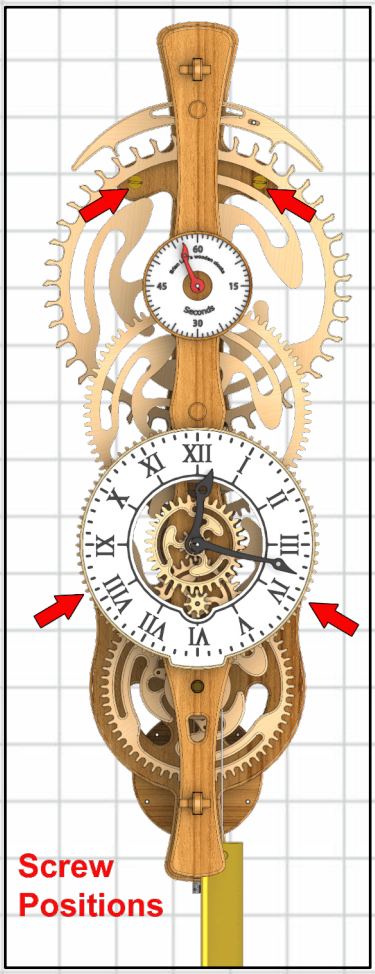
Step 8 Setting up the Weight and Cord and getting it running

Before fixing the clock to the wall you need set up the Cord on the Drum, the Cord should be The length of the drop fom Drum to floor plus 200 mm extra for tying off and wrapping around the drum. Take care to wrap I Clockwise around the drum other wise the gravity ratchet will not engage. At the other end of the cord tie a Bowline Knot to engage with the weight Haning Pin







After assembling the clock and fixing the Cord the clock can be mounted vertically onto the chosen wall with the centre of the Dial at a height of around 160cm this should give a running time around 25hours.

First use the Screw hole on the Right Hand side behind the Dial and secure the clock with a single screw in that position. Make it tight enough to hold the clock in a Horizontal position. Fit the second screw at the top left position and tighten until you can still move that side of the clock up and down slightly as you are going to need to do that to get the clock running smoothly. Add a weight of around 800 grams and set the Pendulum Swinging. Watch the action of the escapement arm and observe how much it enters between the teeth on either side, now move that side of the clock either up or down until it enters the same amount on both sides and the clock is ticking evenly. Tighten the other screw and then add the other two screws . Thats it now over time you can adjust the pendulum Bob up or down to get the clock running faster or slower.

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HINTS AND TIPS

- I need to use headed pins for some of the shafts in this clock design but small diameter Clevis pins are hard to find and so I have looked for alternatives. Round nails might work although the finish on those can be quite rough, An alternative I have used on this clock is a plain steel dowel for the shaft and a small plastic split washer that is slightly undersized, I couldn't find a source for these either but they are fairly easy to make. Another alternative is to use carbon steel ground pins for the shafts, and then fit a larger diameter Rod type magnet to cap the end and prevent any parts falling off. Best not to use these close to any ball bearings as it can apply a drag to the rotating balls

- The Pendulum Bob needs to be fitted so that the centre of the Bob is about 110cm from the pivot point. This should allow the pendulum to swing a complete cycle every two seconds. The pendulum swing can be adjusted to make the clock run faster or slower by moving the Bob up to speed it up and down to make it run slower. I have found over the years that a slightly heavier Pendulum Bob is an advantage as it seems to overcome any momentary fluctuations caused by a sticking gear train, to achieve this on this clock I have added 9 mm diameter steel ball bearings to the pocket inside the Pendulum Bob, making the overall weight around 120 grams.

- Establishing the actual weight to use for the main clock weight, is done initially by trial and error. Each clock build is different and that has an effect on the size of weight to use. I normally use a large Coke bottle partly filled with water to start and add or remove water to get the clock running continuously.
  You would do this finally after assembling the clock and making sure everything is running freely and the escapement is set up correctly. Usually, a bit of back and forth here to adjust the escapement then adjust the weight.
  There are many styles of weight that can be used and I have shown several of these in a separate article that can be seen here
  https://brianlawswoodenclocks.blogspot.com/2021/05/the-woodenclocks-weight-drive.html

- If you intend to print out the clock profiles for use in conjunction with a Scrollsaw the this article from my Blog should help https://brianlawswoodenclocks.blogspot.com/2014/09/printing-clock-plans-using-pdf-and-dxf.html
  I would also recommend printing the parts using Foxit Reader as it seems to give a better solid black print out than Adobe Acrobat,

- Before assembling any gears onto their shafts cut all the shafts to length and then try them between the front and Back assembled frames, they should be free to rotate and slide forwards and backwards a small amount all quite freely.

