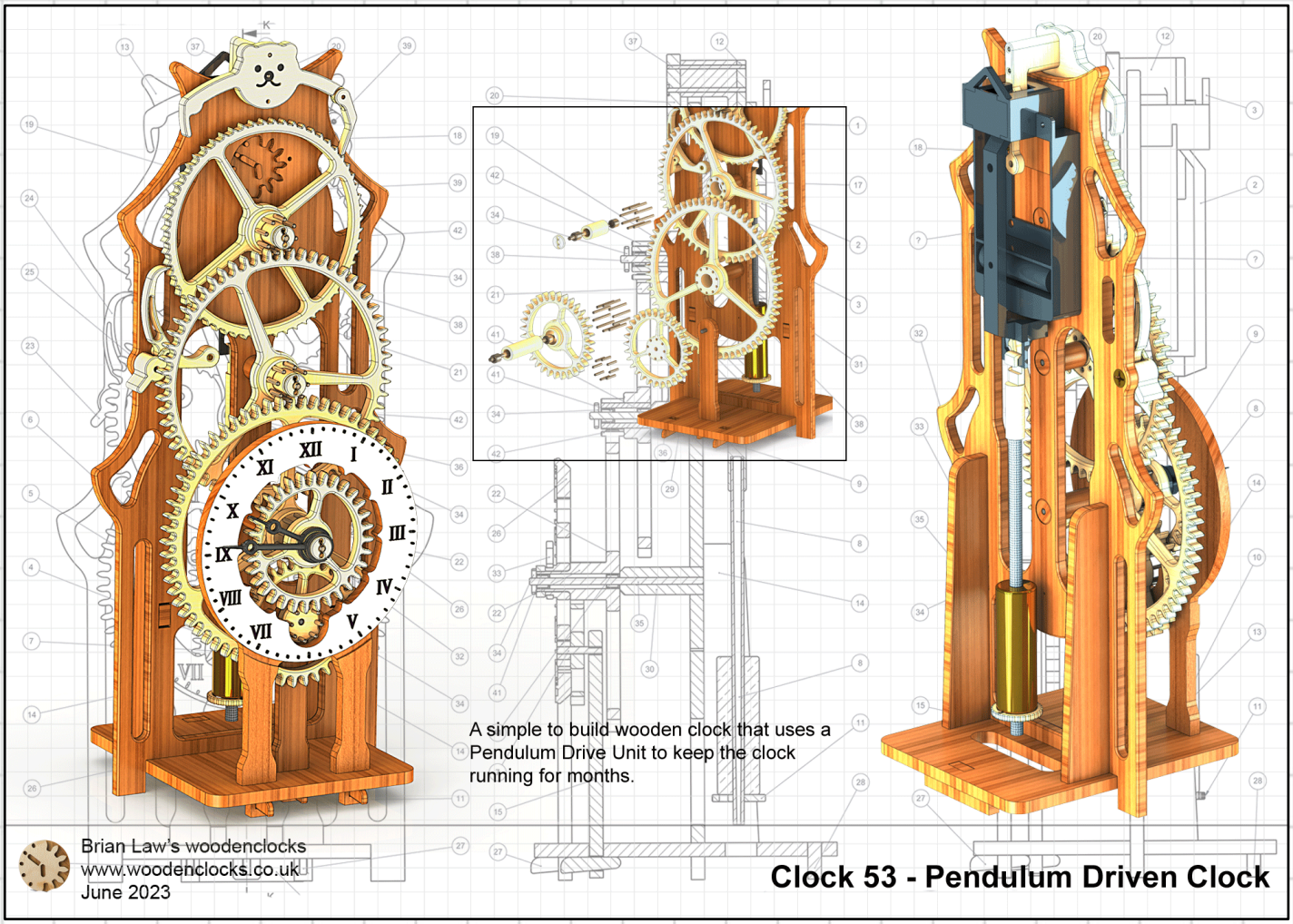
Clock 53 - Pendulum Driven clock

Construction instructions for Clock 53



Over the last 30 years I have been designing and building wooden clocks and the one thing that they all have in common is they are entirely mechanical with no electrical or electronic drive systems, they either use a weight or a powerful spring to drive them. That is going to change on this next clock with the introduction of a Pendulum Drive Unit usually used along with a quartz powered motor to drive the hands of a clock.

What this means in practice is that the whole working of the clock is reversed, whereas a conventional design drives the clock from the bottom up through the gears to the escapement, this one will be driven from the top using the motion of the Pendulum to turn the escape wheel.

The clock runs continuously using a single AA battery and as I write this it has been running for around 4 weeks so can't tell yet what the long term running will be.

The Pendulum drive unit is an inexpensive plastic cased attachment purchased from the internet for around $5 needing only the addition of a clip on connector to attach it to your clock.There a number of these drive units for sale and they are mostly the same. The most common ones available that I have actually used in building the prototypes have slight differences and these have modified parts to suit I have termed these TYPE 1 labelled CNLOT and TYPE 2, JinHong 5668. Or indeed any similar device you find could well work just as well if it can be modified in the ways the parts have been modified for this prototype build.

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, Ø2.1 mm, Ø2.9mm, Ø3 mm, Ø3.1 mm, Ø3.2, Ø6 mm

Router Cutters Ø 1.5mm, 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.

Materials

For all the wooden Parts

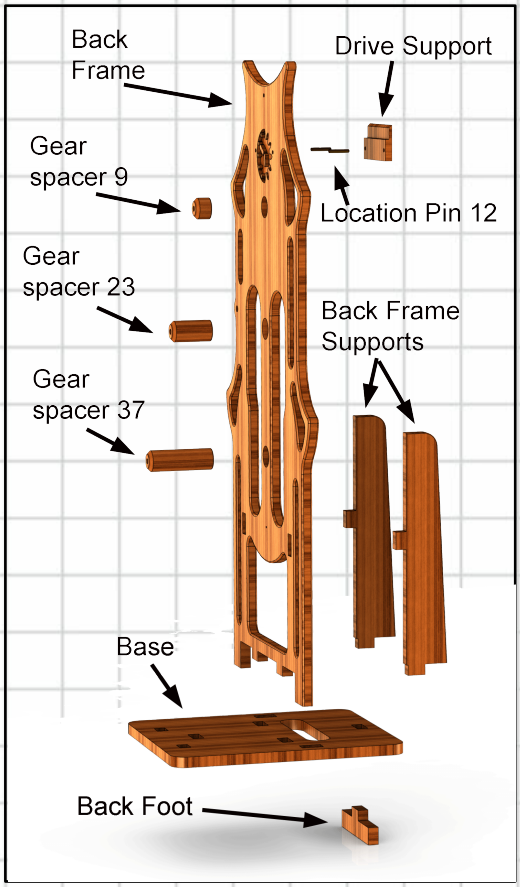
The choice of material to build the clocks from is a very personal one and is down to you to decide. I prefer to use actual timber, Cherry for the frames and Maple for the gears and other parts. I use timber machined to a standard size of 125mm x 6mm, and 125mm X 10mm, and these are fabricated into blanks for the larger components by 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 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 quicker. However, on this particular clock, I would advise against using Plywood for anything other than the frame parts as greater accuracy is needed for the gears and the Escapement parts.
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.
Ø2mm Drill Rod or Silver Steel 450mm Long for the pins
No 8 or 10 wood screws 63 mm long for wall fixing 4 required
Ø19 mm Brass Rod 60 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.

