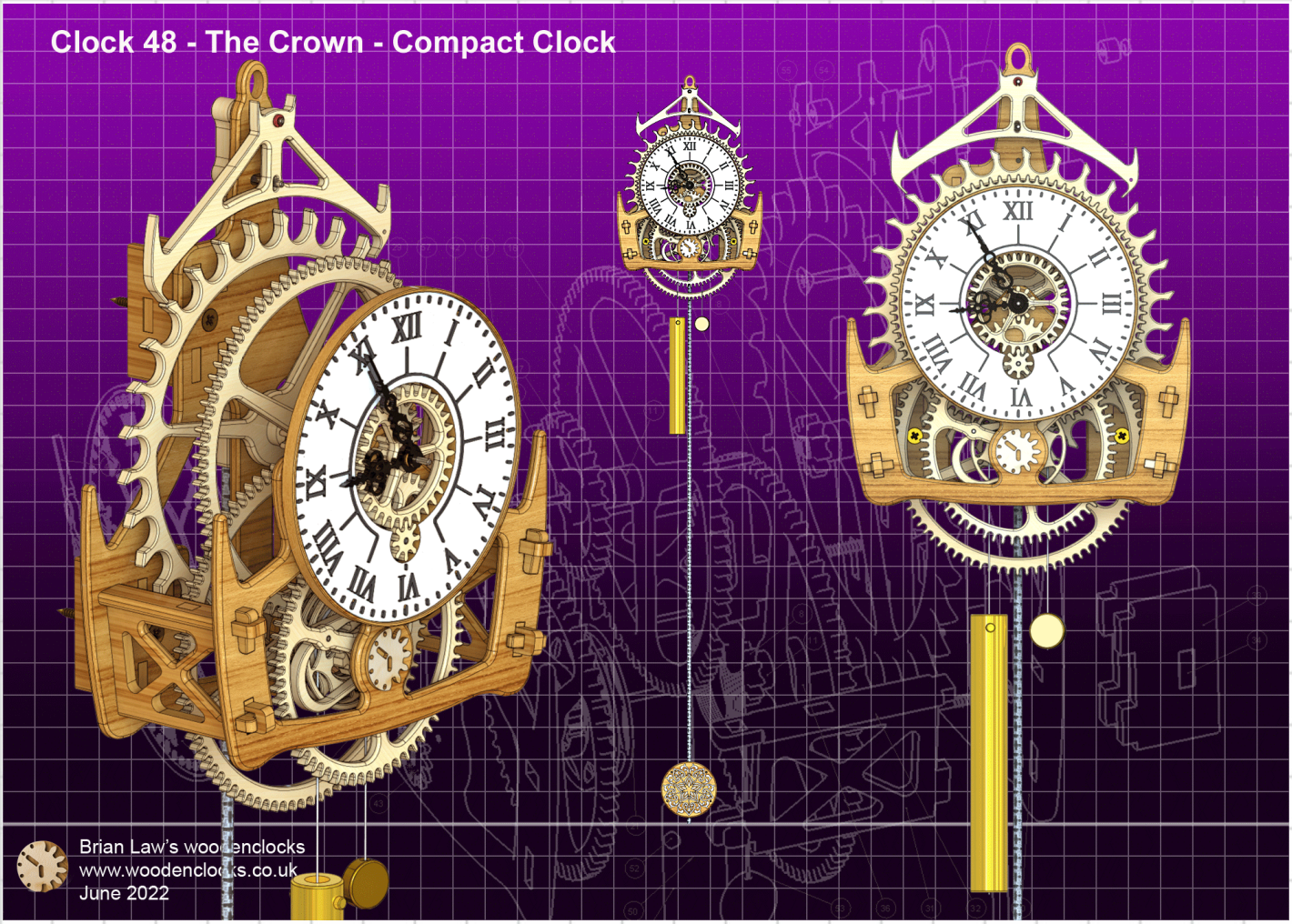
Clock 48 - The Crown - Compact clock

Construction instructions for Clock 48



This clock I have termed the Crown because it does have a passing resemblance to one and it is after all the year of the Queens Jubilee.
I have used a new design for the gear train which has one less shaft and two less gears than the ones used before. It is also folded over on itself so as to make it more compact and yet run for longer with less weight. This arrangement combined with the simplified Escapement makes it easier and quicker to build without loosing any accuracy. It is designed such that all of the parts can be cut with your CNC machine so no need for a lathe on this one. although I would recommend you have some form of drill press to assemble the gears to the shafts. I have shown it here with a Brass weight but I have also included the files for the construction of a box to hold either Lead Shot or Catapult Ammo (ball Bearings) to provide an easily adjustable weight.

The prototype runs for 25 hours 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.

Clock 48- The Clown - Compact Clock

Construction instructions for Clock 48

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, Ø2.9mm, 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.

Clock 48 - The Crown - Compact clock

Construction instructions for Clock 48

Materials

For all the wooden Parts

The choice of material to build the clocks from is a very personal one and is really 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 these are fabricated into blanks for the larger components by gluing 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 layout 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 60 mm long for wall fixing 3required

No 8 or 10 wood screws 25 mm long for Pivot support 1 required

Ø30 Brass Rod 140 mm long for the weight (800Grams)

Ø6 Brass Rod 25 mm long for the weight hanger

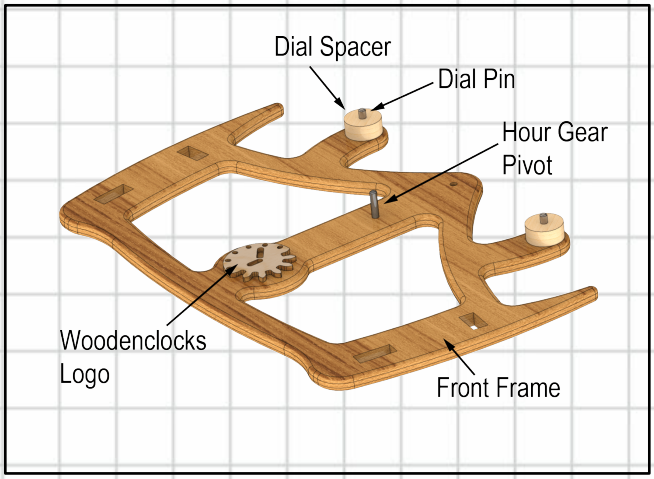
3 mm thick Plastic sheet for hands and Endstops, ABS or HIPS

Note these are the minimums amount of material necessary to build the clock I used more in the prototype and you may well be advised to by 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.

