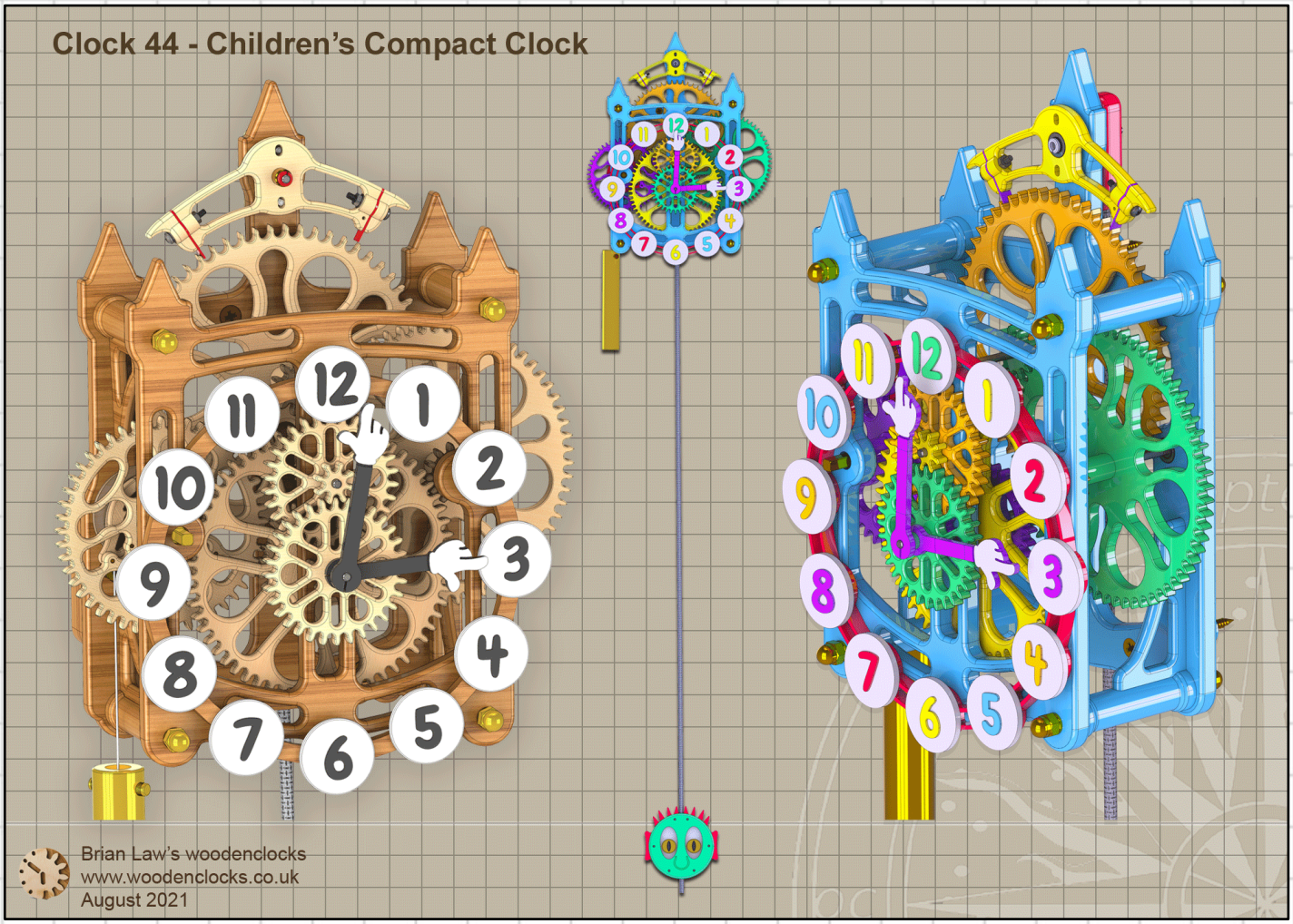
Clock 44-Compact Children's Clock

Construction instructions for Clock 44



When I set out to design this clock I wanted it to be suitable for a Children's room, a playful and colourful design that was to run quietly for 24 hours. Unlike the original children's clock that ran on a mainspring this one was to be more traditional and run using a driving weight. It also uses the more efficient gear train used in Clock 43.

This does have a downside though as it increases the difficulty in building the clock as the teeth on the Escape wheel now need to be cut very accurately in order to ensure the the pallets will be able to interact properly with them. As a consequence of this I would recommend that this clock is not cut out using hand sawn methods, as the accuracy requirements are too high.

The clock will run for 26 hrs using a 0.6 Kg. main weight.

The clock can be built either from wood using a CNC router or by 3D printing the parts, most everything can be printed on a 200mm x 200 mm bed except for the Front and back frames which will need to be split at the neck with the Top section then solvent bonded or super glued with a stiffening plate behind.

Clock 44-Compact Children's Clock

Construction instructions for Clock 44

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. Small Lathe, this is not essential but it would make making the clock a lot easier for all the round parts that are needed.
Small Milling machine or **Pedestal Drill** 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, Ø1.9, Ø2 mm, Ø2.1,Ø2.9, Ø3mm, Ø3.1,Ø4 mm ,Ø3.9mm, Ø4.1 mm, Ø6.5 mm

Router Cutters Ø 2, Ø3 and possibly Ø6 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 44 - Compact Children's Clock

Construction instructions for Clock 44

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 125 mm x 6 mm and 125 x 9 mm 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 1200 mm 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

Ø4 mm Drill Rod or Silver Steel 350 mm Long for all the shafts and numerous pins.
Ø3 mm Drill Rod or Silver Steel 125 mm Long
Ø2 mm Drill Rod or Silver Steel 200 mm Long

Ø20 Wooden dowel 350 mm
Ø16 Wooden dowel 200 mm
Ø12 Wooden dowel 150 mm

No 10 wood screws 60 mm long for wall fixing 4 required
Ø6mm Steel Threaded rod 350 mm long
Ø8 mm Brass Rod 100 mm for the Drive Shaft
Ø38 mm Brass Rod 150mm long for the weight

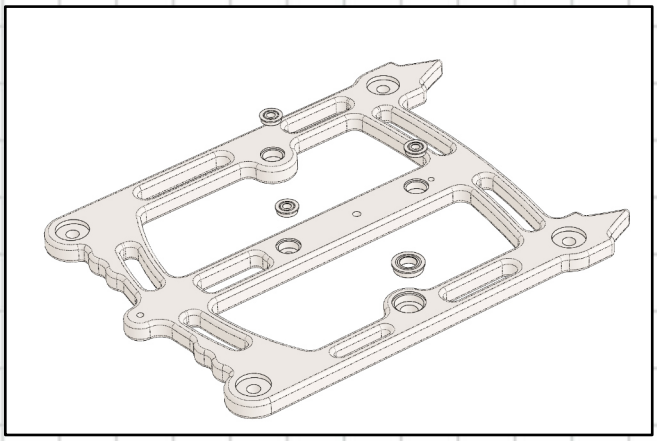
1 mm, and 3 mm Plastic sheet for hands and pallets, ABS or HIPS

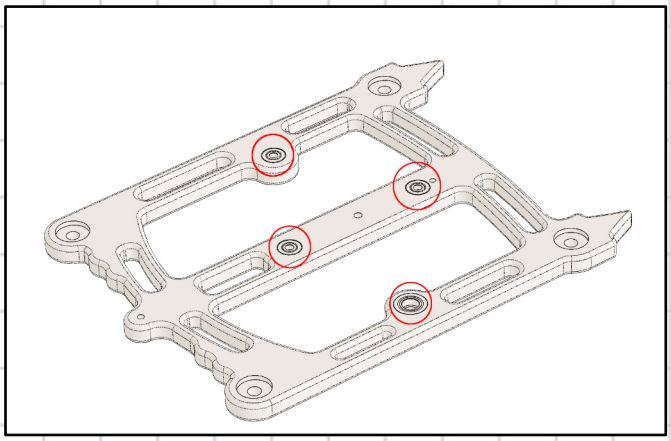
Note these are the minimums amount of material necessary to build the clock I used more in the prototype and you may well be advised to by extra to cover those accidental losses that occur. If I have missed anything here, you will find them in the parts list for the clock anyway.