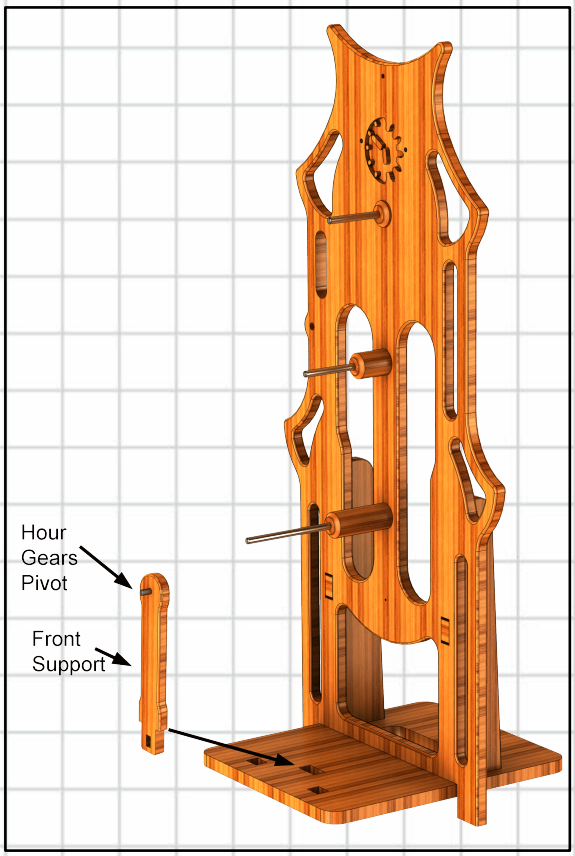
Clock 53 - Pendulum Driven clock

Construction instructions for Clock 53

Step 1 Preparation of the Frames



Fit and glue all parts together.

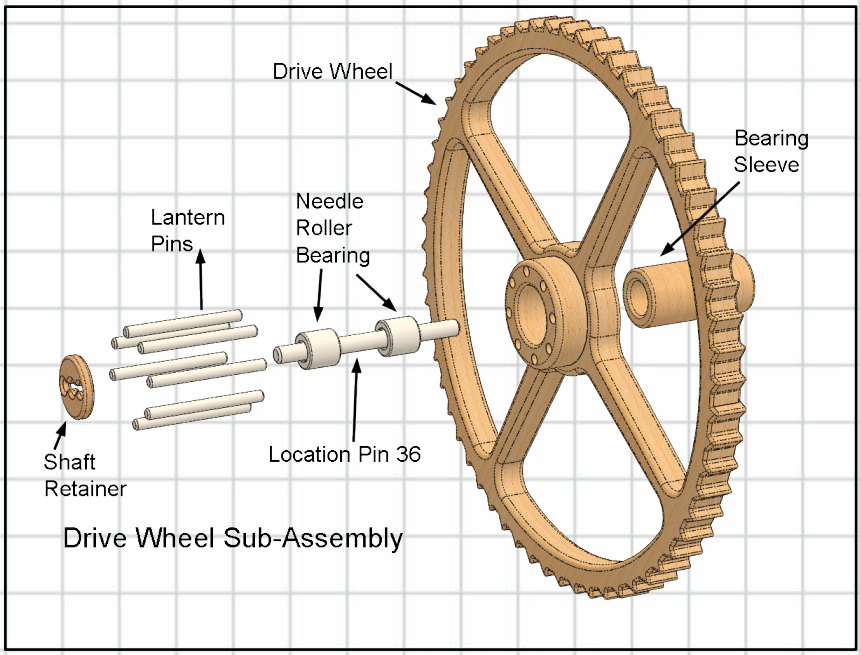


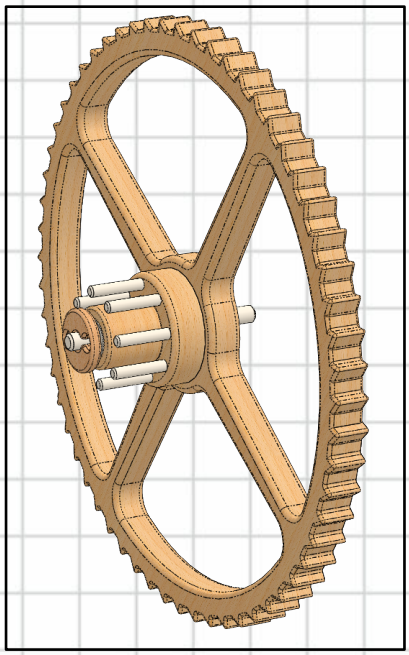
After gluing all the parts together it is time to prepare the Front Support by fitting the Hour Gears Pivot Pin into the top hole. This can be put to one side now whilst all the gear train sub assemblies are fitted.

Clock 53 - Pendulum Driven clock

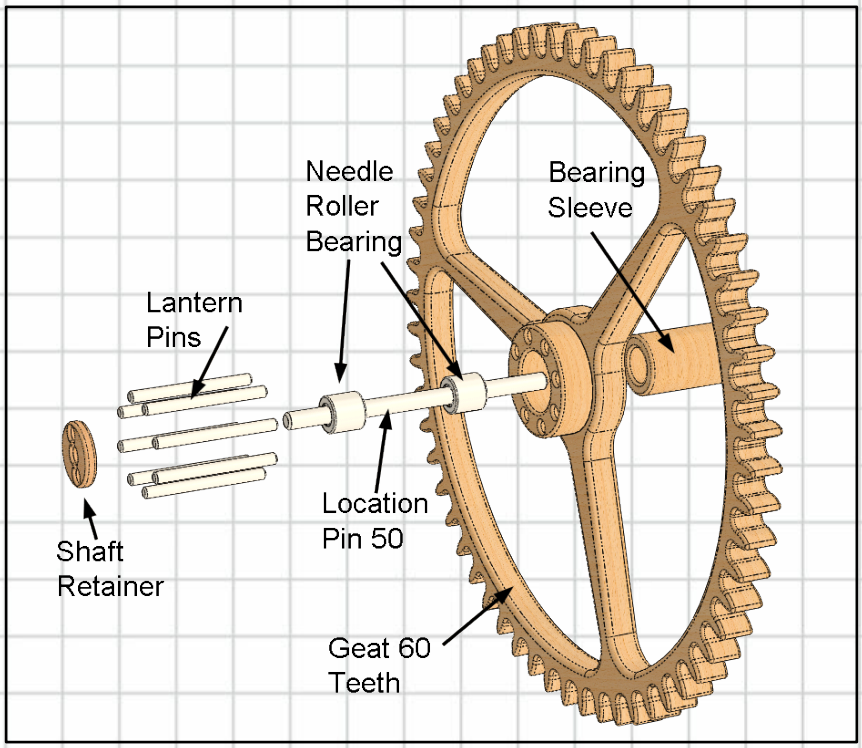
Construction instructions for Clock 53

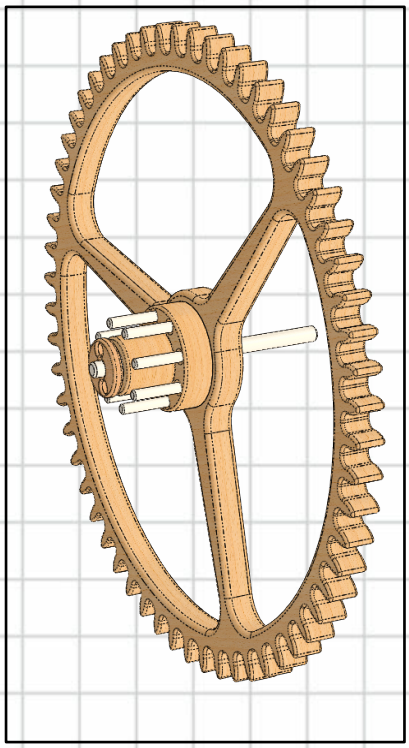
Step 2 Preparation of the Gear trains





You should note that the Location Pin 36 is already in position fixed to the Back frame and is only shown so that you can see how all the other parts relate to it. To start fit the Lantern Pins into the 64 toothed gear and then fit the Bearing sleeve into the Drive Wheel and the Needle Roller Bearings into each end of it. They should all be a tight fit.