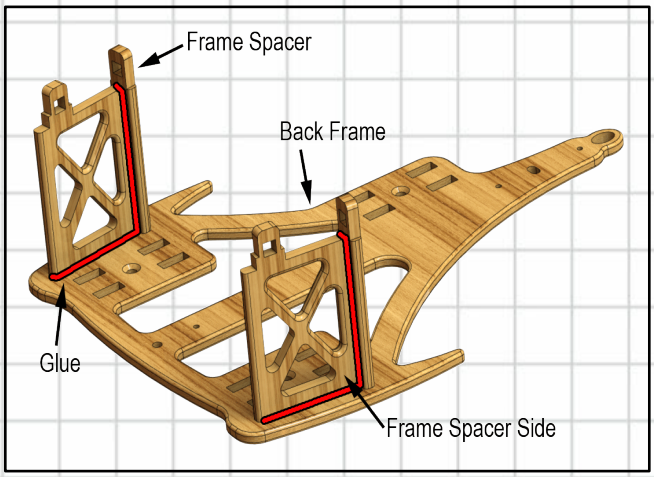
Clock 48 - The Crown - Compact clock

Construction instructions for Clock 48

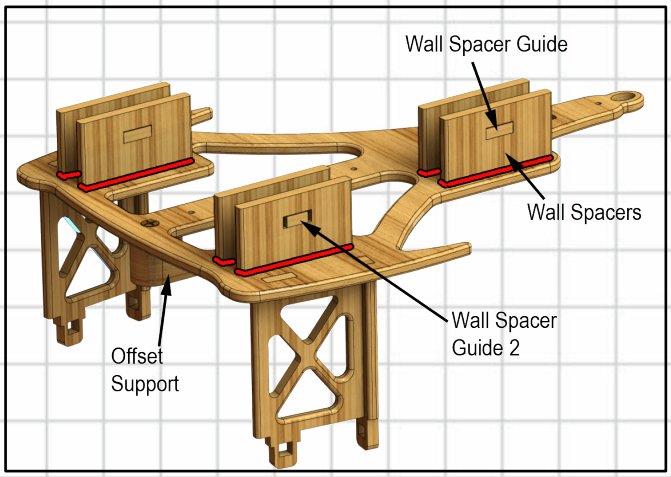
Step 1 Preparation of the Frames



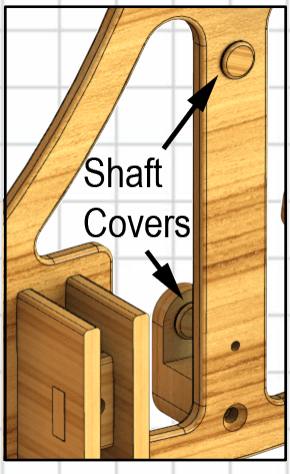
Start by fitting the 3 pins shown into the Front Front Frame and the placing the Dial spacers over the two top pins. The woodenclocks Logo acts as a shaft cover for the bottom shaft.
Note the hole in the centre of the front frame needs no cover as the Minutes shaft protrudes through this one.



Fit and Glue the Frame spacers and the Frame spacer sides in place. Make sure they sit vertical by fitting the front frame temporarily .



Fit the pairs of Wall spacers and their guides together and then glue in place to the back of the Back frame.Note the Wall spacer Guide 2 is free to move up and down a bit to aid aligning the clock on the wall.



Shaft covers need to be fitted to the rear of the Back frame as well to prevent the shafts from protruding through the back face. This keeps all the meshing gears aligned.

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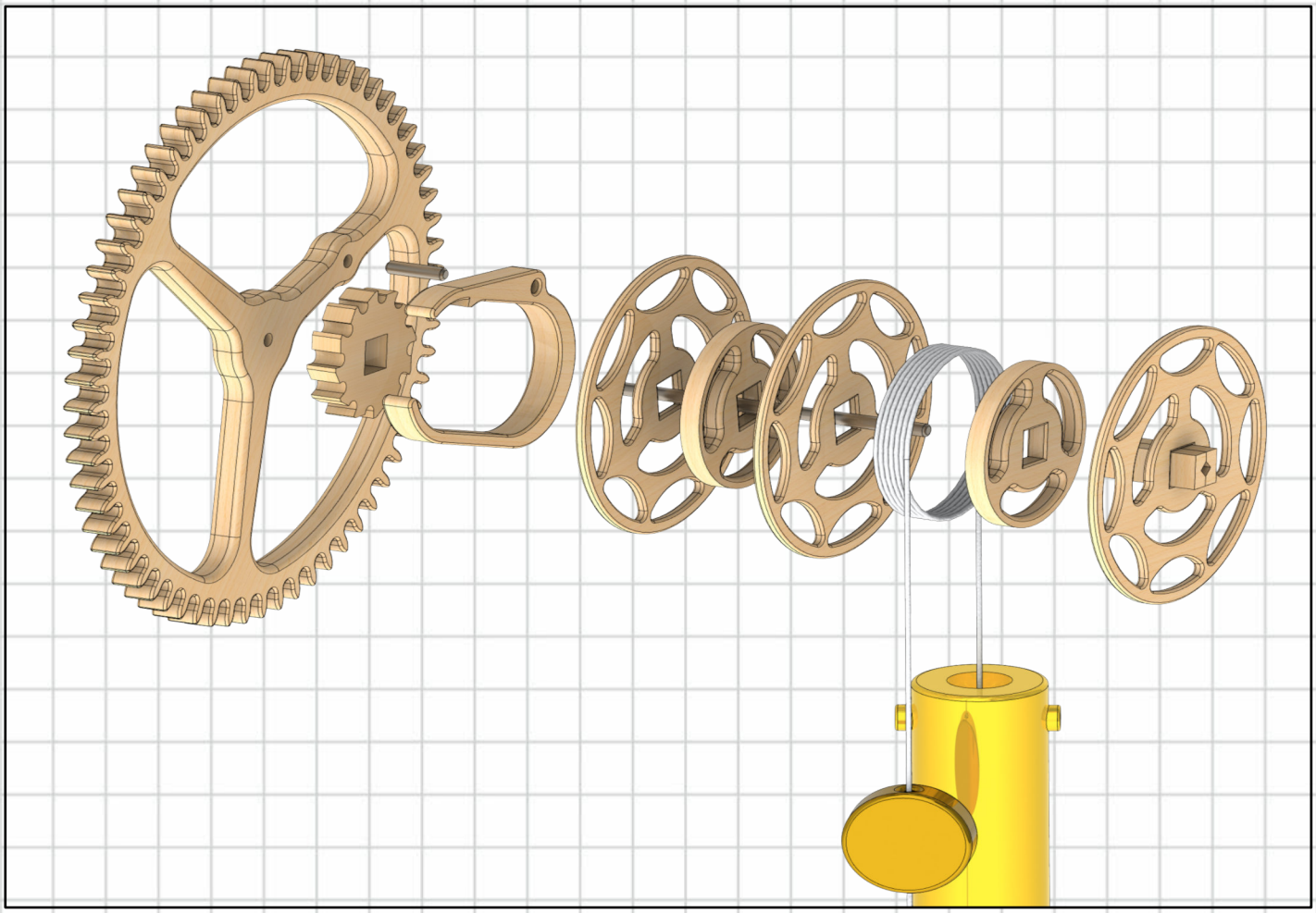
Construction instructions for Clock 48