Clock 44 - Compact Children's Clock

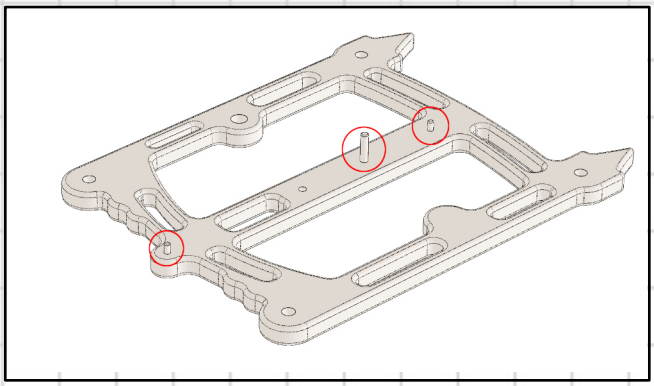
Construction instructions for Clock 44

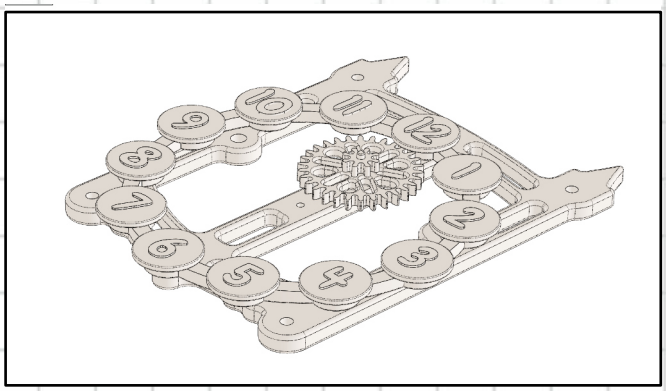
Step 1 Preparation of the Frames



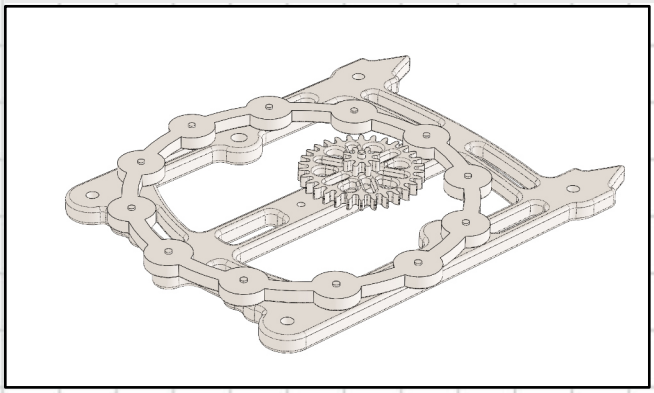


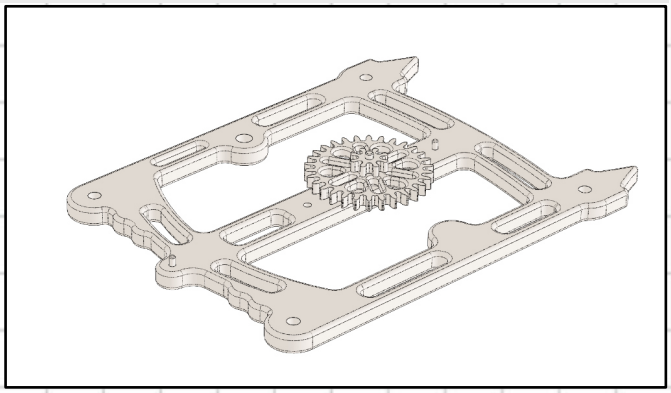
First job is to fit the bearing into their respective pockets in the frame, It would be best to use a Drill Press fitted with a short length of rod to mount the bearing on so that it is pushed into position nice and square to the frame.





With the bearings fitted then turn the frame over and fit the short Pivot pin and the two Dial location pins into the front face of the Front Frame. Then fit place the 30/8 toothed combination gear over the Pivot pin.



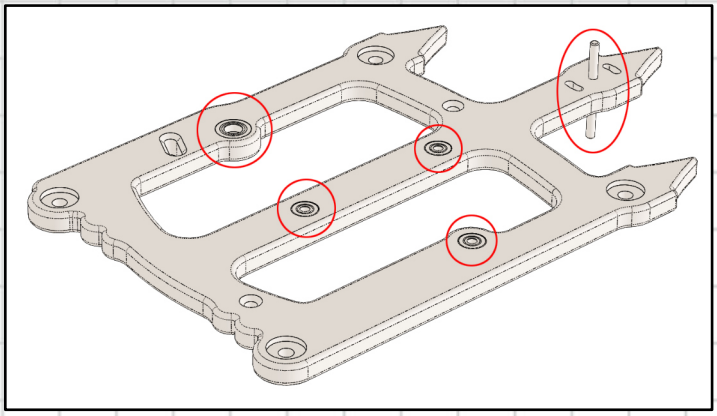


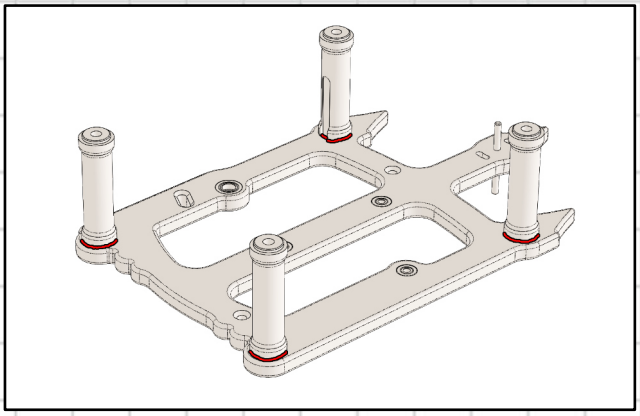
To complete the assembly of the front frame, the dial base is located on the top and bottom pins and glued in place, followed by the gluing the Number Discs onto the dial base. Note the number 12 over laps the 30/8 tooth gear so if you need to remove them then you will need to pull out the Pivot pin to release them.

Clock 44 - Compact Children's Clock

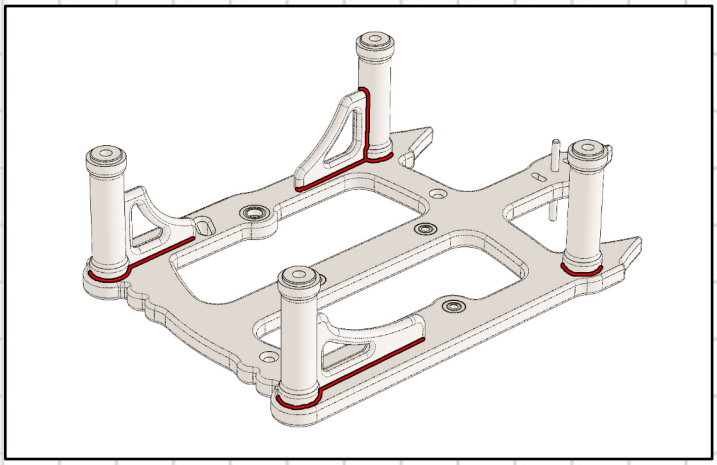
Construction instructions for Clock 44

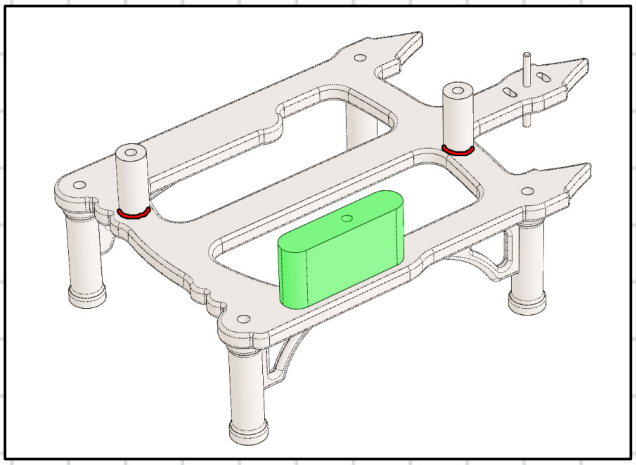
Step 1 Preparation of the Frames





Next job is to fit the bearings to the Back frame, again it would be best to use a Drill Press fitted with a short length of rod to mount the bearing on so that it is pushed into position nice and square to the frame. The Frame spacers are fitted next and glued into position as shown above the one at the top right hand side is the one without the slot as this one has no Brace fitted.