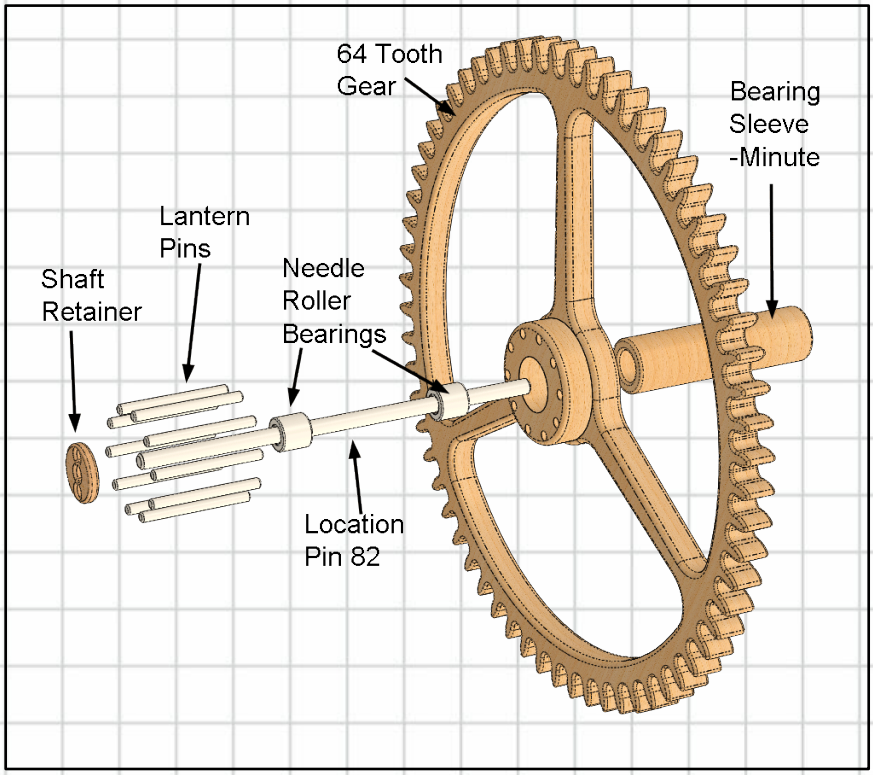


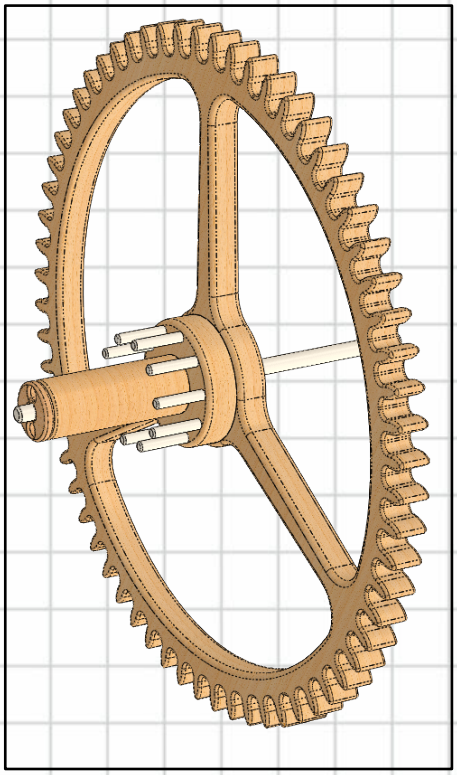
The same procedure is followed to assemble the 60 toothed gear assembly

Clock 53 - Pendulum Driven clock

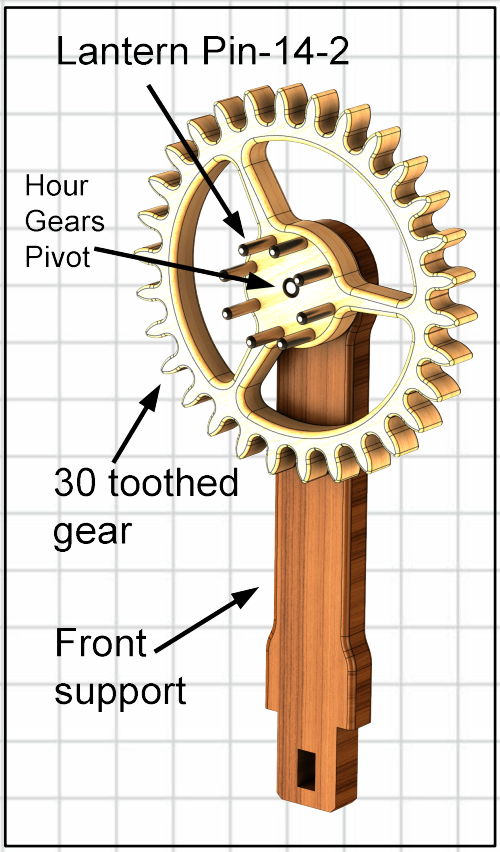
Construction instructions for Clock 53

Step 2 Preparation of the Gear trains





Again the same procedure is followed to assemble the 60 toothed gear assembly

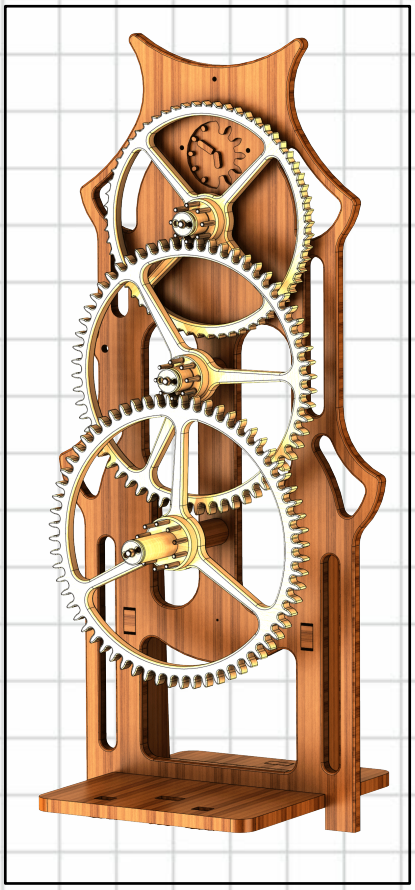


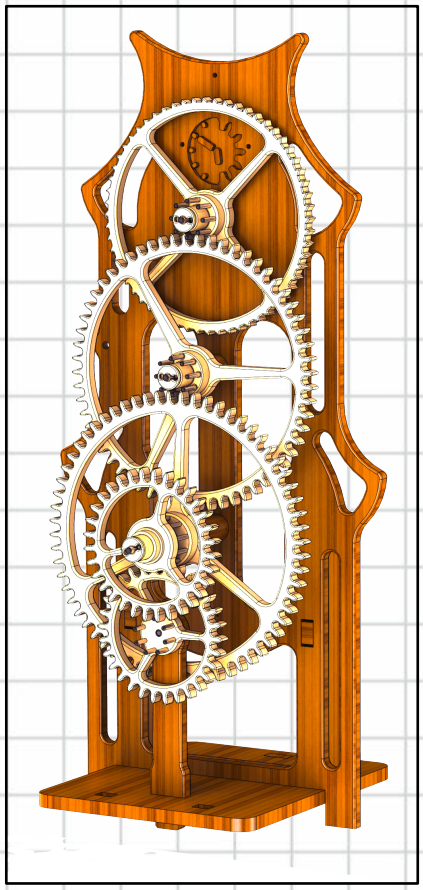
Again The final gear is mounted on a separate component, the Front Frame shown here. All the pins are a tight fit into their mounts but the gear itself is a loose fit on the Hour Gears Pivot