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 anti-clockwise around the drum closest to the 64 toothed gear when viewed from the front, the other cord is used to rewind the clock and is wound in the opposite direction. The cord should

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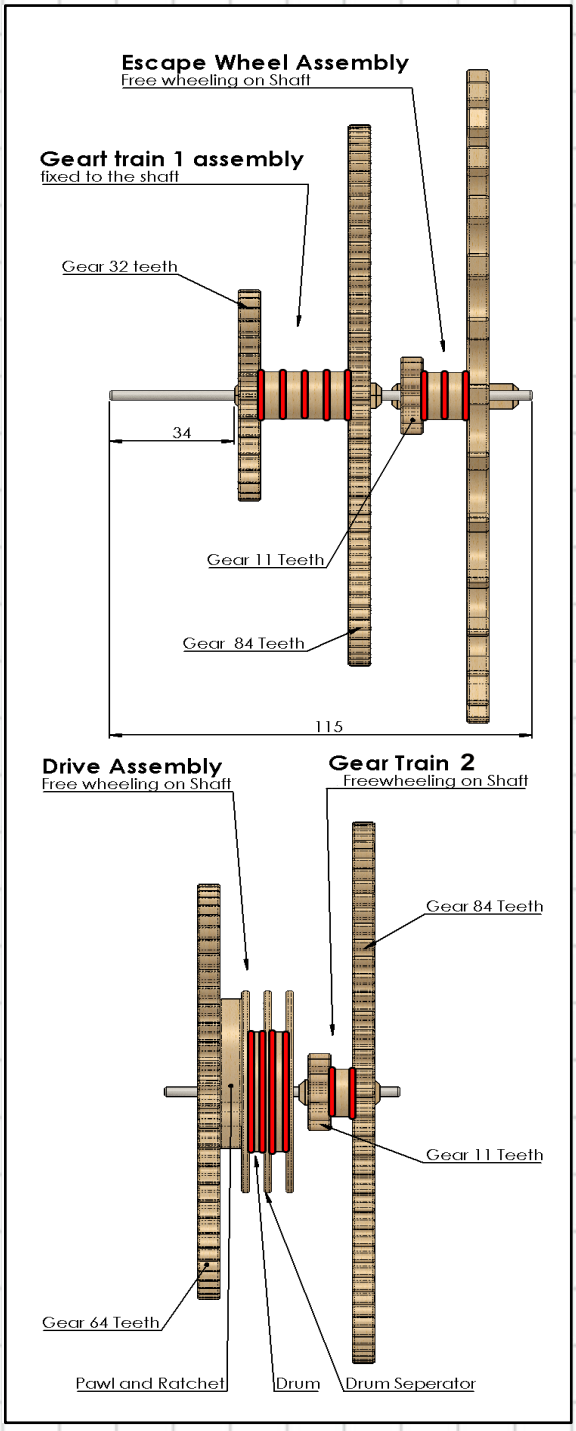
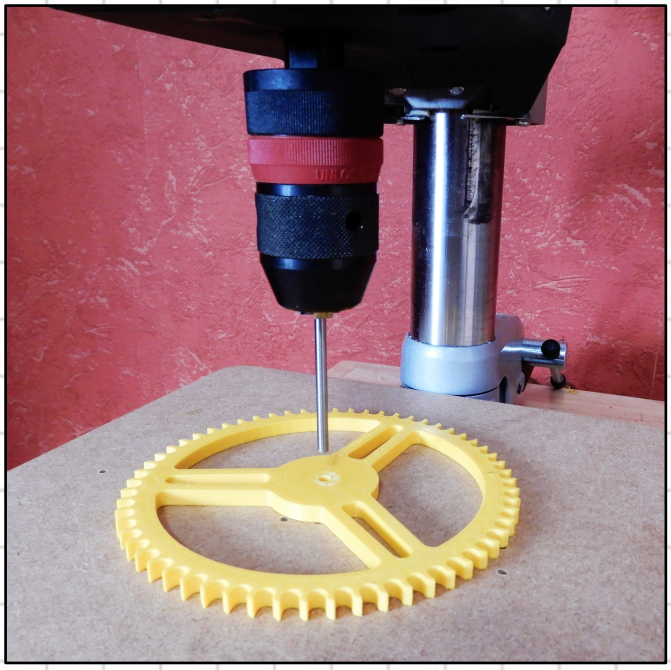
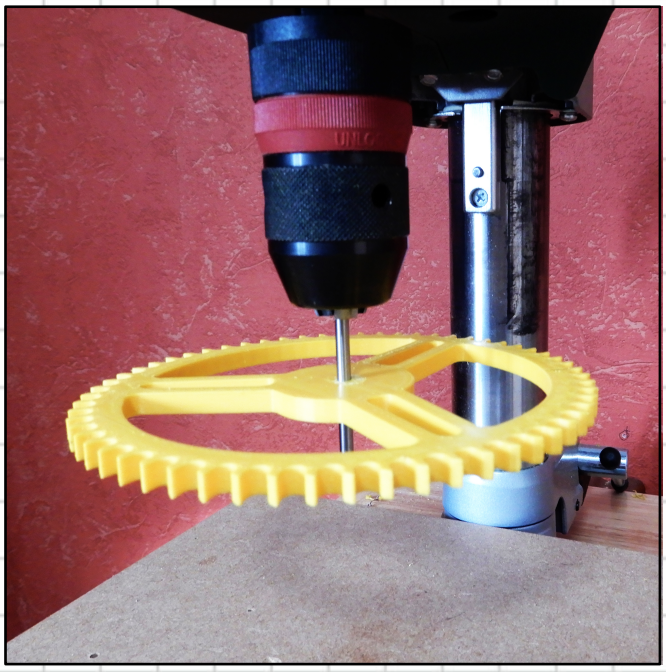
Construction instructions for Clock 48

