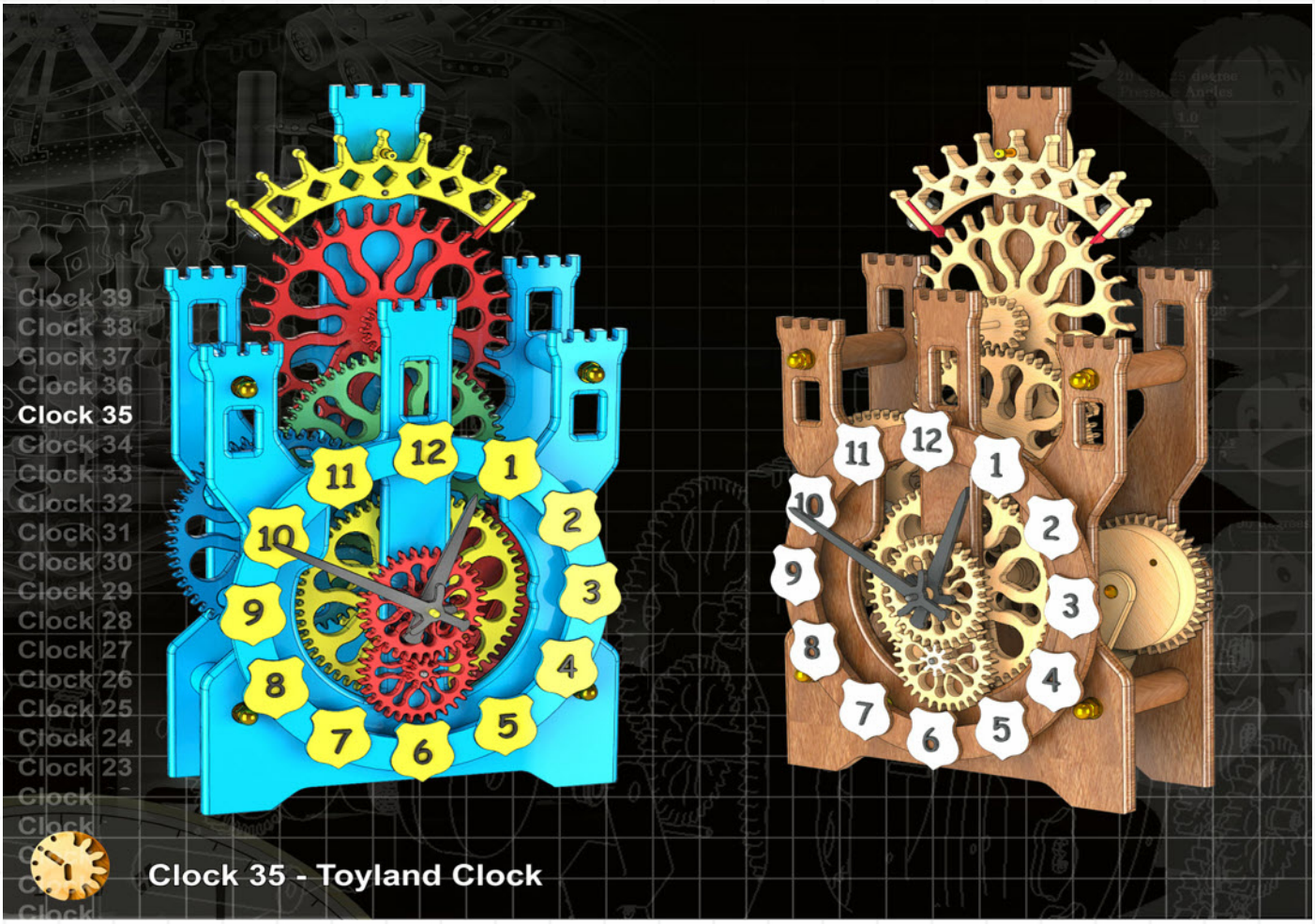
Clock 35 - Toyland

Construction instructions for Clock 35



This clock has been designed for children, it is a stand-alone unit and can be positioned on a shelf or cabinet out of the reach of very young hands who may be tempted to touch. The clock is shown in two forms above, on the left a more traditional wooden clock style and on the right a multi-coloured version. The finish you choose to adopt is really entirely your own choice and I am only showing two of the many ways in which you can finish your own build of the clock. The instructions that follow are illustrated using the traditional design but whatever design you choose to adopt, these basic instructions will apply.