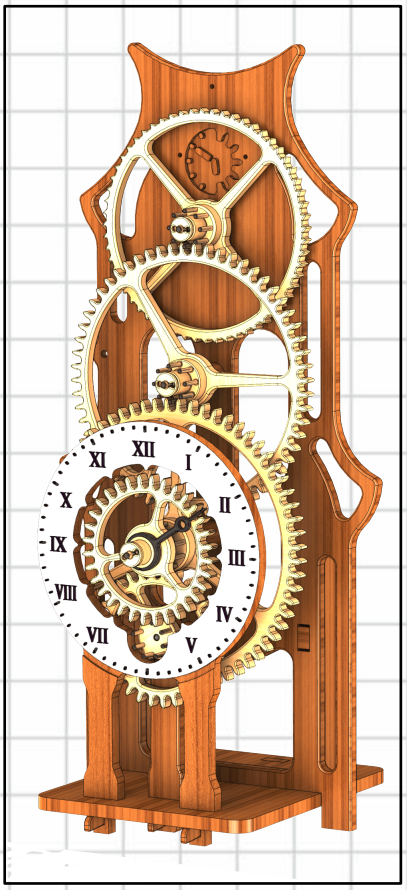
Clock 53 - Pendulum Driven clock

Construction instructions for Clock 53

Step 3 Loading all gear sub assemblies







The 3 gear sub assemblies are pushed onto their respective shafts and held onto the shaft using the Shaft retainers fitted lose enough so that the gears can rotate freely Check for smooth running of the complete geartrain by rotating the Drive wheel slowly and check for any catching of the gears.

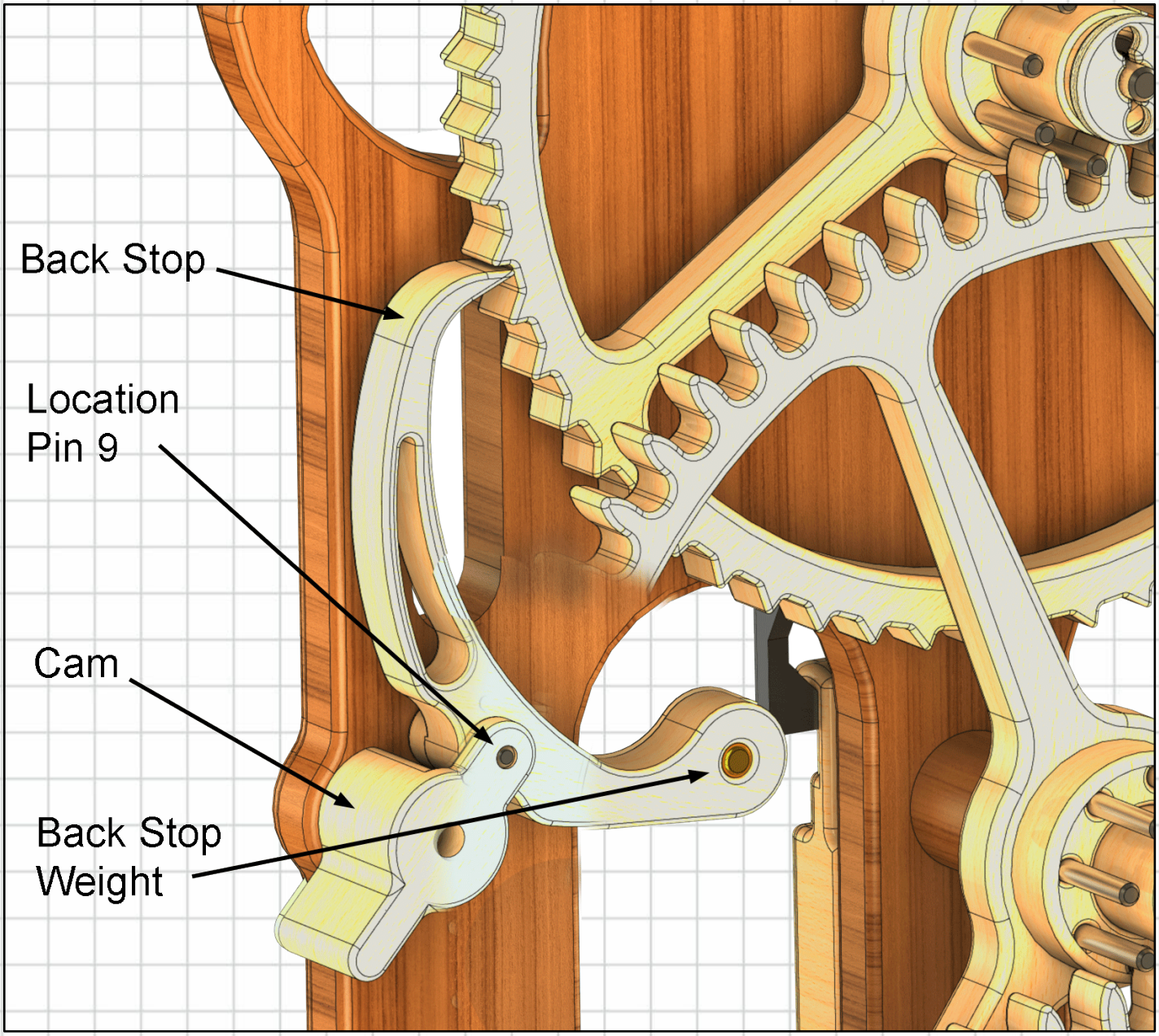
Next fit the Front Support with its attached gear into the slot in the base and leave it lose until the Dial is slotted in place and the secure all the protruding tabs underneath using the 3 Wedges.

Now fit the hands to the hands to their respective locations on the protruding bottom shafts.