Step 3 Preparation of the Drive train sub assemblies





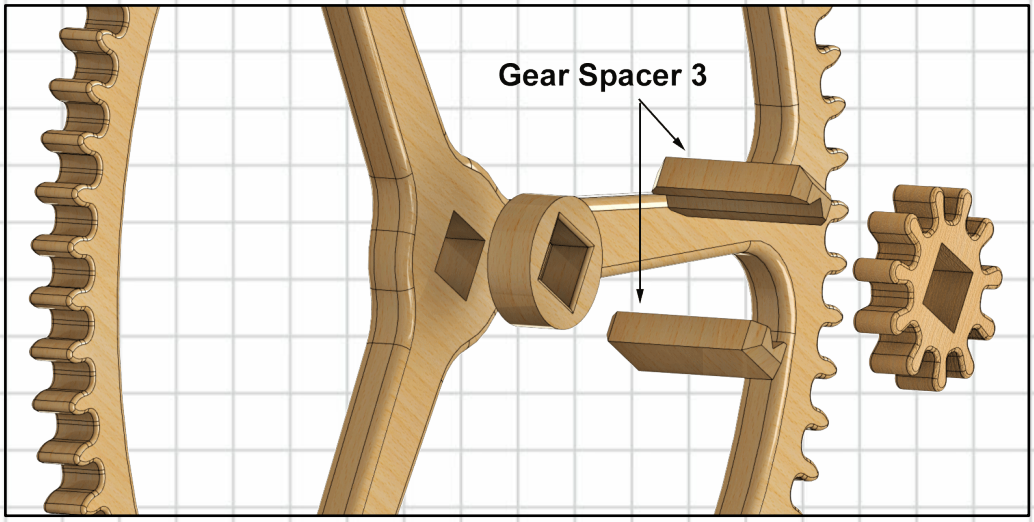


The Drive train sub assemblies shown above are all very similar and require to be assembled in the same manner. I recommend you use a drill press to do this as I have done, as it ensures that the gears are all mounted square to the shaft,.They should all be a Free wheeling on the shaft except for the **Gear train 1**. Make sure to glue all gears and spacers together so there is no relative movement between the parts.

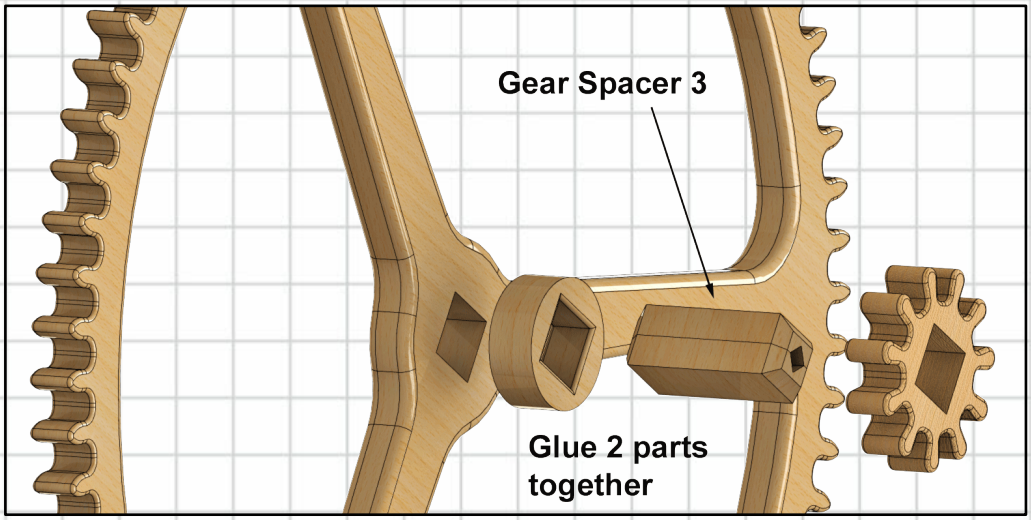
Clock 48 - The Crown - Compact Clock

Construction instructions for Clock 48

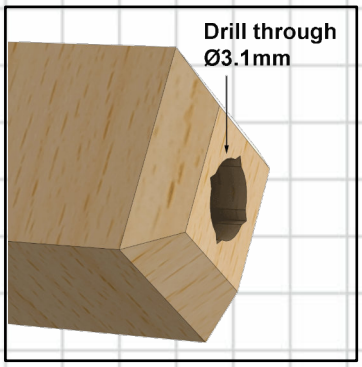
Step 4 Preparation of the Drive train sub assemblies``



Glue together the 2 parts of Gear Spacer 3

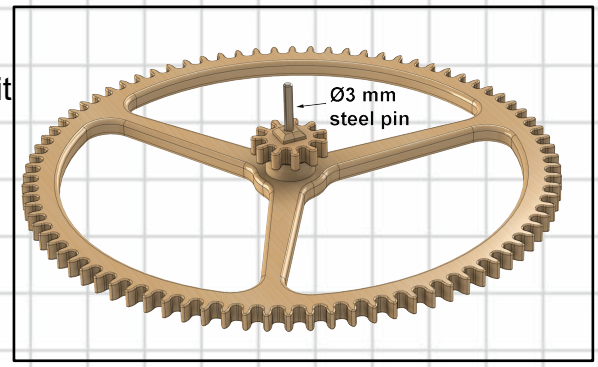


Note!