For the first time in one of the clock designs I have to include some alternate parts that can be made using 3D printing, I found it useful this time to print some of the parts, and in this way I could achieve the colours in the gears and in couple of the more complex parts 3D printing offered a much easier way to construct. So if you want to do the same then the necessary STL files are included.

I have designed this clock for my Great Grandson Ollie so the prototype uses the 3D printed coloured parts and has the Front and Back Panels Painted MDF.

I learnt a lot from this build and found some small changes should be made to the plans to incorporate those learning's, so if you notice differences when watching the video, then that is the reason why.

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Construction instructions for Clock 35

Equipment

The following equipment is desirable:

CNC Router or Laser or Waterjet and if not one of these then a Scrollsaw or a Bandsaw. Small Lathe, this is not absolutely essential but it would make making the clock a lot easier for all of the round parts that are needed.
Small Milling machine or **Pedestal Drill** with work holding vice. There are 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, Ø3mm, Ø4 and Ø4.1 mm, Ø6.5

Router Cutters 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 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 really down to you to decide. I personally 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 6 mm and 125 x 9 mm and these are fabricated into blanks for the larger components by glueing two strips together.

You can, however, use a 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.

You can also use Perspex with which you can create some quite colourful clocks (see Clock 19).
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 Drill Rod or Silver Steel 660 mm Long for all the shafts and numerous pins.
Ø3 mm Rod or Silver Steel 150 mm Long
Ø2 mm Rod or Silver Steel 150 mm Long
Ø4 mm Nuts, Bolts and washers for holding the Pallets into the Escapement
Woodscrews
6 MM Threaded rod 500 mm long
Ø16 mm Brass Rod 100 mm for the Pendulum Bob
Ø16 mm Brass Rod 100 mm for the Spring Arbor
Ø6 mm Brass Rod 100 mm for the Pendulum Pivots
Ø16 mm Acetal Rod 100 mm for the Spring Case Bearings
Note these are the minimum amounts 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.

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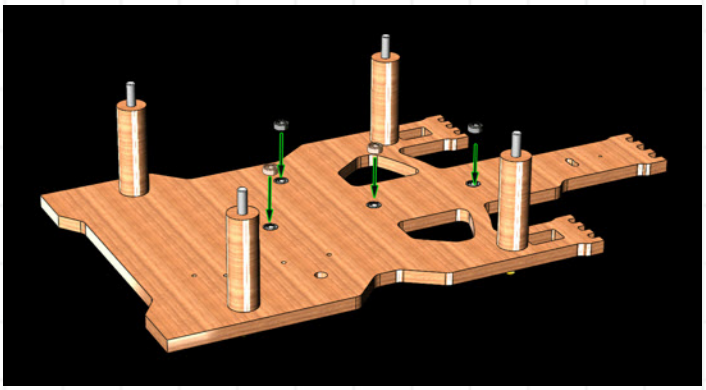
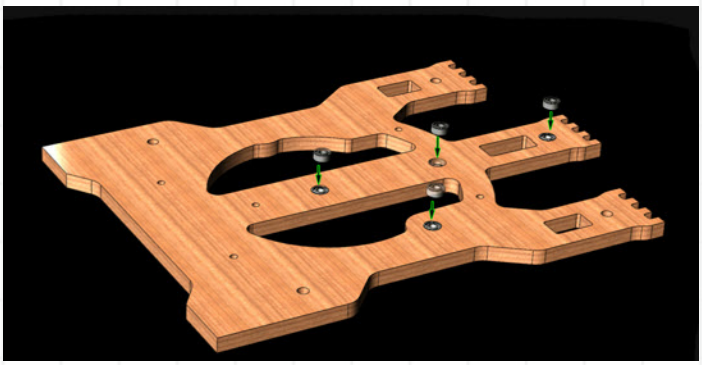
Construction instructions for Clock 35