Clock 53 - 24 Hour Clock with Gravity Escapement

Construction instructions for Clock 53

Step 5 Fitting the Back Stop

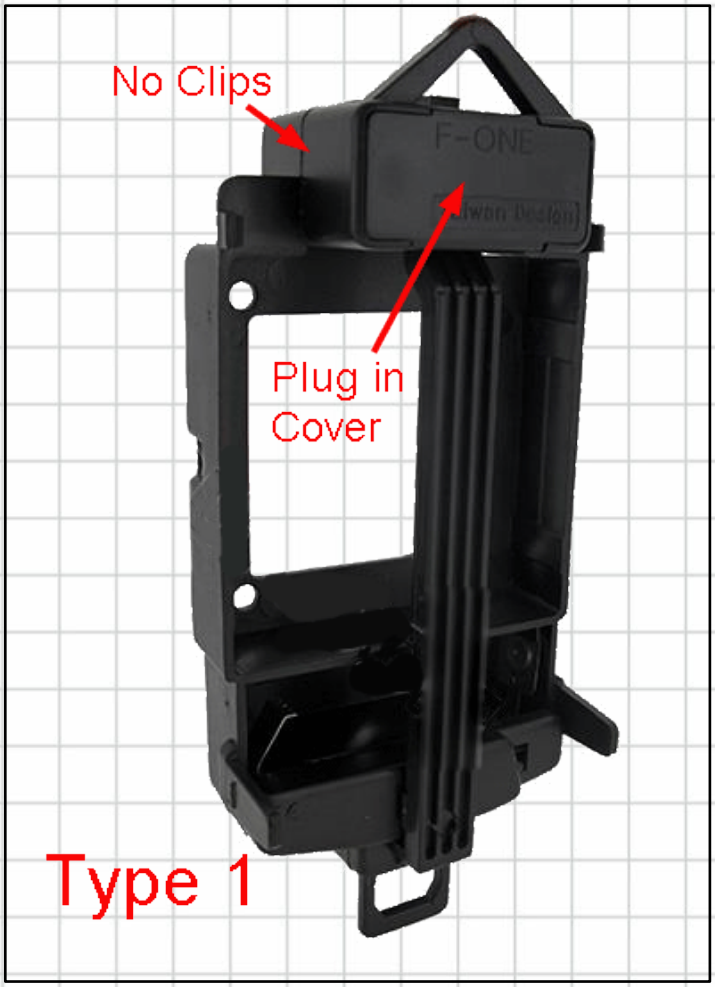


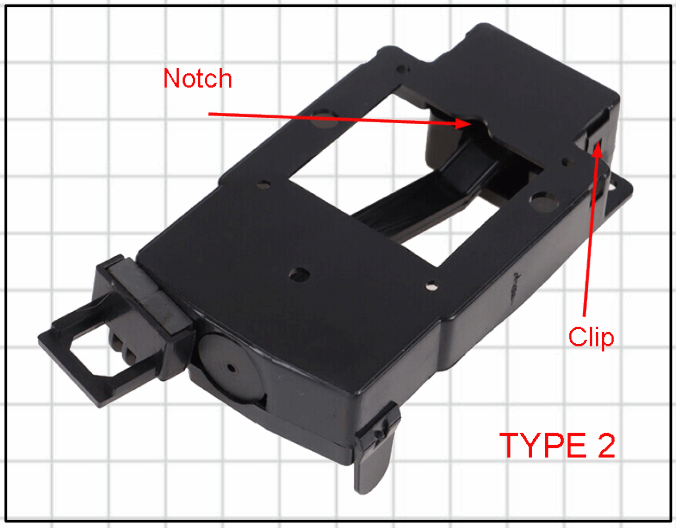
The Back Stop shown above comprises the Back stop itself and the Cam that allows the position of the Back stop to be adjusted so as to position the teeth on the Drive Wheel so they engage the Finger correctly. I have shown a small weight fitted to the end of the backstop in case the backstop needs it to engage quickly with the teeth. The cam is secured with a small screw fitted from the rear. Part of the 60 toothed gear has been cut away so as to get a better view of the Back Stop.

Clock 53 - Pendulum Driven clock

Construction instructions for Clock 53

Step 6 The Pendulum Drive Unit





These are the two types of Pendulum Drive Units that I have used on this project. They are basically the same with a couple of slight differences that you need to know about before making all the components. The first difference is in the diameter of the tube at the top of the pendulum itself, Type 1 is slightly bigger so I have drawn up two versions of the Connector component to suit both. The second difference is in the width of the square cut out in the back of the box is slightly different, again two versions are provided of the Drive Support that connects in this hole.

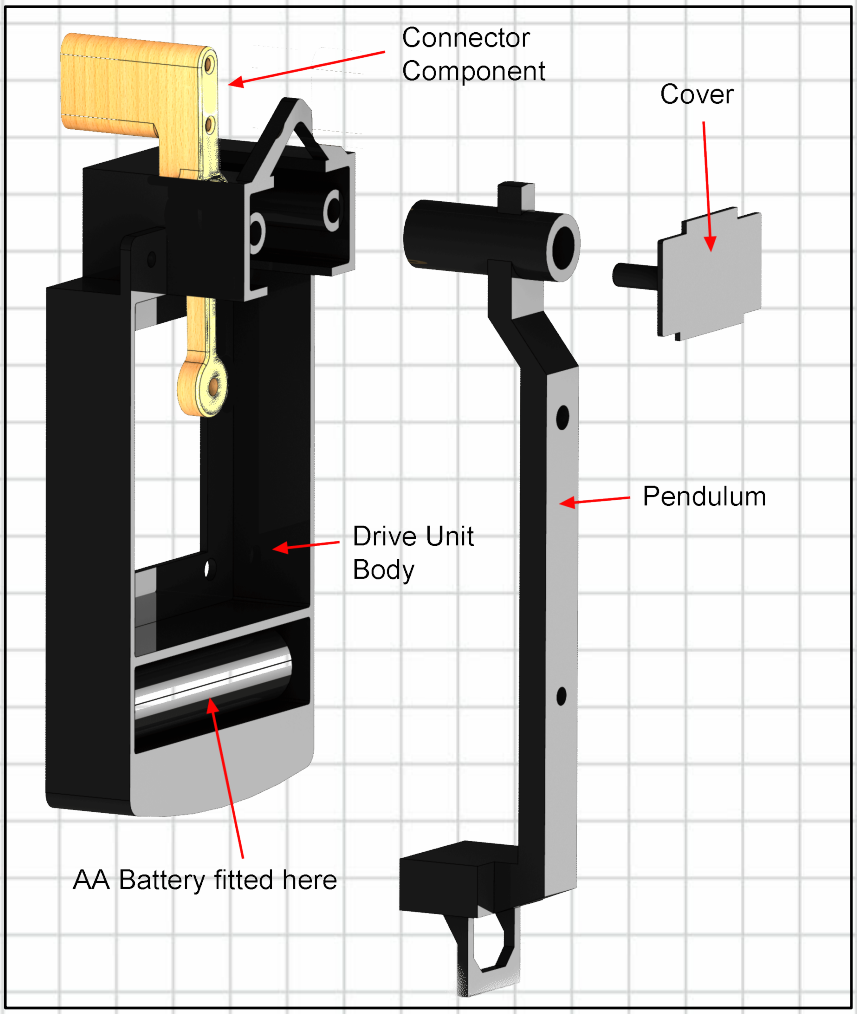
To fit the Connector component you need to remove the Plug in cover on Type 1 by gently prising it off with a small screwdriver or thin blade, it won't come off easily as there are two plugs holding it in and the may break off if your not careful. Once the cover is removed the pendulum can be withdrawn and then the Connector component dropped in and fitted over the Tube at the top of the pendulum and pushed right up to its stop. Now push the Pendulum back in place and refit the cover. If you broke off the Plugs then use tape to hold it in place.

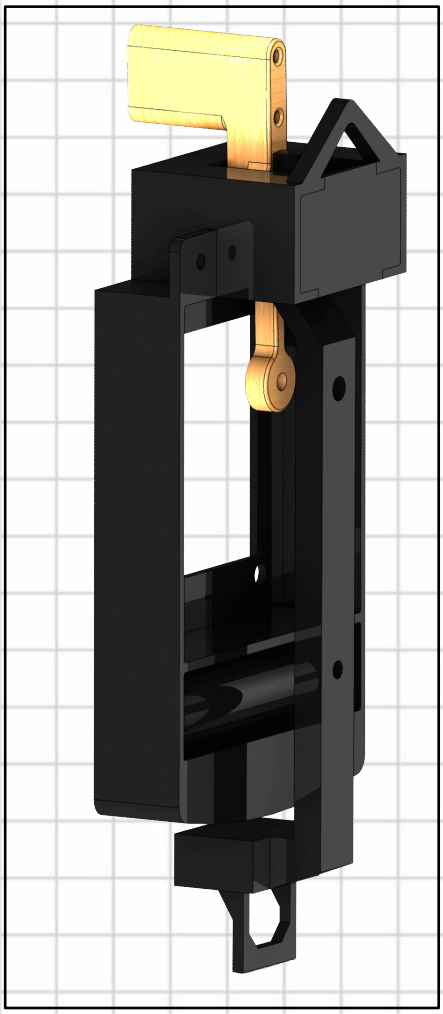
For the Type 2 unit the procedure is the same but the cover is removed by pulling open the clips and sliding the cover off, much easier this one.