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Construction instructions for Clock 49

HINTS AND TIPS - continued

- Main Weight between 750-1000 grams
- Distance from pivot to centre of Pendulum Bob 110cms
- Run time 24 hrs when dial is set at 1600 mm above the floor.

- When fitting the gear sub-assemblies into the frame make sure the mating gears engage and run smoothly. The faces of mating gears should be aligned so they fully engage with each other, i.e. the front faces of the gears are lined up. There is some clearance built into the design so that when the gears are enclosed between Front and Back frames they are free to move without rubbing on the frames.

- For the dial on this clock you could use a V bit cutter to cut out the numerals and minutes ring. I use Artcam Express which gives a good clean-cut edge and very fine detail without having to use extremely small diameter cutter. A free alternative to Artcam is a program called F-Engrave, There are many ways to construct the dial some can be found here in a two part article from my Blog https://brianlawswoodenclocks.blogspot.com/2014/11/clock-dials.html https://brianlawswoodenclocks.blogspot.com/2014/11/clock-dials-part-2.html

- If you have problems getting the clock running initially it could be that the problem is in the gear train itself, one or more of the gears may not be meshing correctly,
  You need to test each pair of gears in turn, by mounting each meshing pair in the frames on their own and turning them by hand very slowly with little pressure. if any pair sticks or interferes with the other you should mark the teeth that are affected and carry on until you have turned the large gear around completely, then strip down and dress the teeth you have marked until they work together smoothly. Repeat this process for all the meshing pairs of gears are running freely.
  It is not sufficient to test them when the gears are mounted in the clock and then left to run continuously unrestricted, as the free running gears will easily override any slight interference, whereas when the gears are running in the clock with the escapement in place they never run fast and so easily feel the effects of interference.
- Alternatively the Pendulum / Escapement may not be running freely on the 3 mm diameter shaft they are fitted to. The parts should be a running fit in the 3 mm diameter shaft.

- The DXF files supplied include all the parts that can be cut using the CNC router, they do not include any pins or nuts and bolts, information on these parts are included in the Detail drawings supplied in PDF format.

- The parts shown laid out in a single DXF files ready for you to extract and use in your CAM software. The profiles are shown on 6 separate layers , these being ‘Outside Cuts’ ‘Inside Cuts’ ‘Pockets ’ ‘Non Cutting Profiles’ and ‘V cuts’ and ‘Chamfers’. The layers are colour coordinated as shown.

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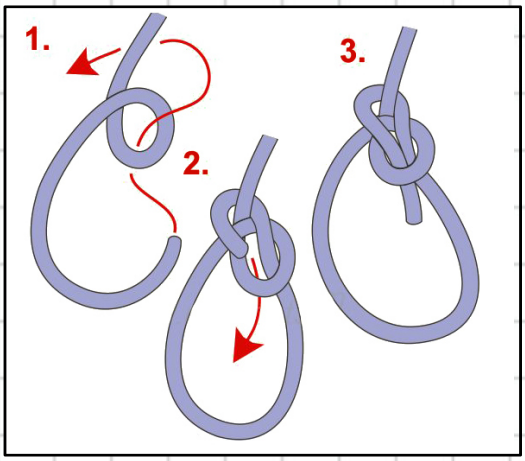
Construction instructions for Clock 49

HINTS AND TIPS - continued



I always use a Bow Line Knot on the end of the cord holding the driving weight of a clock, it is one of the most useful knots you can know. The Bowline forms a secure loop that will not jam and is easy to tie and untie. The Bowline is most commonly used for forming a fixed loop, large or small at the end of a line. Tried and tested over centuries, this knot is reliable, strong and stable. Even after severe tension is applied it is easy to untie.