Step 1 Preparation of the sub assemblies



Back Panel

With the Back Panel laying on its back, glue the 4 frame spacers in position and insert the Threaded Rod and Dome nuts and washers. Now insert the four Ø10 diameter bearings into their pockets as shown



Front Panel

Repeat the fitting of the bearings into the Front Panel

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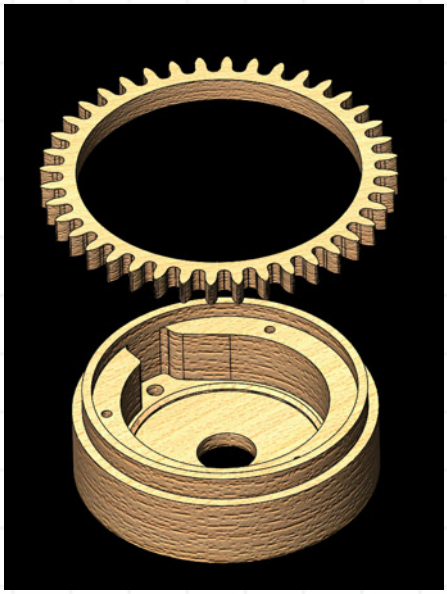
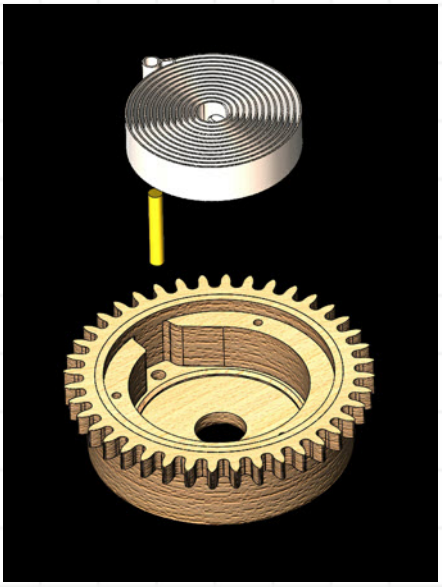
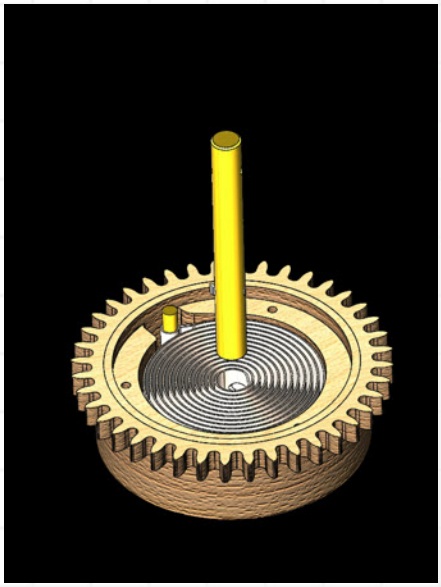
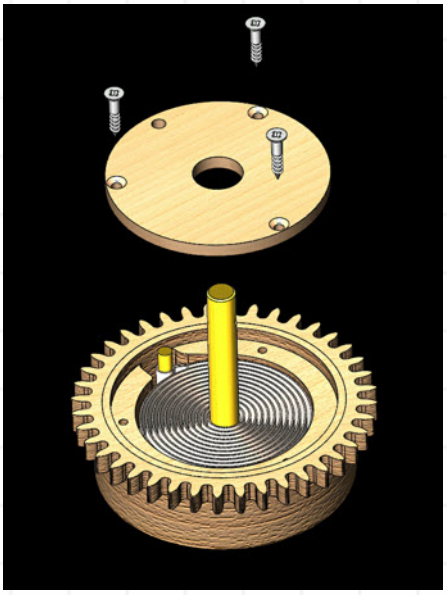
Construction instructions for Clock 35

First, fit and then glue the 38 tooth Gear Ring to the Spring Outer case..
Next fit the spring Pin through its hole in the case and then fit the spring into the case by laying the spring wrapped in its wire tie over the pin and into the case inner hole and rest the wire on the edge. Now using a drill press and an appropriately sized block push the spring into place. See video
https://youtu.be/Jiw4SPPkl0w
Now fit the the arbor by inserting it into the springs centre and whilst pushing it in rotate the Arbor backwards so the steel pin can be can move into the spring and engage in the hole in the tail of




Finish this part of the assembly by fitting the cover plate with its 3 screws.