Clock 53 - Pendulum Driven clock

Construction instructions for Clock 53

Step 7 Fitting the Connector to the Pendulum Drive unit





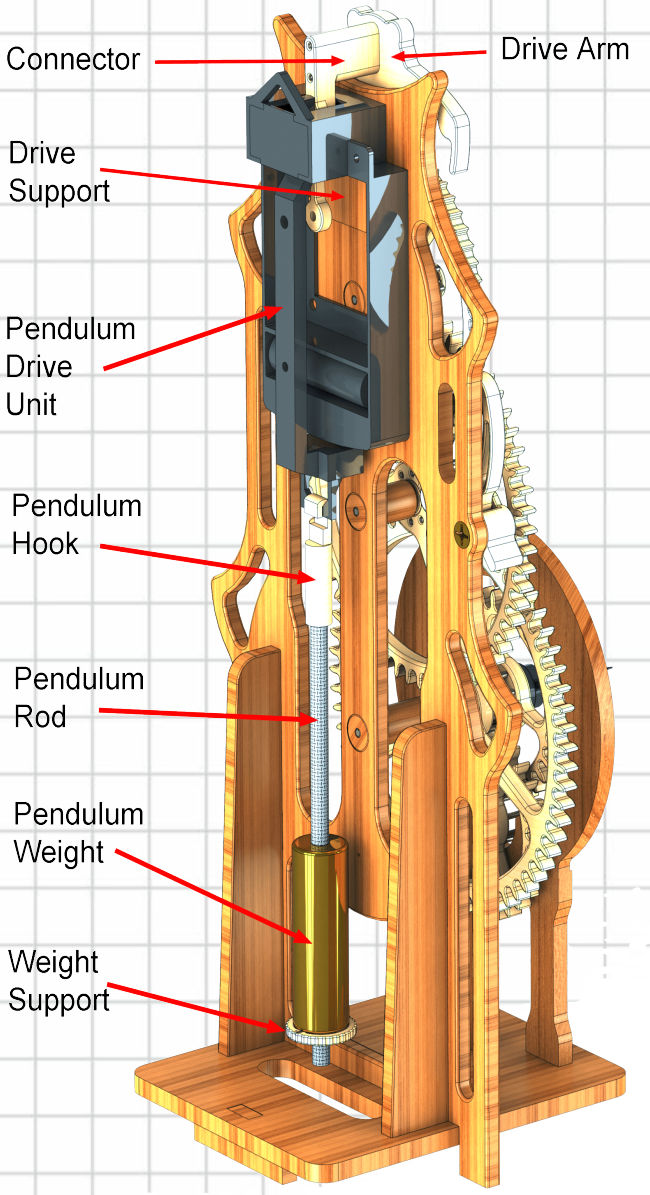
To fit the Connector component you need to remove the Plug in cover on Type 1 by gently prising it off with a small screwdriver or thin blade, it won't come off easily as there are two plugs holding it in and the may break off if your not careful. Once the cover is removed the pendulum can be withdrawn and then the Connector component dropped in and fitted over the Tube at the top of the pendulum and pushed right up to its stop. Now refit the cover. If you broke off the Plugs when removing the cover then use tape to hold it in place.

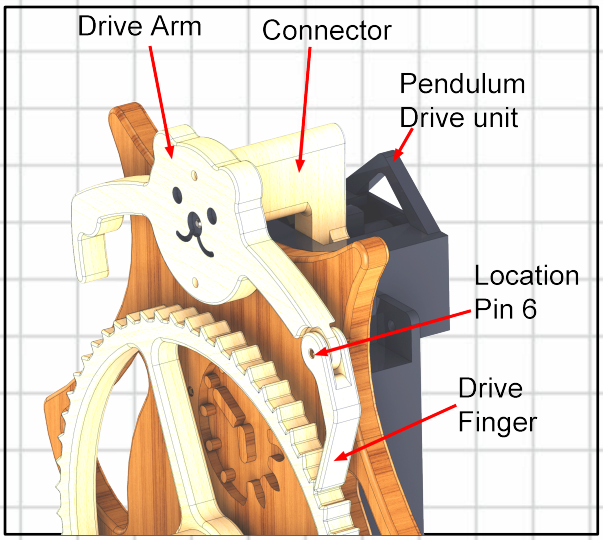
For the Type 2 unit the procedure is the same but the cover is removed by pulling open the clips and sliding the cover off, much easier this one.