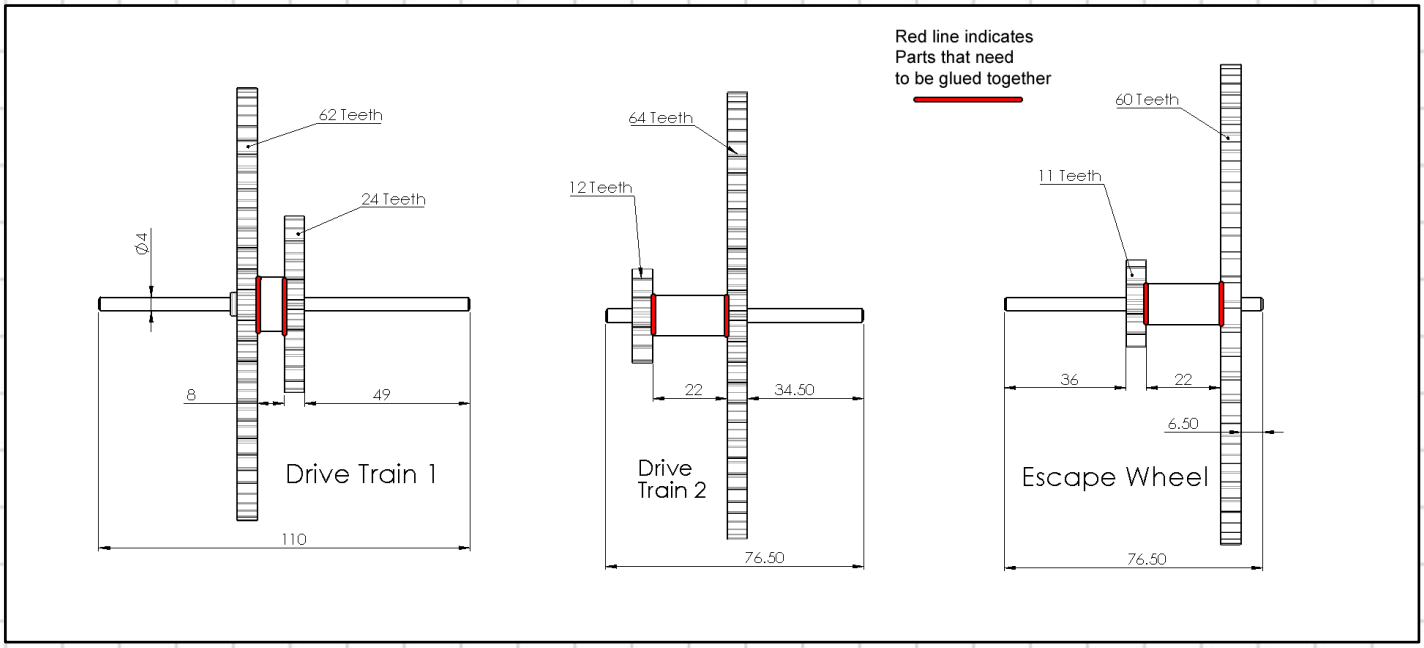
With the Frame Spacers glued in place now add the Braces as shown above and glue in position.

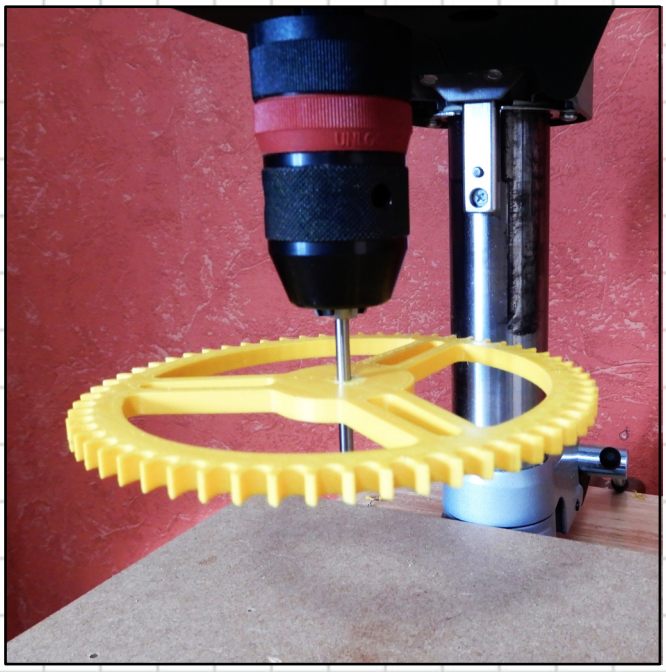
Now turn the frame over to locate and glue the Wall Spacers into position over the relevant holes and slot in the frame. Note the slot behind the large hole in the long spacer is to allow you to adjust the clocks fitting to the wall. This is necessary as the clock needs to be fitted vertically using a spirit level so as to ensure the escapement works properly. So when fitting the clock to the wall fit the top screw first then adjust and fit the screw through the slotted hole and finally the slot in the bottom hole. Note the Wall spacer shown here in green is not glued in place as it needs to float when the frame is being adjusted on the wall.

Clock 44 - Compact Children's Clock

Construction instructions for Clock 44

Step 2 Preparation of the Drive train sub assemblies



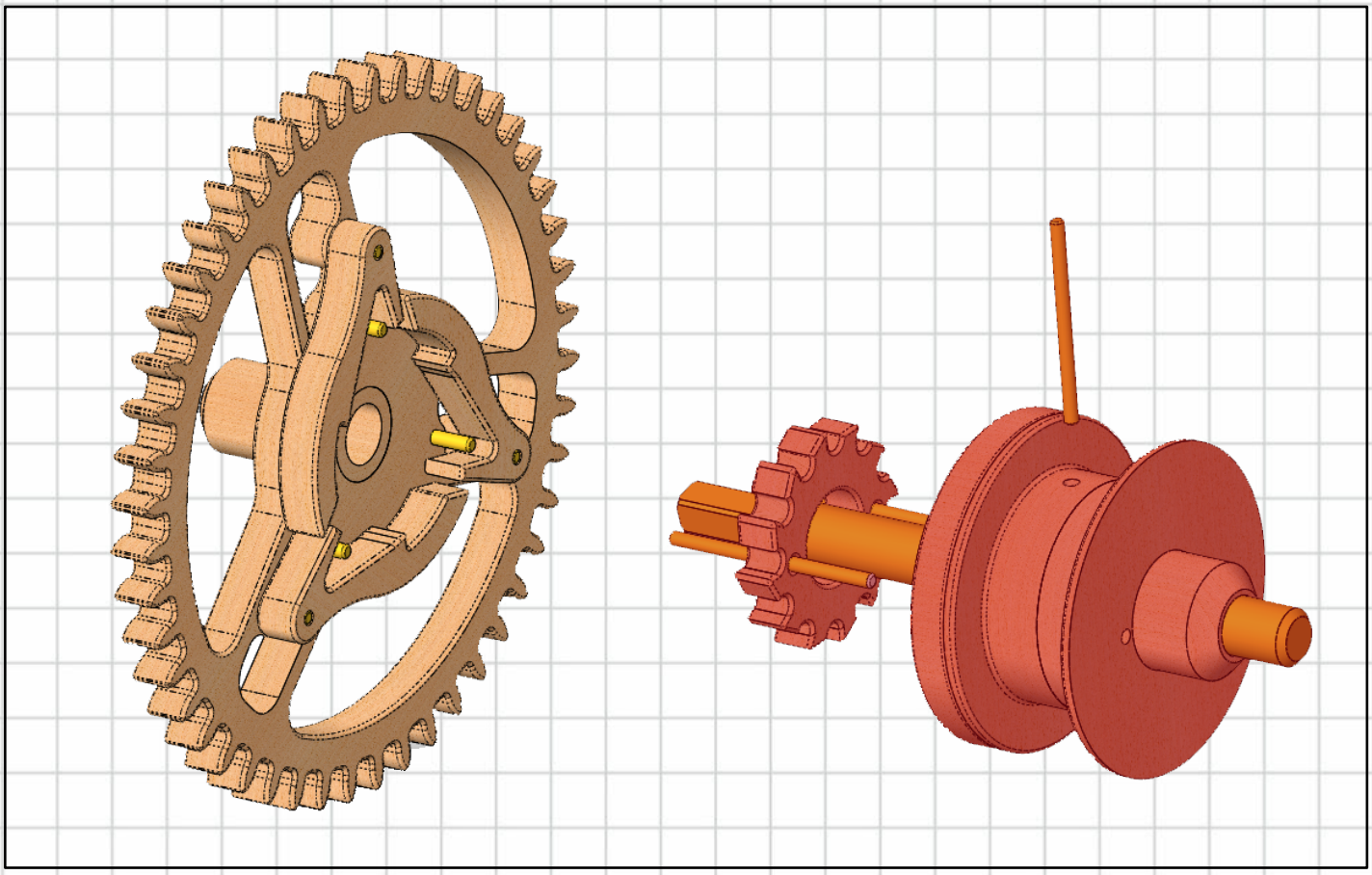


The 3 Drive train sub assemblies shown above are all very similar and require to be assembled in the same manner. I recommend you use a drill press to do this as I have done, as it ensures that the gears are all mounted square to the shaft,.They should all be a tight fit on the shaft so that it is the shaft moving within the bearings when the clock is running. Drive train one is a slight exception, as it has a pin fitted through each gear as well to make sure there is no relative movement between the gears on the shaft when the load is applied. The other two don't need the pin as the loads on these gears is relatively light, but it would be wise to glue the three parts together to stop any relative movement of the these gears .