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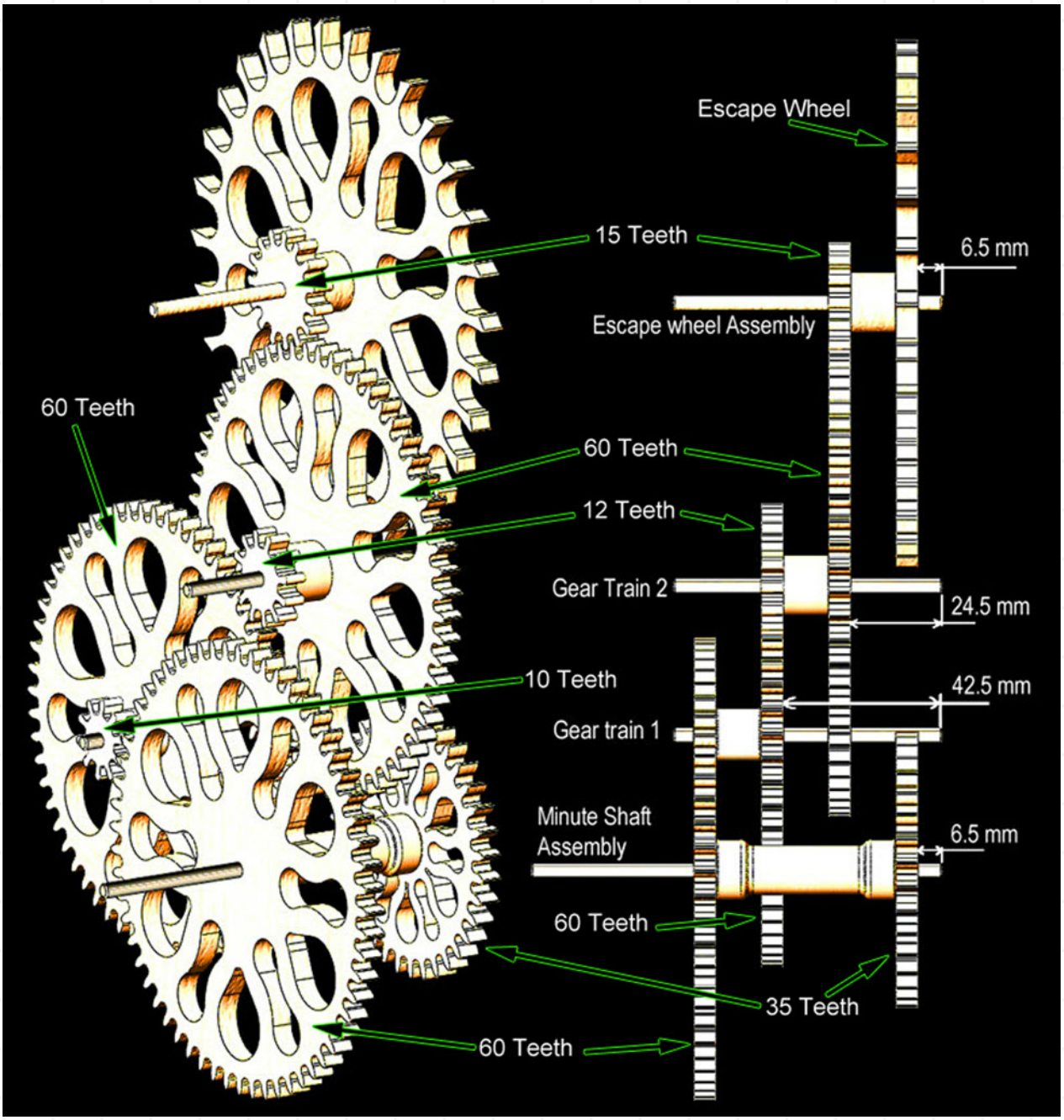
Construction instructions for Clock 35