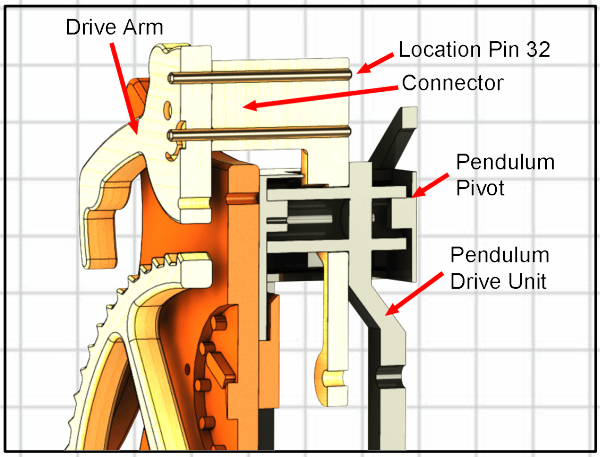
Clock 53 - Pendulum Driven clock

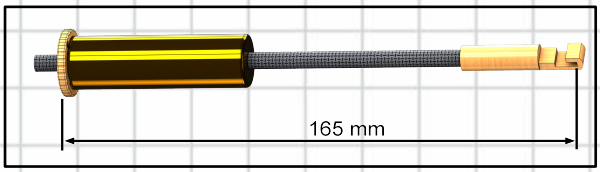
Construction instructions for Clock 53

Step 8 Fit the Pendulum Drive Unit to the Back frame









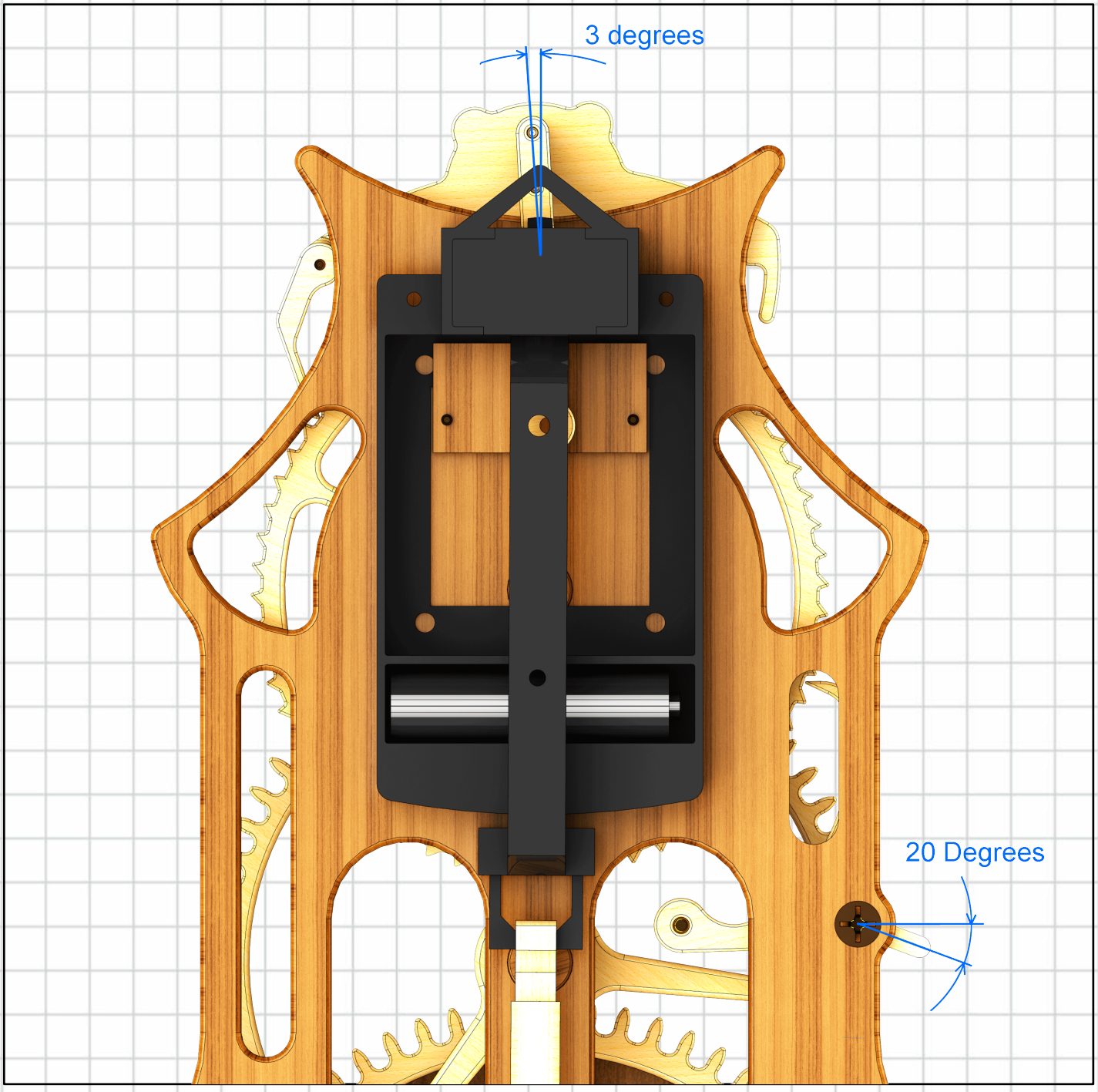
The main picture shows the Pendulum Drive unit sitting on the back of the Back Frame on the Drive support. Hanging from the bottom is the pendulum Hook with the Rod and the weight. Round the front The Drive Arm and Drive finger have been plugged onto the Connector with the Drive finger engaging the Teeth on the Drive wheel (not shown here). The timing of the clock is adjusted by moving the weight either Up to increase speed or Down to slow it. The position of the weight on my prototype is shown in the bottom picture this clock is running to within a minute per day at this setting.

You will note when you fit the Drive connector into the Pendulum Drive Unit that the pivot for the Pendulum is two short moulded wedges inside the case that the inside of the tube at the top of the Pendulum sits on. This is super simple and super low friction but it can move around a little when the clock is being handled . So you should ensure that the bore of the tube is resting squarely on the Wedges as it swings back and forth. If its not just give the clock a little jiggle by twisting at the base to help settle it.