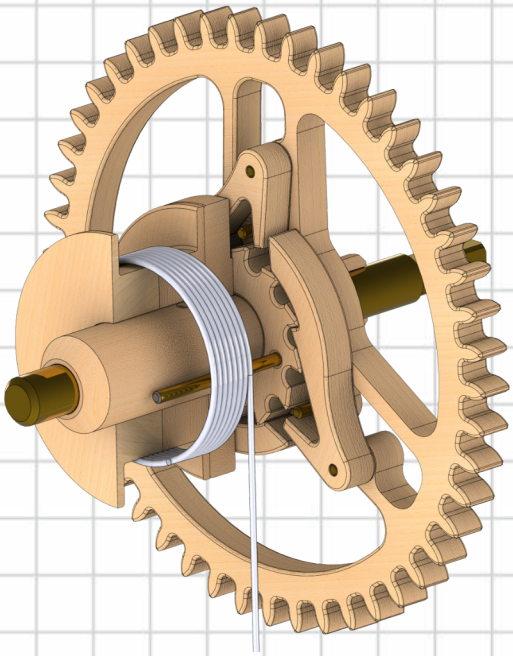
Clock 44 - Compact Children's Clock

Construction instructions for Clock 44

Step 3 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, Essentially all the parts that are toned Red are to be glued and pinned to the Ø8 mm Brass shaft running through the centre. The rest of the parts need to be assembled as shown with the centre sleeve being glued into the large gear wheel and the whole being free to revolve on the Brass shaft.

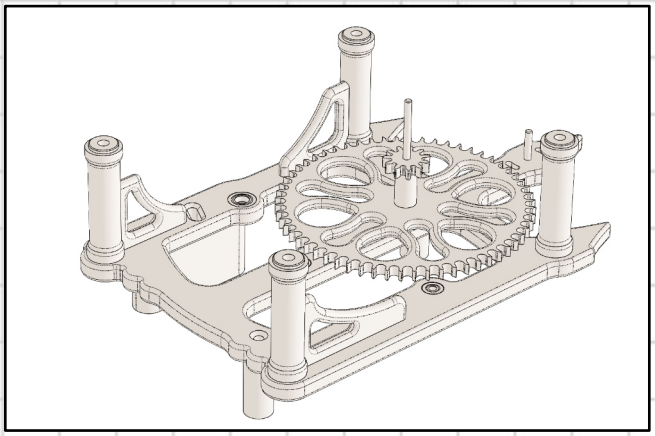


Take a special note about the side onto which the Pawls are mounted on the Large gear, and the way round that the Pawls are facing when fitted to the pins.
Note also the second set of three pins that the Pawls sit astride, the Pawls are to be a loose fit on the pivot pins so they move freely under gravity. And the second set of pins are there to stop them falling too far.
The cord used to support the main weight is wrapped around the drum anti-clockwise when viewed from the front, the end of the cord is attached to the drum using sticky tape, the repeated wrapping of the cord around the drum holds it in place.

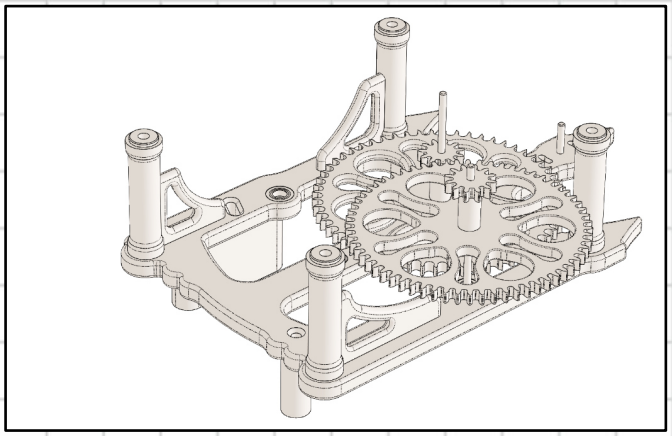
Clock 44 - Compact Children's Clock

Construction instructions for Clock 44

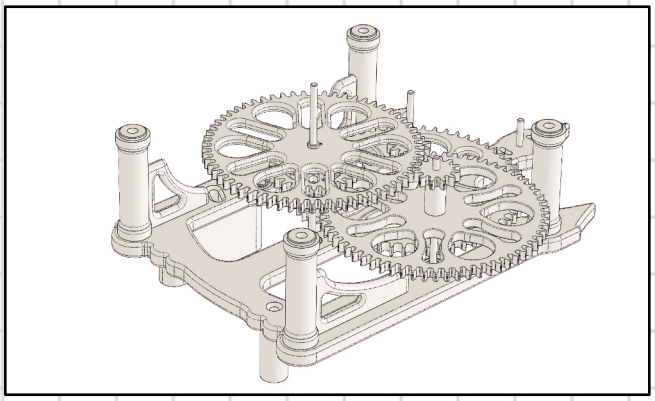
Step 4 Fitting the Gear trains



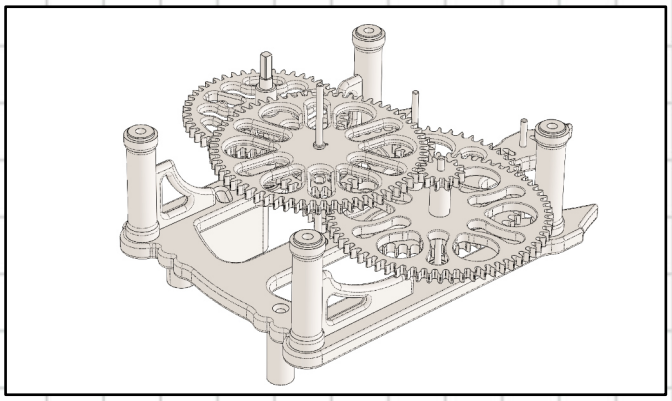
Fit the Escape Wheel sub assy.



Fit the Drive train 2



Fit the Drive Train 1 sub assembly

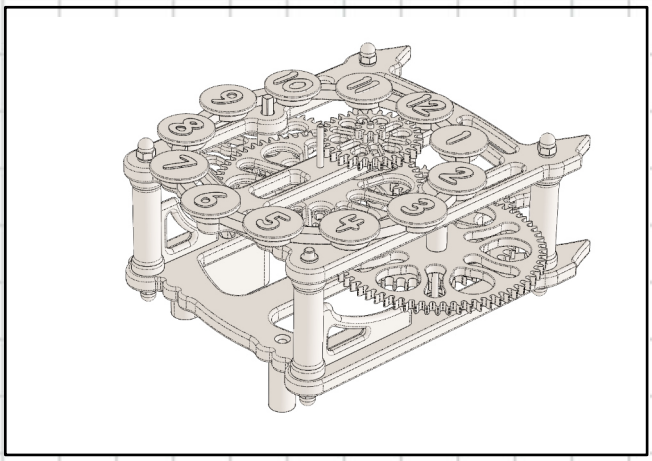


Fit the Drive Sub assembly along with the Weight cord wrapped around the drum. You can leave the actual weight until after the clock has been fitted to the wall.