Geartrain1 needs to be a tight fit

on its shaft



Drill through the spacer with Ø3.1 mm drill to produce a lose fit on the shaft. Drill and fit a 3mm pin into your bench and assemble and glue all the parts on to it. This should keep all parts square to pin

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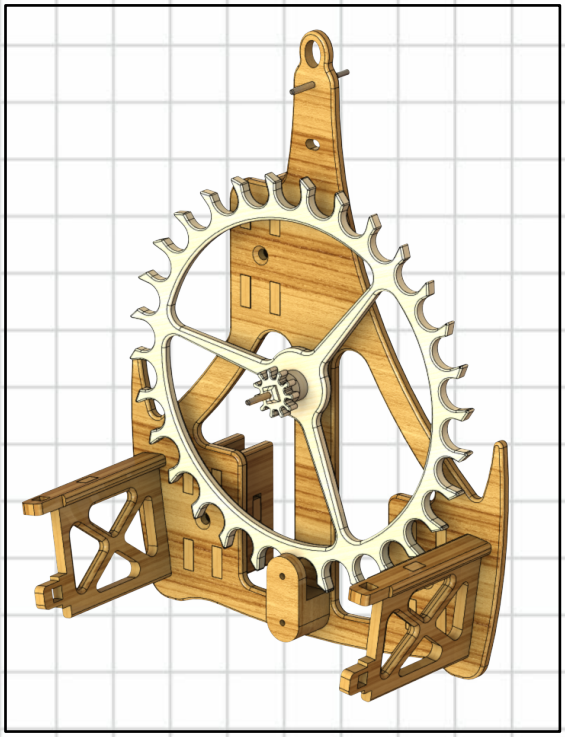
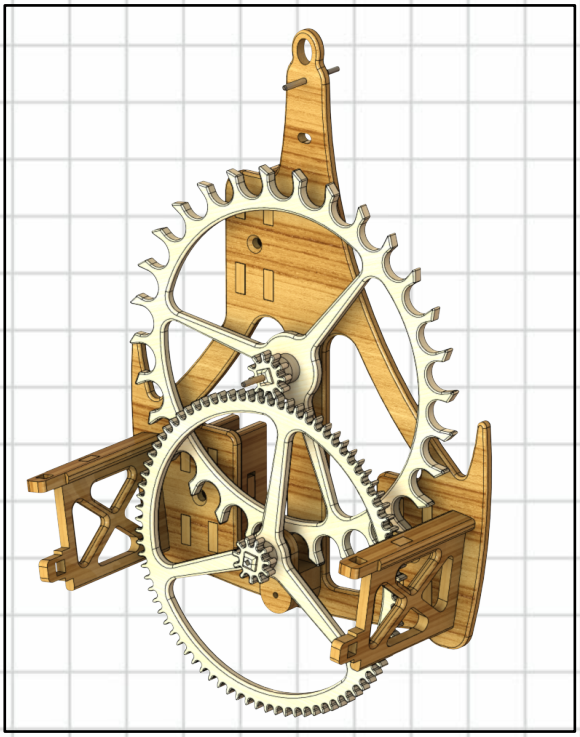
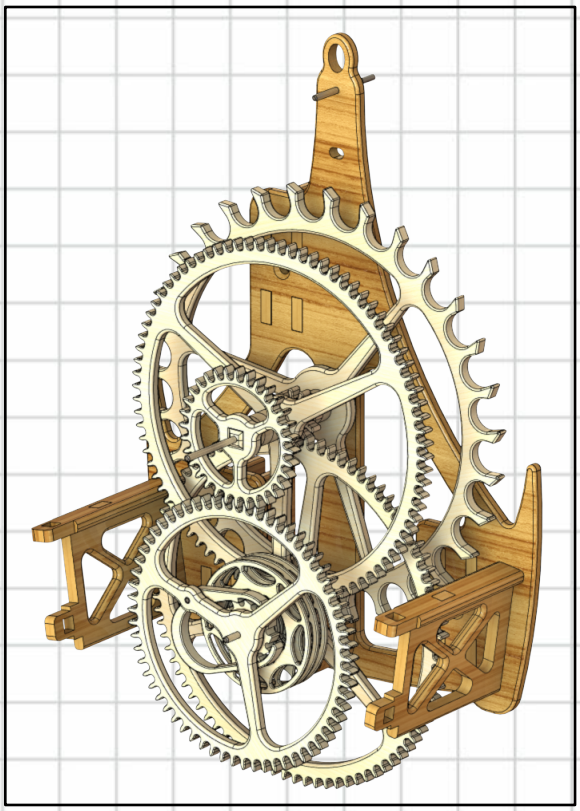
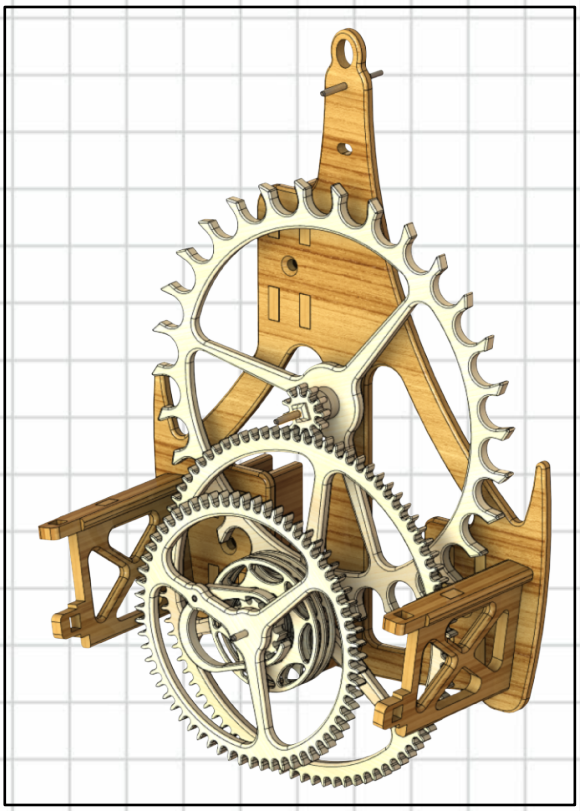
Construction instructions for Clock 48

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 the drive assembly which has the shaft already fitted to it. Now place the Gear train 1 Assembly onto the top shaft shown in the illustration below.