Clock 53 - Pendulum Driven clock

Construction instructions for Clock 53

Step 9 Connecting the Drive Arm

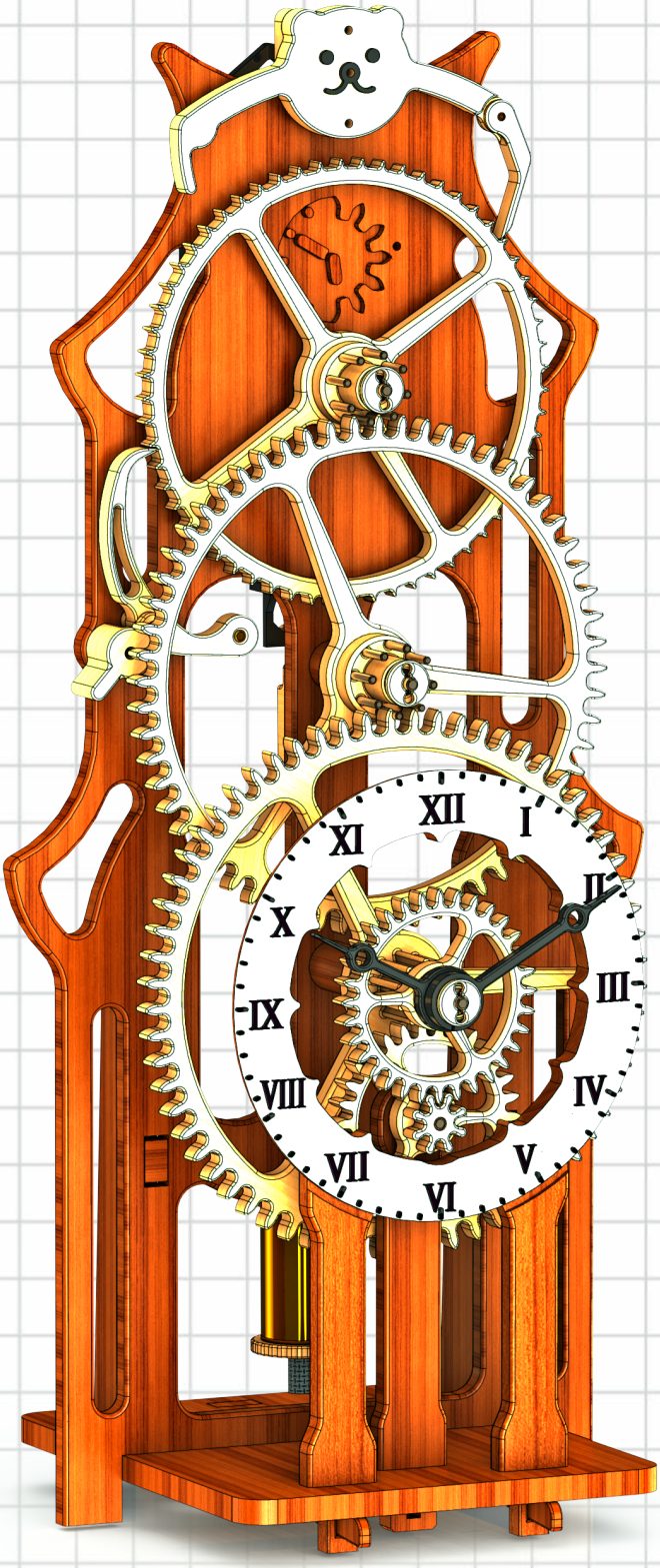


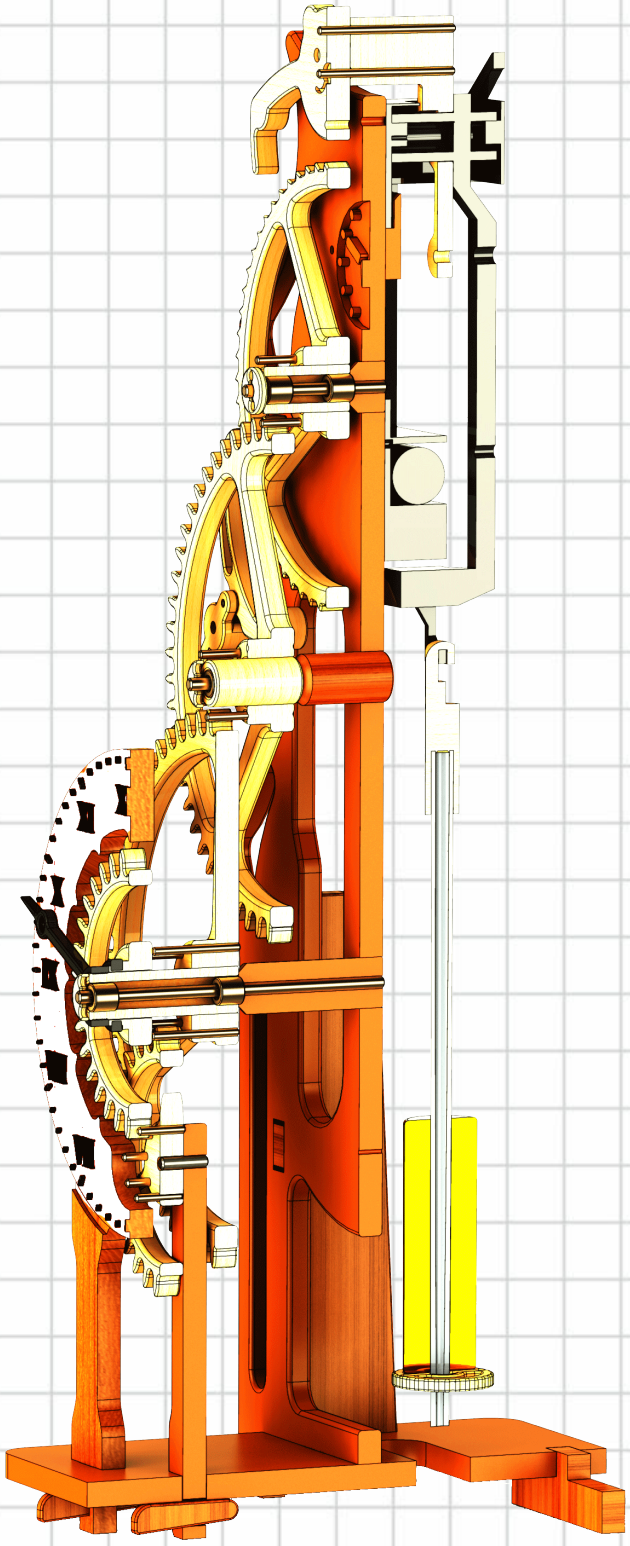
To get the clock running when it has been built can be a little frustrating as it requires you to adjust the Drive connector at the top of the clock and the Backstop on the side so that they work in harmony to keep the clock running continuously. I start with the Drive connector vertical and only move it slightly from that position to push on the next tooth in the Drive Wheel a little. The Back Stop is then adjusted to stop any excessive backwards movement. It is then a gentle dance back and forth with the Backstop to keep it ticking. To me it almost seemed as though the Pendulum Drive Unit was playing games with me by varying its stroke, but I guess that's just me getting frustrated as all of a sudden it starts to work just fine.

Clock 53 - Pendulum Driven clock

Construction instructions for Clock 53

Step 9 Complete





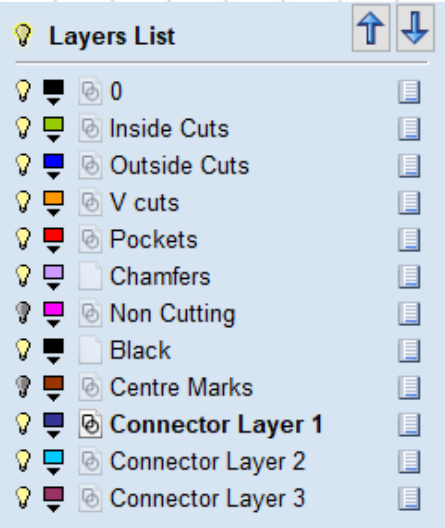
HINTS AND TIPS

- 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,
- 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.

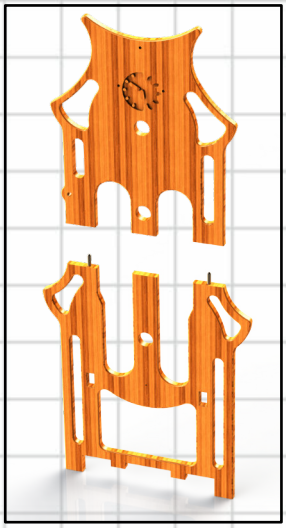
- The DXF files supplied include all the parts that can be cut using the CNC router, they do not include any pins or nuts and bolts, information on these parts are included in the Detail drawings supplied in PDF format.

- 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 separate layers , these being ‘Outside Cuts’ ‘Inside Cuts’ ‘Pockets ’ ‘Non Cutting Profiles’ and ‘V cuts’ and ‘Black’. The layers are colour coordinated as shown.



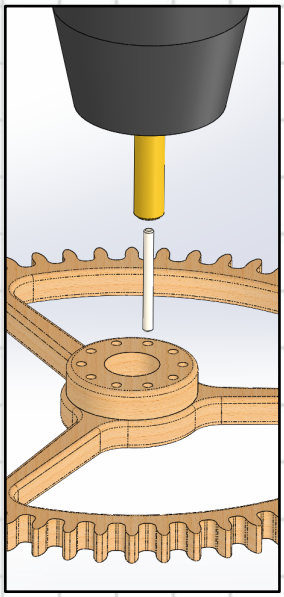
Additional layers have been added as well, the 'Black' layer is for printing out to scale as a PDF file so that you can cut out the profiles for sticking onto the wood when cutting out with a Scroll Saw. The Centre marks can also be used if cutting by hand or scroll saw doe drilling the holes.

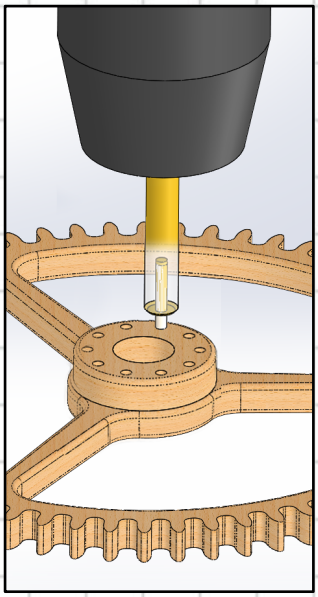
HINTS AND TIPS - continued



When the parts of the clock are just to big to be printed on the Build plate then the part must be split into separate pieces. This is illustrated opposite where the front panel of the clock has been split into 5 pieces . The parts are printed with 3mm diameter holes into the faces of the splits so that steel pins can be inserted when the parts are assembled back into a whole part. I normally use a thin superglue for this purpose if printing with PLA, but I use a solvent bond technique with Acetone if printing with ABS.

On this clock I have supplied the STL files for all of the parts as well as a separate set of split parts for the front and Back panels along with a split set for the Gravity arm.





Fitting the Lantern Pins accuratly can be a bit tricky so I have used a short length of Brass rod 6 mm Diameter with a 2.1 mm diameter hole 10 mm deep drilled in one end. This holds the pin vertical whist you push into place. The 6 diameter of the rod is just small enough to squeeze between pins as the new pin is fitted.