The individual gears and spacers now need to be fitted to their respective shafts to the dimensions shown above. It is best if you use a Drill press or a Lathe so that you can hold the shaft in the chuck whilst you push it through the centre holes in the gears and spacers. This will ensure the gears are fitted squarely to the shafts and do not wobble when rotated.
The ends of the shafts should also be polished with fine emery paper while turning in a drill or lathe so that they will fit easily into the bearings when assembling.

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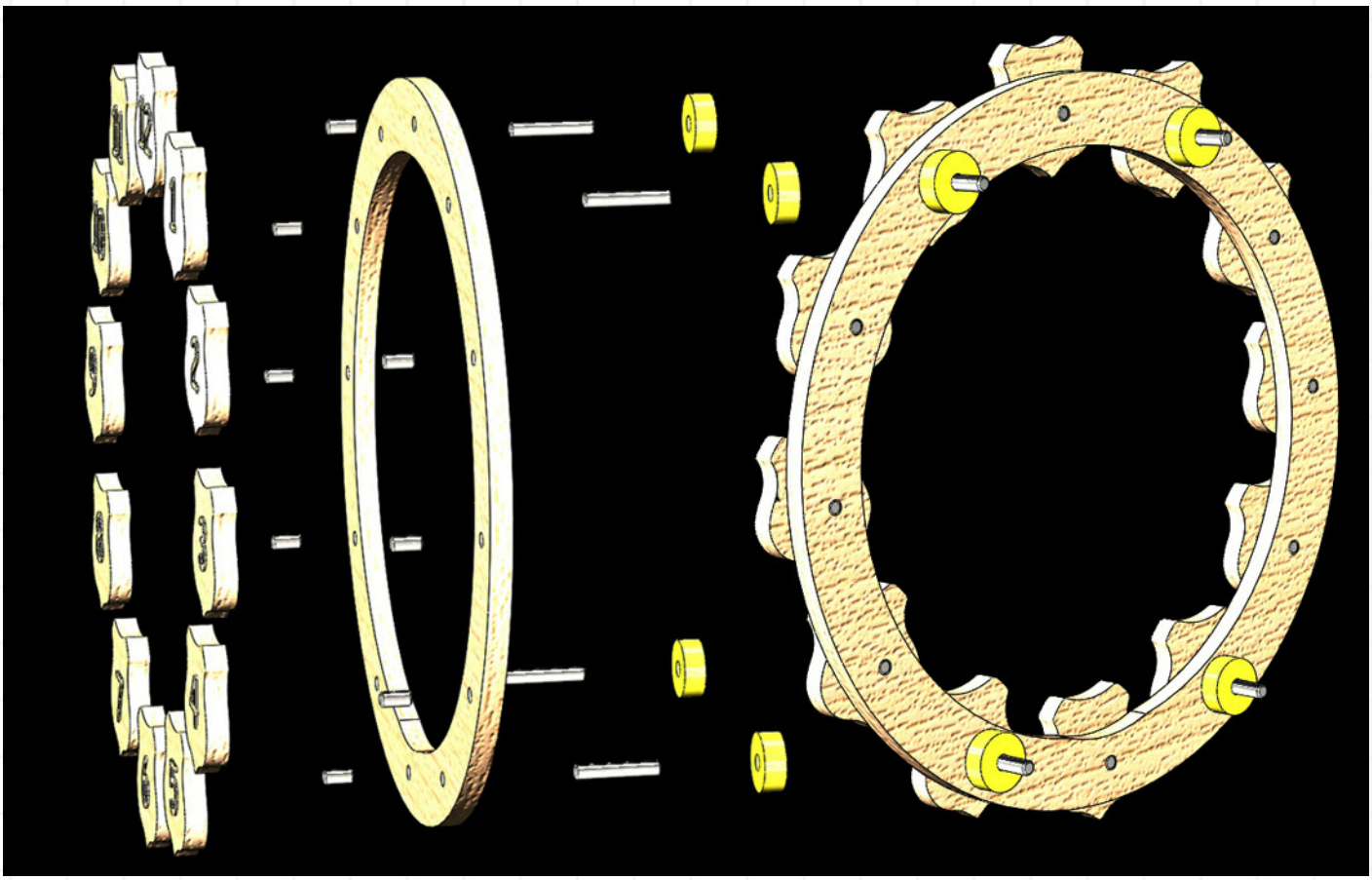
Construction instructions for Clock 35