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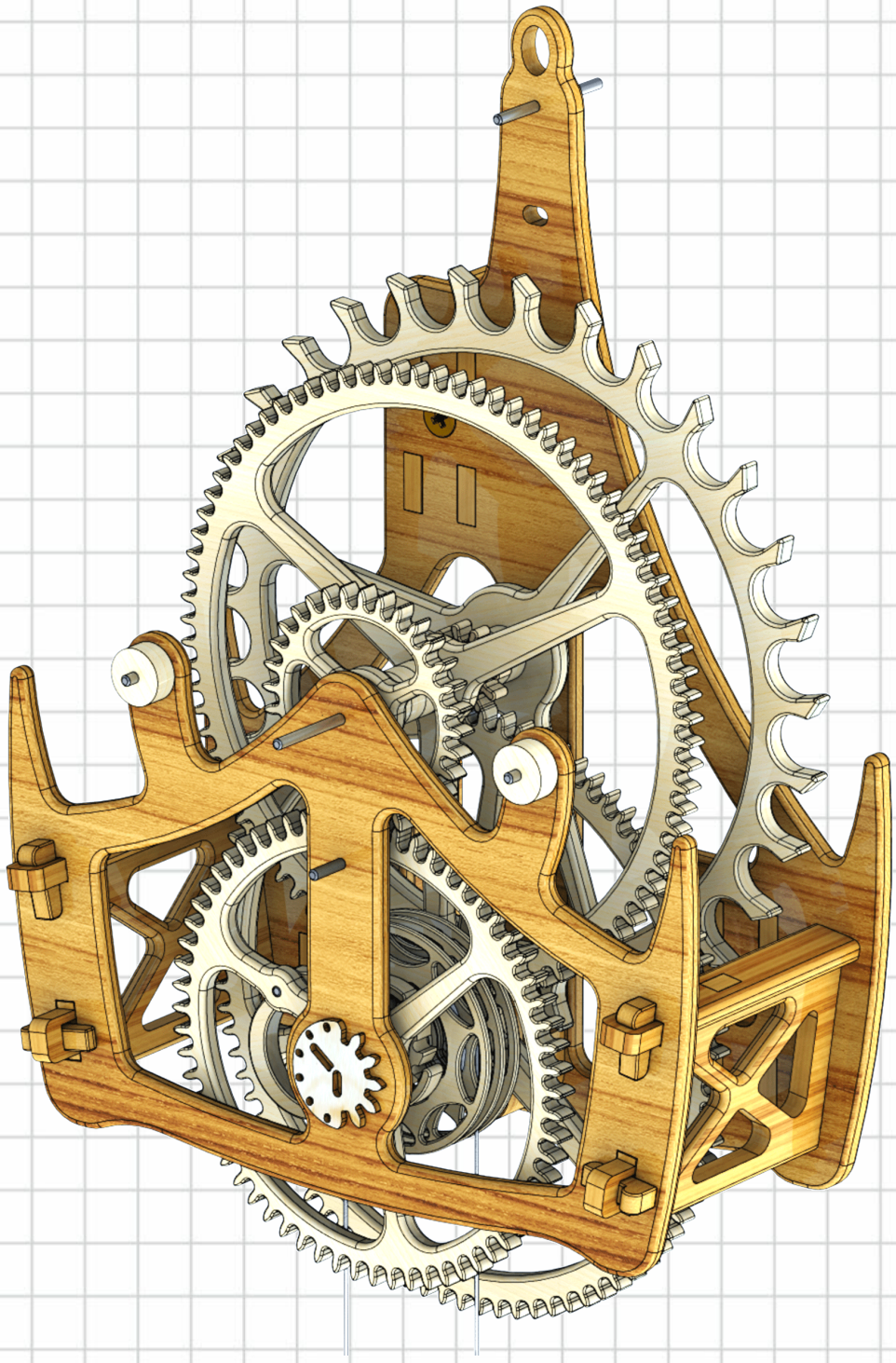
Construction instructions for Clock 48

Step 6 Fit the Front Frame



Fit the front frame by fitting over the 4 protruding Frame Spacers and engaging the the two protruding gear shafts. Secure in position with the four Wedges.

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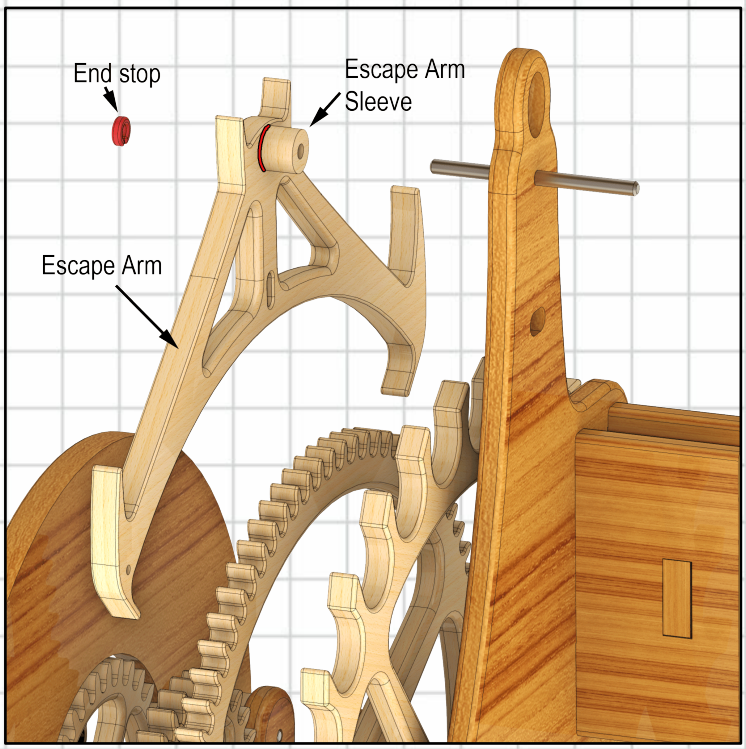
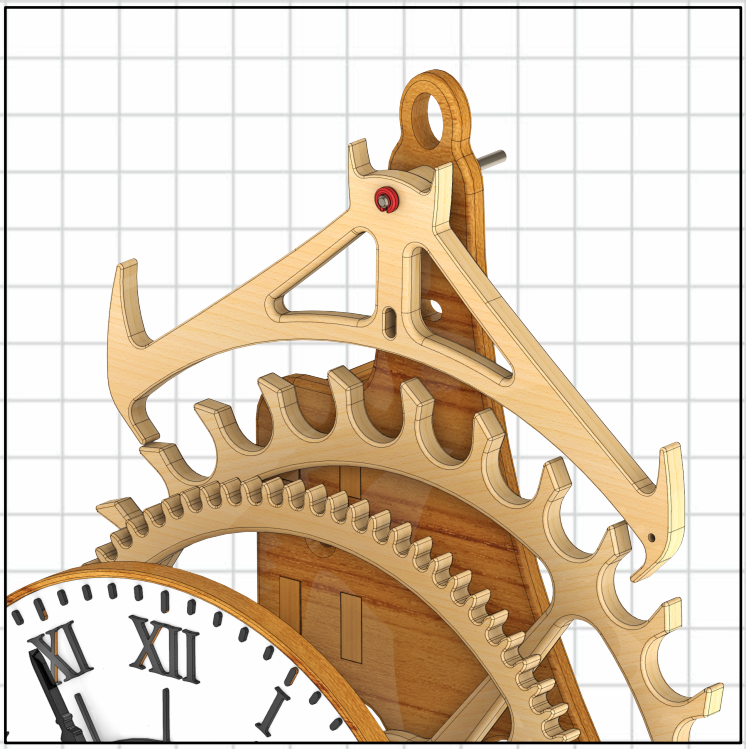
Construction instructions for Clock 48

Step 7 Fit the Escapement Arm



Glue the Escape arm Sleeve 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 .Now slide the Escapement Arm onto the protruding shaft and secure with the endstop shown below.