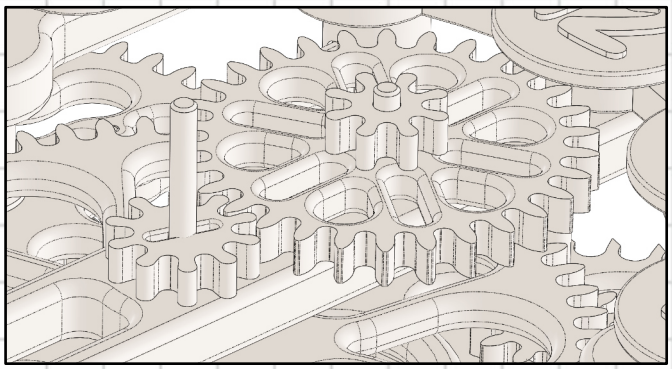
Clock 44 - Compact Children's Clock

Construction instructions for Clock 44

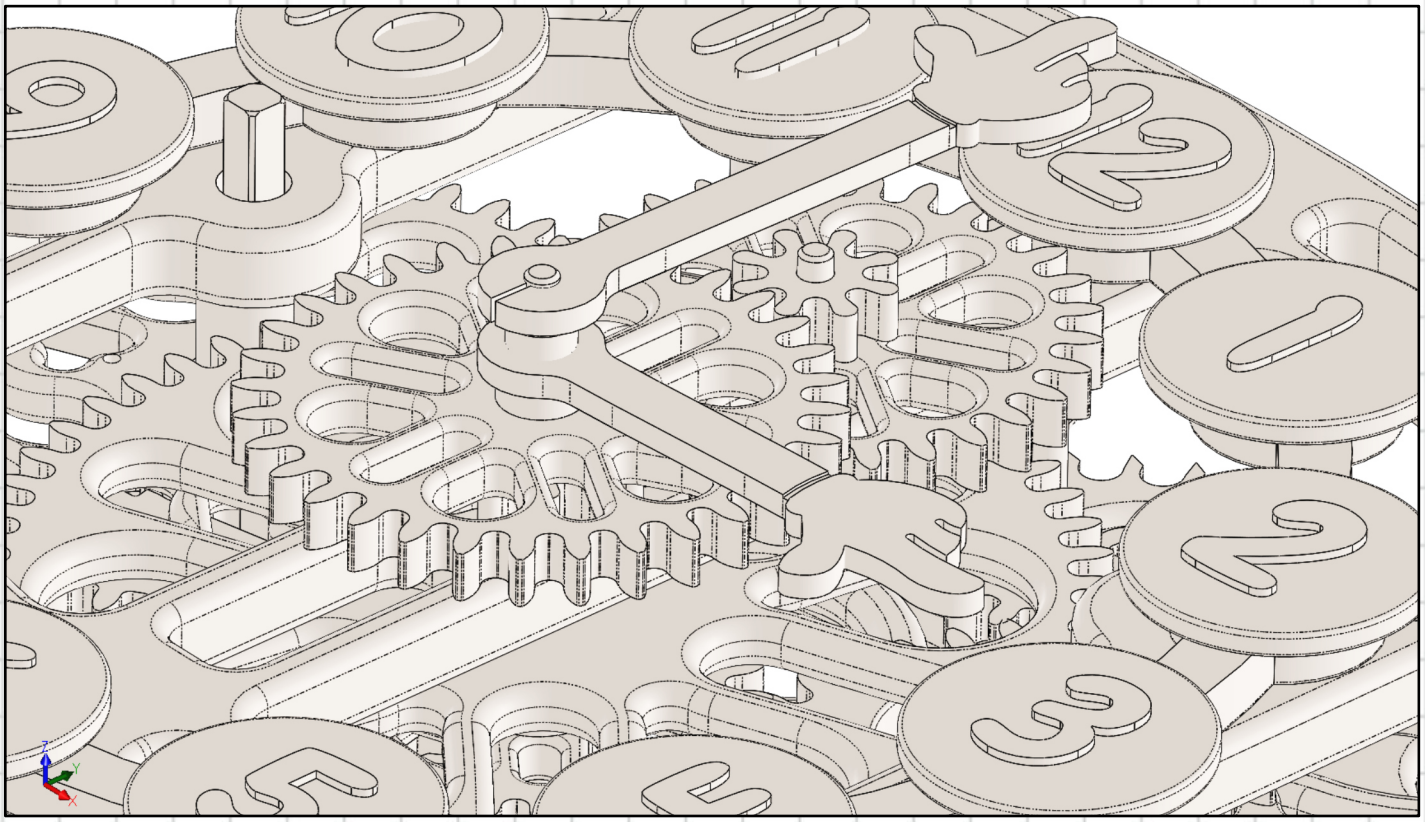
Step 5 Fitting the Front frame and the Hour gears



Fit the Front Frame over the Threaded rods and secure with nuts and washers.



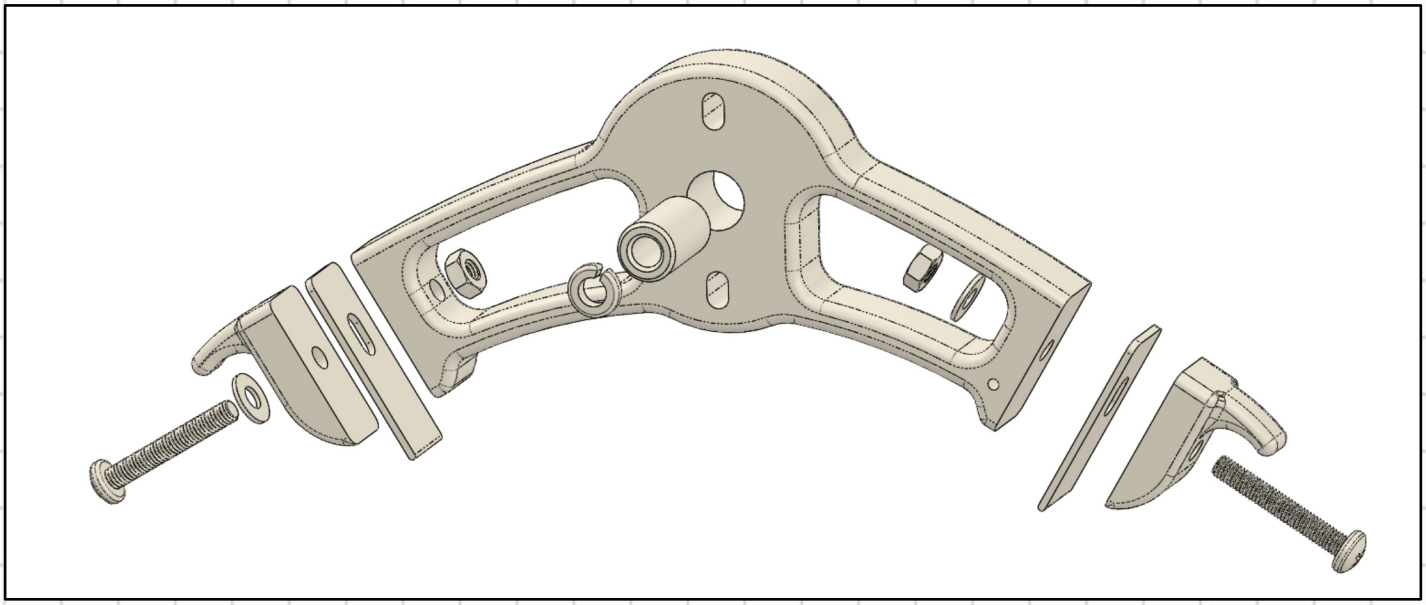
Fit the 10 tooth gear over its shaft and note that it is a tight fit on that shaft, it has a slot across the hole to make it easier to removed when dismantling.



Now you can fit the 32 tooth gear fitted with its Hour tube over the Shaft an finally the Hour and Minute hands. Make sure that there is sufficient separation between the two hands so that they can't touch each other as they rotate.