The Dial is the next to be assembled, the Shields will need to have a Ø4 mm hole drilled into the back so that they can be located by the short Ø4 mm pins fitted to the front of the Dial Ring, (I have provided details of a small Jig you can make to act as a guide for drilling this hole, details can be found on the detail drawing.)
This will enable you to orientate the shields so they sit vertically on the Dial Ring as you glue them to it.
Next, fit the 4 Dial spacers using the 4 longer Dial pins and glue in position, the pins will locate on the Front panel of the clock.

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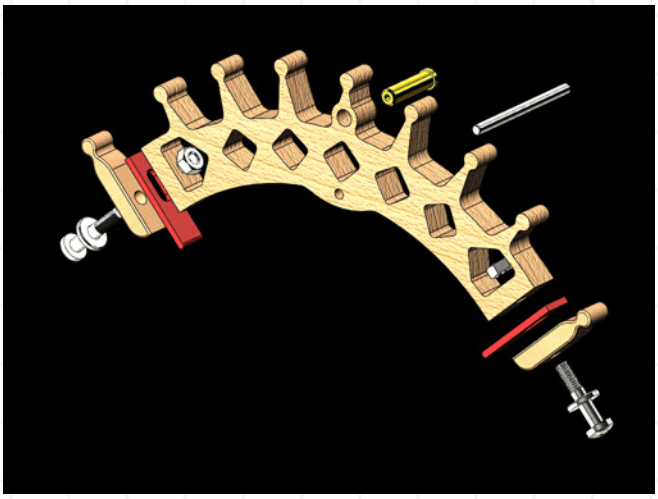
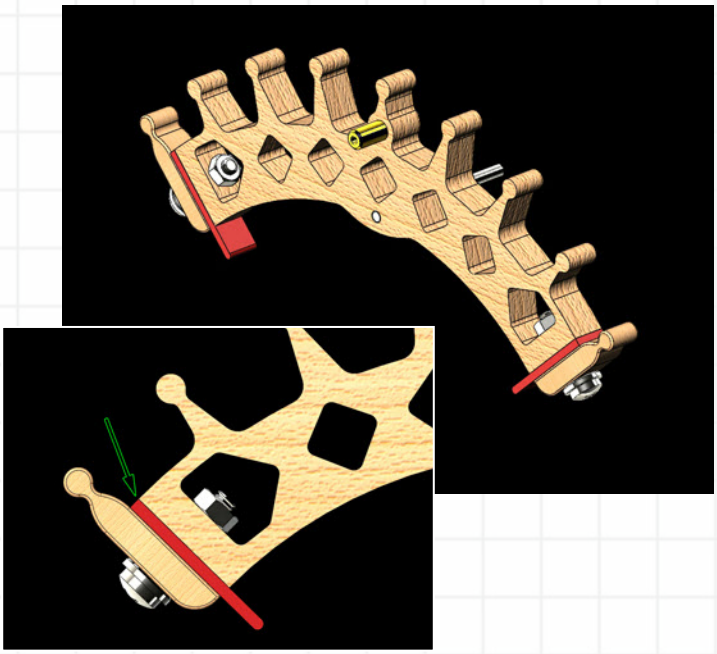
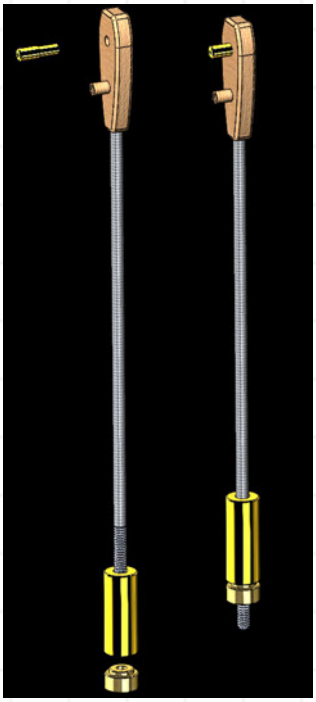
Construction instructions for Clock 35