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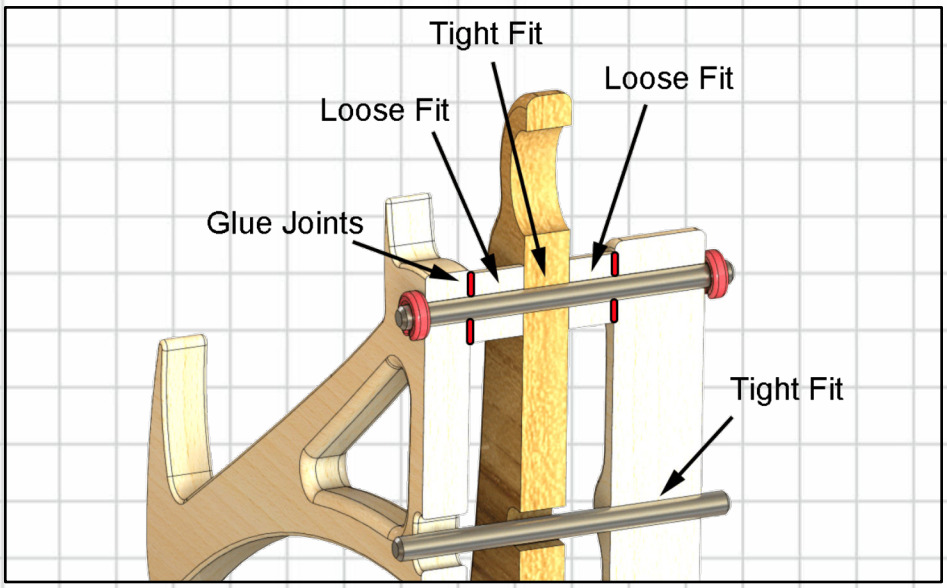
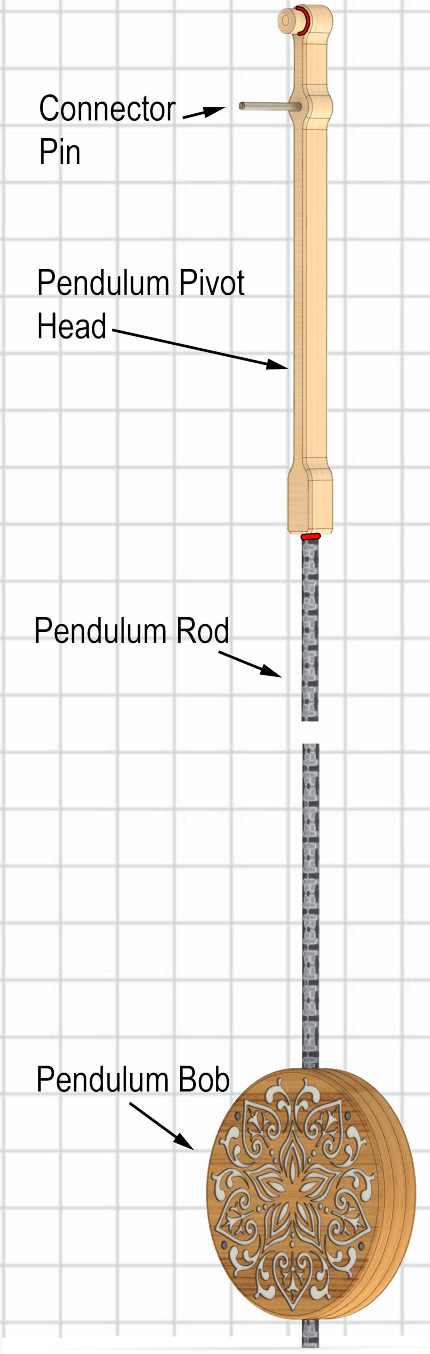
Construction instructions for Clock 48

Step 6 Preparation of the Pendulum sub assembly

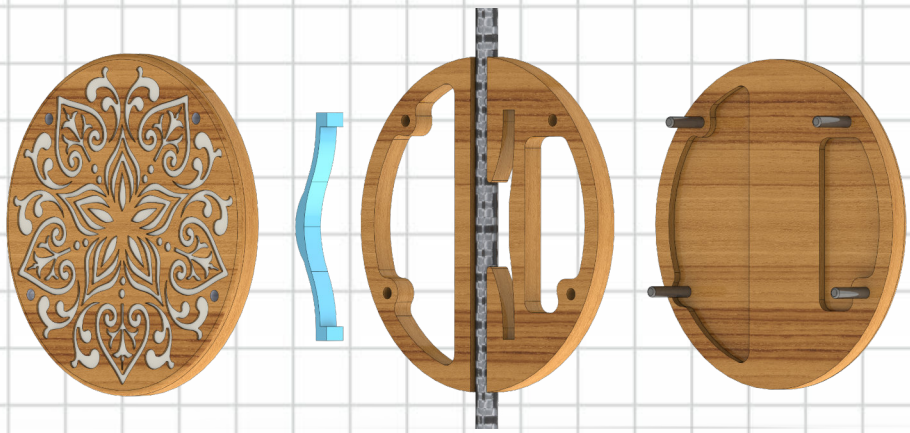


With the Escapement Arm and the Pendulum Assembled to the clock this cross section shows the fits required to allow them to swing together smoothly, the connector pin fitting loosely into the slot in the escapement arm ensures that his happens , it should not be too loose or too tight as this will prevent the impulse being transmitted to the Pendulum.



The Pendulum is assembled as shown with the Connector Pin being a tight fit into the Pendulum Head. The Pendulum Pivot Spacer is glued into position and held there temporarily with a pin while it dries, then removed an the hole drilled out.
The Pendulum Rod is pressed into the underside bottom hole in the Pendulum Head and either glued or pinned in position.

The pendulum Bob is assembled as shown below with enough 9mm diameter Ball bearings or lead shot put into the centre pockets to bring the weight up to around 120grams. The 4 pins are a tight fit in the Bottom Bob and a little looser in the other two so it can be dismantled if needed. The blue Pendulum Lock part can be adjusted for tightness by filing a little material from the central bump before final assembly.