Construction instructions for Clock 44

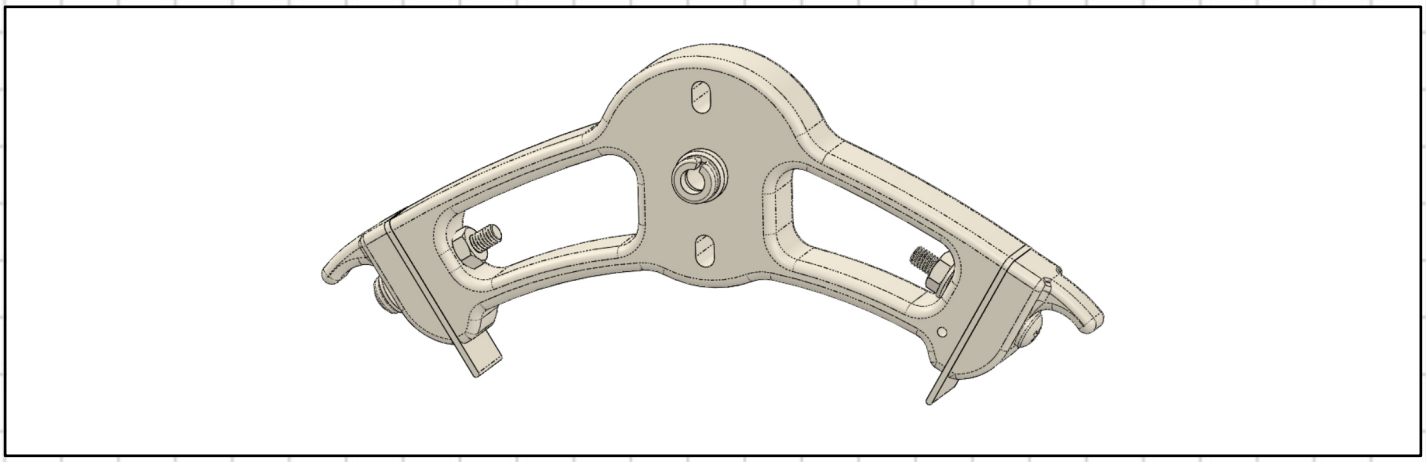
Step 6 Preparation of the Escape Arm sub assembly



First fit the Brass Bush into the centre hole in the arm and then attach the two red Pallets to each end using the M3 Nuts,Bolts and Washers. The pallets should be position with the top edge level with the top corner of the Arm, and the sides parallel with the faces of the Arm.

The Arm assembly is now ready to be fitted to the Pivot Pin situated at the very top of the Back Frame. The small diameter split ring or 'End Stop' shown in the front of the Bearing is a tight fit on the Pivot pin and should be fitted after the Arm is mounted on the clock.

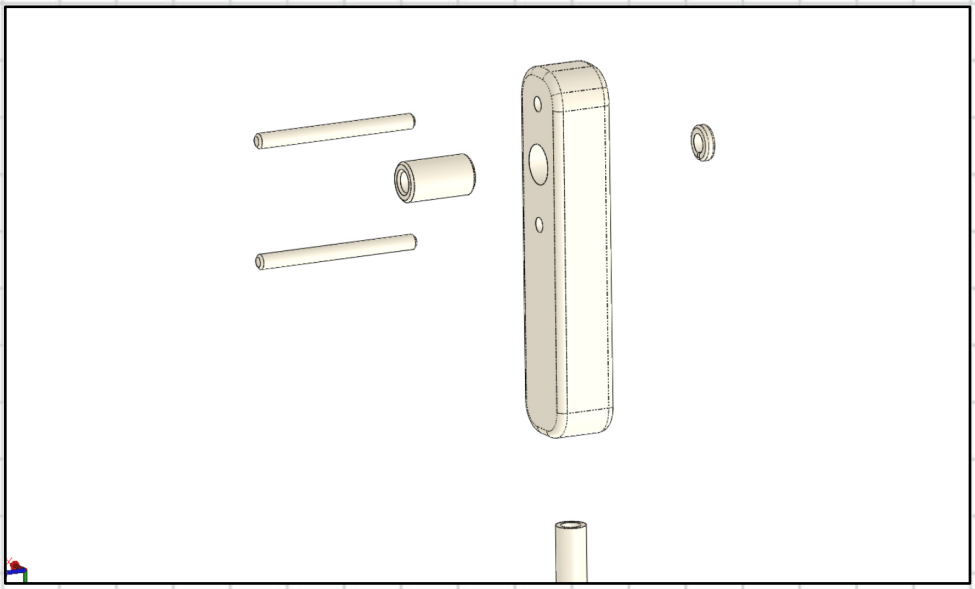
The small hole shown here next to the Pallet is there as an indicator that this is the Right hand side.

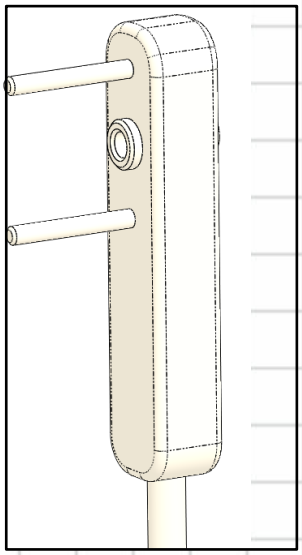


Clock 44 - Compact Children's Clock

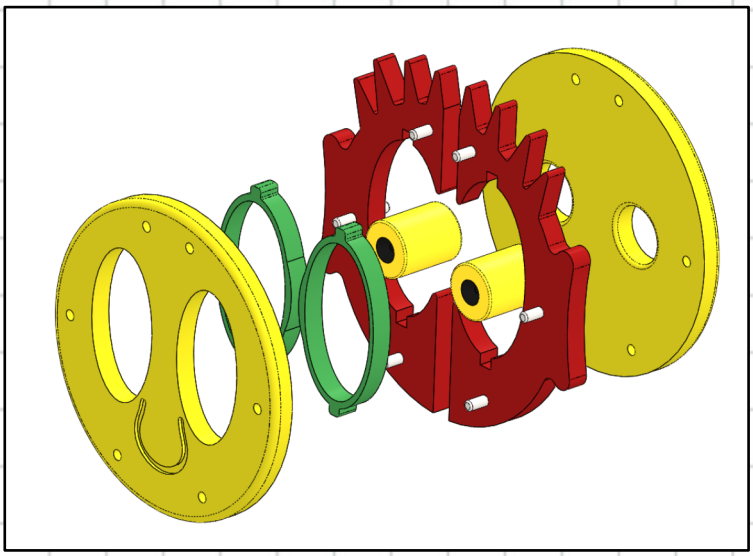
Construction instructions for Clock 44

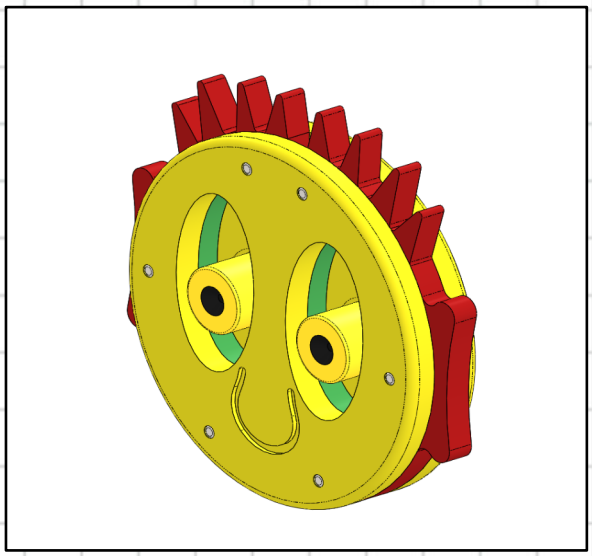
Step 7 Preparation of the Pendulum sub assembly





The Pendulum Head is assembled as shown with the bush a press fit within the body and the two connector pins either side. The Carbon Fibre Rod is pressed into the underside bottom hole and either glued or pinned in position.

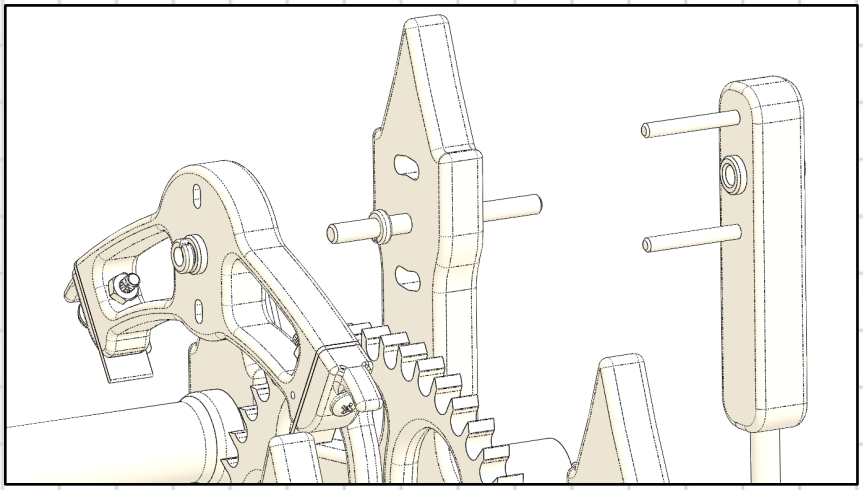




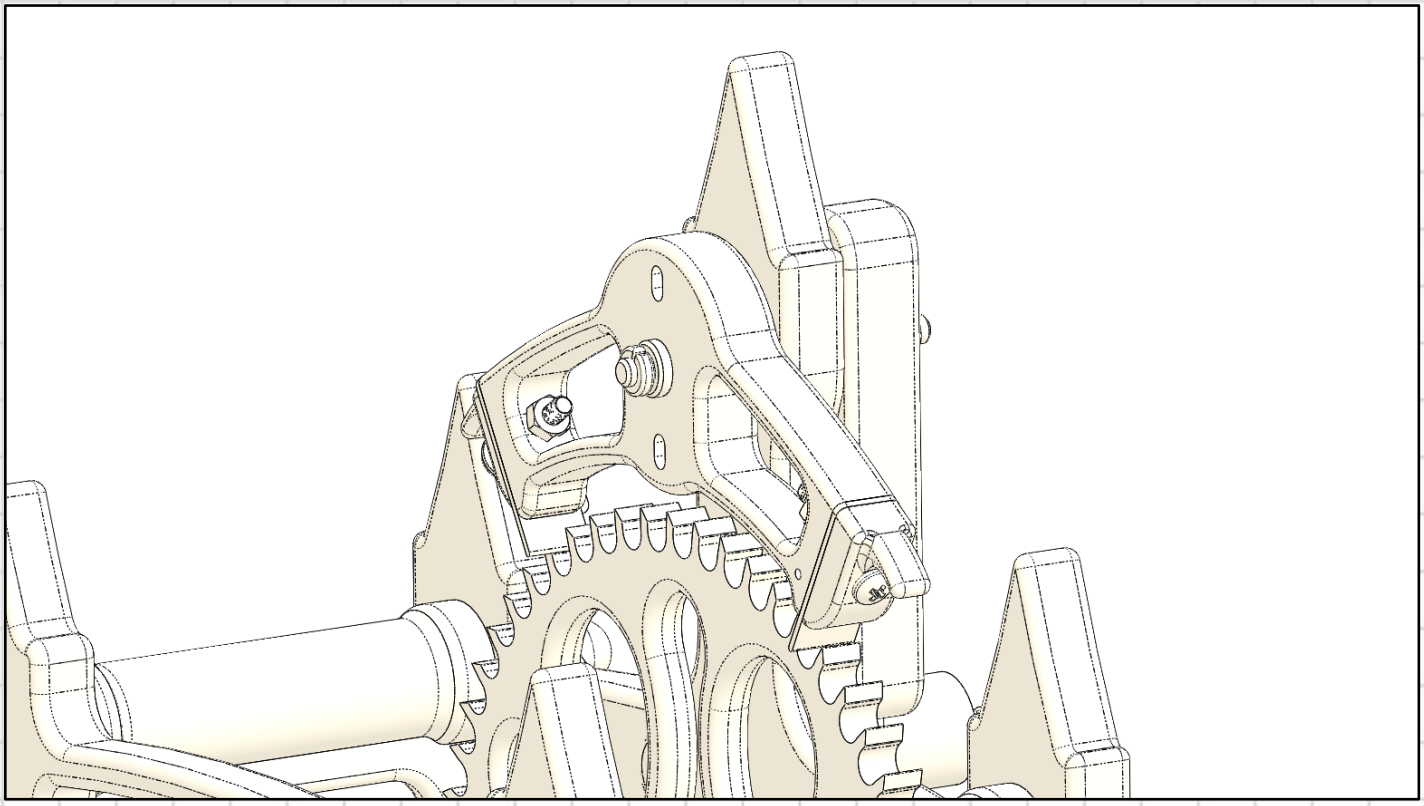
At the bottom end of the Pendulum Rod the Pendulum Bob is to be mounted. The exploded view above shows the relative positions of the parts and the six steel pins used to hold them all in place. The pendulum Rod is squeezed through the centre square hole and is held in place by the 2 oval green parts pressing on the Rods sides. If this is too tight a fit then the thick inner sections of the ovals can be files to suit. The Pendulum Bob needs to be moved either up or down to either speed the clock up or slow it down.

Construction instructions for Clock 44

Step8 Fitting Pendulum sub assembly and Escape Arm to the clock



In this view you can see the Pivot Pin is already mounted in the top of the Back Frame, with the Pendulum sub assembly poised to be fitted. The small spacer is slid on first followed by the Pendulum itself and then the End stop which will prevent the Pendulum working its way of the Pivot pin.

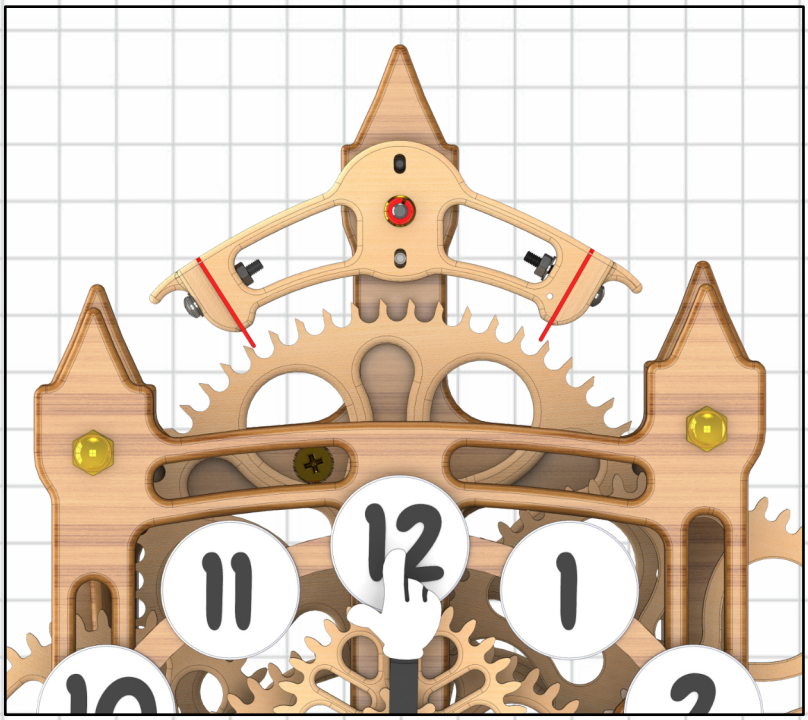


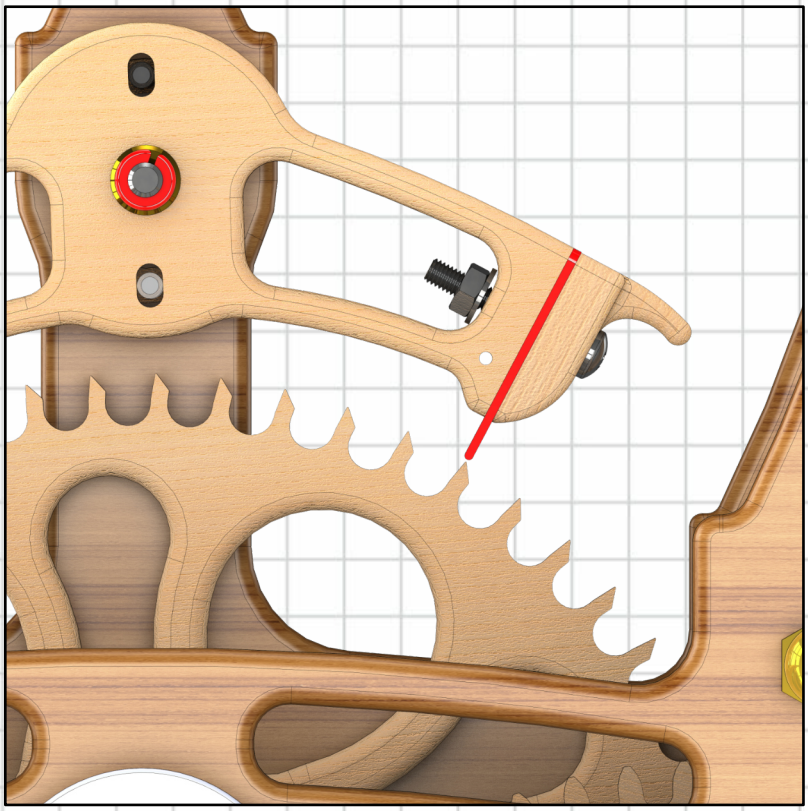
OK this is the finished position with the Escapement Arm sub assembly pushed onto the Pivot pin and again held in place with and small End stop.