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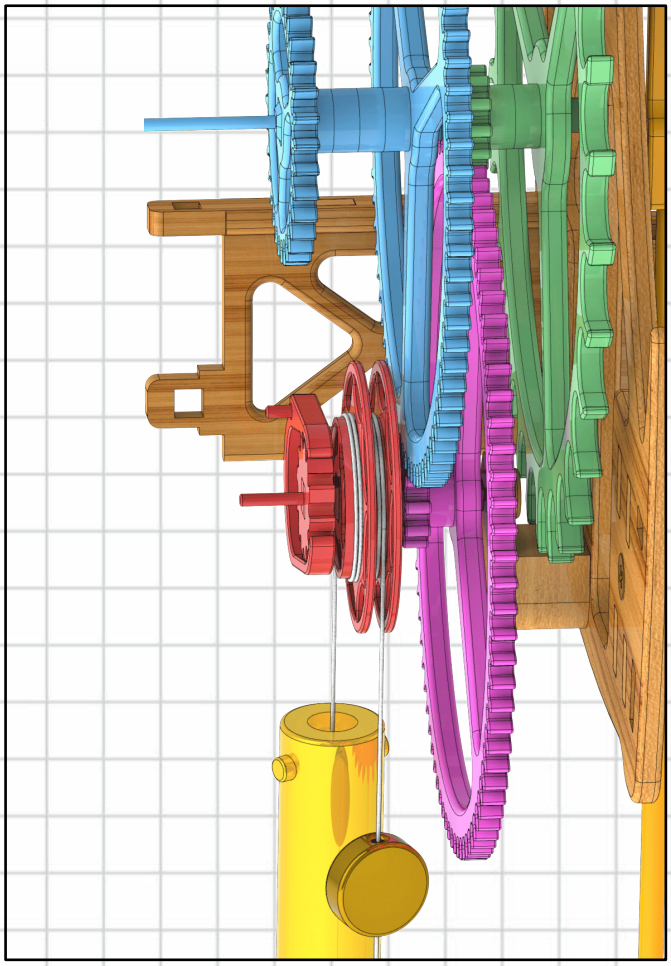
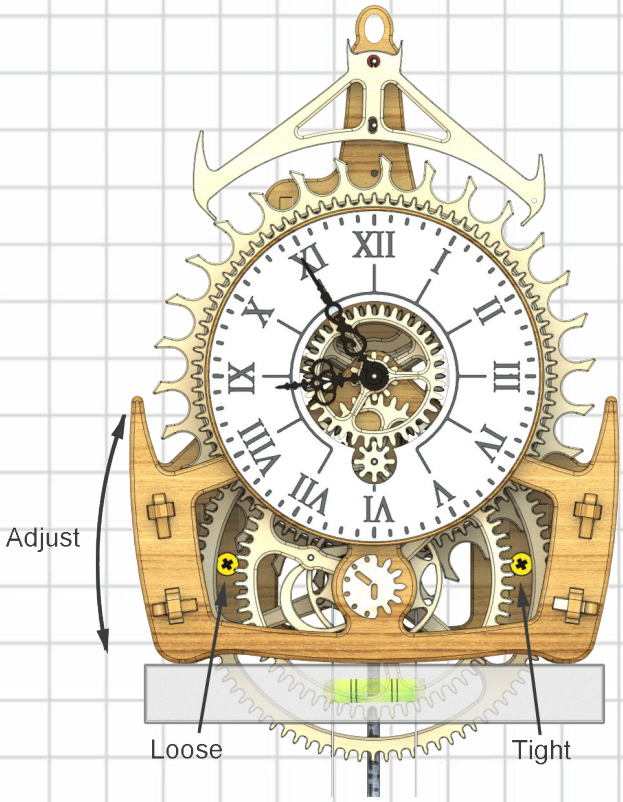
Construction instructions for Clock 48

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 twice the length from the centre of the drum to the ground and tied off in its centre to the central Drum Separator. The cord hanging down to the right should then be wrapped around the drum clockwise a couple of times and a small weight (Counter weight) tied at the bottom where it touches the floor.
The other cord is wrapped around its drum counter clockwise until around 200 mm is left hanging. You need to tie a loop in the end of cord using a Bowline Knot. (This knot will not slip). The weight is then attached to this loop.





After assembling the clock and fixing the Cord the clock can be mounted horizontally onto the chosen wall with the centre of the Dial at a height of around 160cm this should give a running time around 24 hours.
First use the Screw hole on the Right Hand side 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 on the other side 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 then second screw and then add the third screw at the top right position. That it now over time you can adjust the pendulum Bob up or down to get the clock running faster or slower.

Clock 48 - The Crown - Compact Clock

Construction instructions for Clock 48

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.

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.

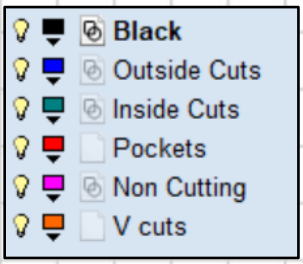
- When fitting the gear sub-assemblies into the frame make sure the mating gears engage and run smoothly. The faces of mating gears should be aligned so they fully engage with each other, i.e. the front faces of the gears are lined up. There is some clearance built into the design so that when the gears 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 ‘Black’ ‘Outside Cuts’ ‘Inside Cuts’ ‘Pockets ’ ‘Non Cutting Profiles’ and ‘V cuts’. The layers are colour coordinated as shown. The Black layer is special as it is used to create the PDF file, used if you are cutting out the profiles by hand.



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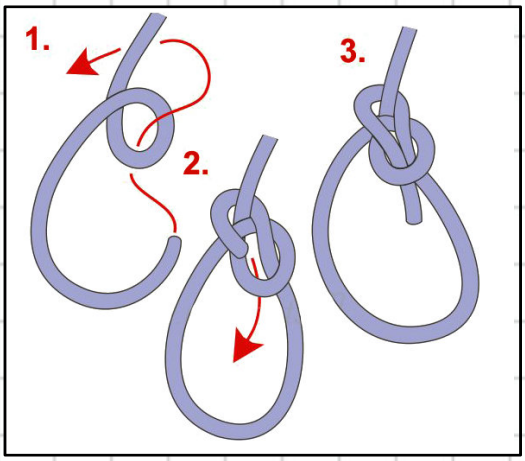
Construction instructions for Clock 48

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.