Clock 44 - Compact Children's Clock

Construction instructions for Clock 44

Step 9 Setting up the Escapement Arm Pallets



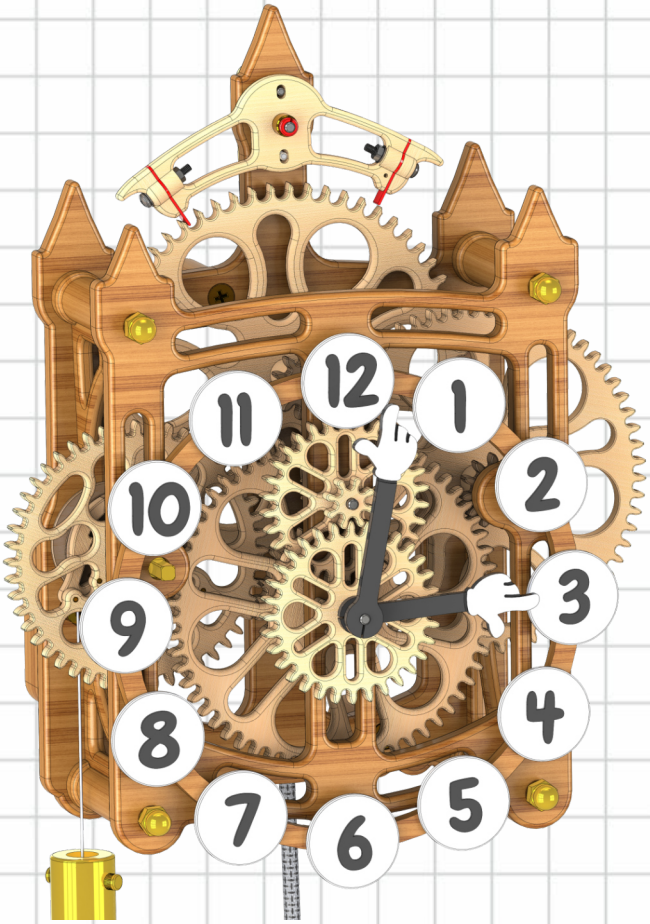


Now the tricky bit, setting up the pallets, in theory your clock should look like the picture above when it is at rest. It is very important with this particular clock to have it screwed to the wall so the the Frame of the clock is vertical, do this using a Spirit level against the side frame of the clock. There is some scope for adjustment when you screw it to the wall, fix it with the top screw first and then with the screw through the slot below that first screw, swing it back and forth until it is vertical then tighten the screw and fit the last screw at the bottom.
The picture at the side shows the most common problem likely to occur, where the pallet hits the top of the tooth. To fix this move the pallet up slightly and try again.
Keep adjusting the pallets until you clear the problem.

Clock 44 - Compact Children's Clock

Construction instructions for Clock 44

Step 10 Running the clock



After getting the clock running by adjusting the Pallets on the Escapement Arm, the next step is to adjust the weight. You really need to run this next procedure before having made the weight as the dimensions I have given for the weight work with my build of the clock but you may well get away with using less weight.

To establish the weight to use for the 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 2 litre water bottle partly filled with water to start and add or remove water to get the clock running continuously.

There are lots of other ways of making the weight and the use of Brass is used here because it needs a relatively small diameter and will not clash with the pendulum. However if you go another route make sure to keep the diameter below Ø50 mm.

That's it, now your clock will hopefully run first time, mine actually did, but that was rare and usually I have a few problems first.

Clock 44 - Compact Children's Clock

Construction instructions for Clock 44

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 1020 mm 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 fitted two 22 mm long Ø16 mm Brass rods into four holes drilled through the Bob.

- For winding the clock I would suggest you use an off the shelf Winder, the Grandfather clock Key number 13 is ideal.

- 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 two litre 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.

  The settings I have used for this clock are:-
- Main Weight 500 to 750 gram
- Distance from pivot to centre of Pendulum Bob 1020 mm
- Run time 27 hrs when dial is set at 1500 mm above the floor.

- 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,

Clock 44 - Compact Children's Clock

Construction instructions for Clock 44

HINTS AND TIPS - continued

- 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 Ø3 shaft they are fitted to. The parts should be a running fit in the Ø3 mm shaft, and the Escapement-Pendulum pin in the centre lower down, should be a slightly loose fit in the slot in the Pendulum Head, if any of these fits are too loose then the parts can twist relative to each other and some impulse will be lost from the Pendulum.

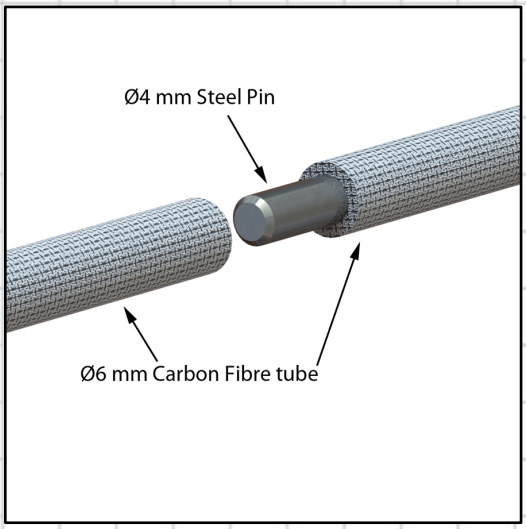
- The DXF files supplied include all the parts that can be cut using the CNC router, they do not include those round items such as the turned parts cut from Doweling nor any pins or nuts and bolts, information on these parts are included in the Detail drawings supplied in PDF format.
The parts shown laid out in a single DXF files ready for you to extract and use in your CAM software. The profiles are shown on 5 separate layers , these being 'Outside Cuts' 'Inside Cuts' 'Pockets', 'Non Cutting Profiles' and Centre Marks The layers are colour coordinated as shown . The centre marks are only really necessary if you are cutting out by hand and Need to know the centre of the circle.

- Concerning bearing Lubrication the type and viscosity of the lubrication in the "as shipped" bearing is highly significant and represents a considerable drag inside the bearing. I recommend that the grease or oil be soaked out with white spirit, I expect that the solvent leaves a thin residue of lubricant, although it is doubtful if this is still there after say twenty years or so. However manufacturers recommend completely dry bearings for absolutely the lowest friction. This is thought to reduce bearing life expectancy somewhat.

Clock 44 - Compact Children's Clock

Construction instructions for Clock 44

HINTS AND TIPS - continued



Some times it is necessary to make the Pendulum Rod longer than the 700 mm or 1000 mm you were able to purchase. If this is the case you will need to cut down a second piece of tube to the additional length that you require. Now you need to make sure the cut ends are square so that when they are butted together there is no gap.

A short length of steel pin Ø 4 mm is used to fit into the ends of the two pieces of tube to support and align them before gluing into place using a strong adhesive like Gorilla glue or Araldite, whilst the glue is setting hold the two tubes along their length to ensure they stay in line.

Clean of the excess and wait for a couple of hours until it is dry before you use the new tube.

Prefix	Suffix
S=Stainless Steel	**RS**=Single Rubber Seal
F=Flanged	**2RS**=2 Rubber Seals
MR=Metric	**Z**=Single Metal Shield
MF=Metric Flanged	**ZZ**=2 Metal Shields
R=Inch	

Recommended bearing type is stainless steel with metal shields as these do not actually touch on the balls inside whereas the flexible seals can do.

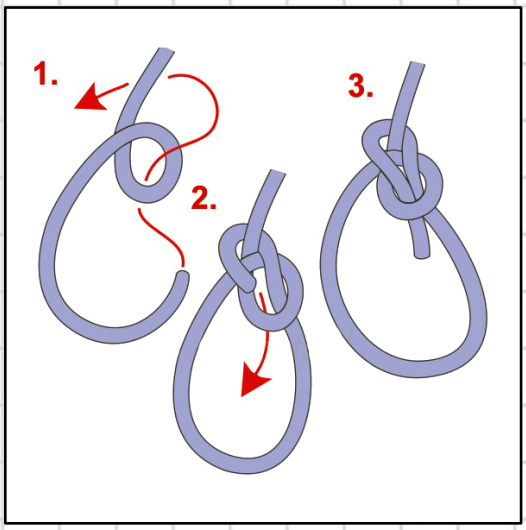
A typical designation would be:-

SMR84ZZ Ball Bearing - Ø4 x Ø8 x 3 mm

Or for a flanged version

SMF84ZZ Ball Bearing - Ø4 x Ø8 x 3 mm

This information supplied by:- https://www.arceurotrade.co.uk/Catalogue/Bearings/Ball-Bearings-Metric/4mm-Bore



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.