First, assemble the Pallets and their clamps to the ends of the Arm using the Ø4 mm nuts and Bolts, ensure that the top of the pallet is fitted level with the top of the Escapement Arm as shown by the green arrow above. This is the starting position and you may need to adjust one or both the pallets to get the clock to tick evenly.

The Escapement Arm is the next to be assembled, start by fitting the brass Escapement Sleeve to the hole in the centre, and then the Pendulum-Escapement Connector to the hole beneath, note that this is fitted from the same side as the Sleeve.



To assemble the pendulum glue the Carbon Fibre shaft into the Pendulum head and the Threaded Rod section glue into the bottom of the Rod. I would normally use Gorilla Glue for this.
Now insert the Pendulum sleeve into the top hole in the head and thread the Pendulum Bob and its locking nut onto the bottom. Screw them up so that the top of the pendulum bob is 225 mm from the pivot point, this should be a good starting point for adjusting the rate of the clock.
Moving the Bob up speeds up the clock and visa versa.

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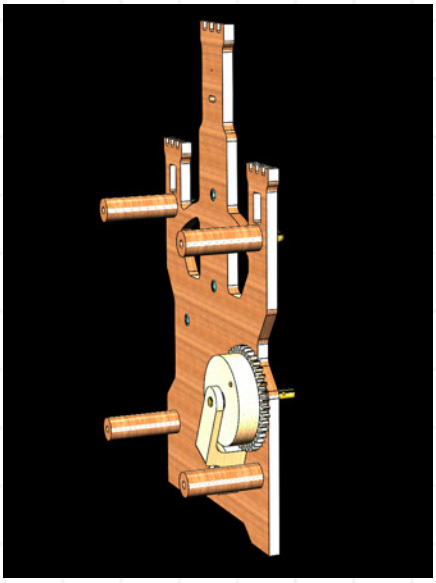
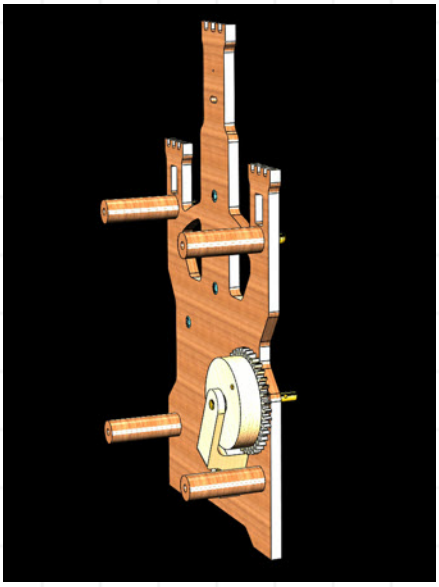
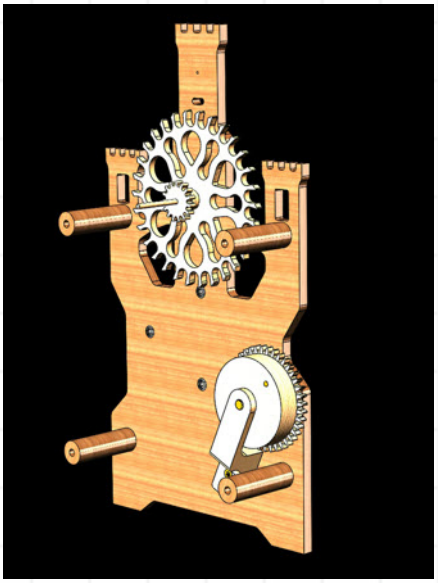
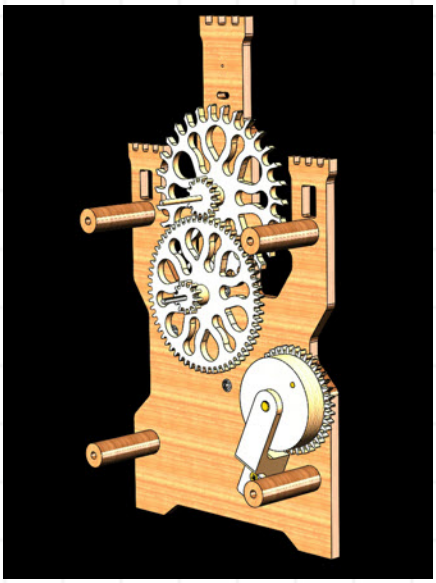
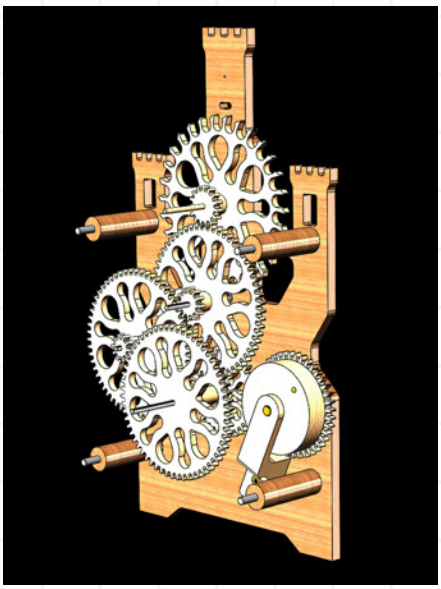
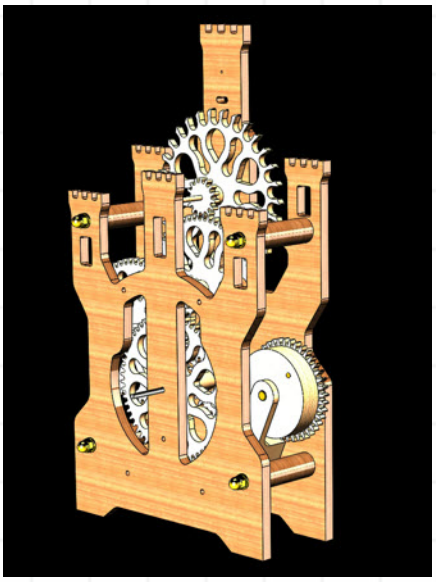




Firstly fit the Spring Drive assembly to the Back Panel using the Spring Support Arm, and fix it in place with the 2 pins and a small woodscrew.
Now progressively fit the gear sub-assemblies into their respective bearings in the Back Panel.
Finally, fit the Front Panel and secure using the 4 Domed nuts and washers.
Make sure all of the gears run freely at this stage by winding the up the spring a few turns and letting them run free. If there is a problem with the gears identify which gear pairs are not running freely and correct be for proceeding.

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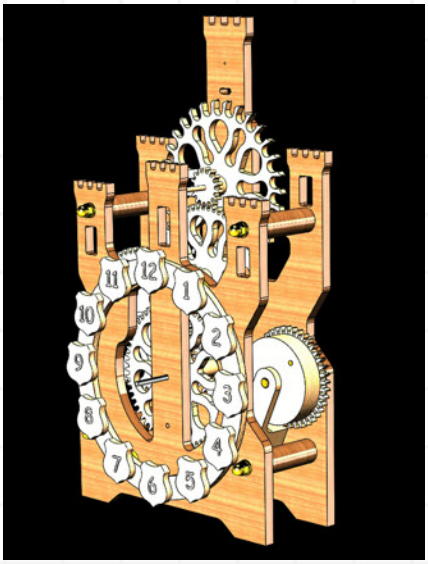

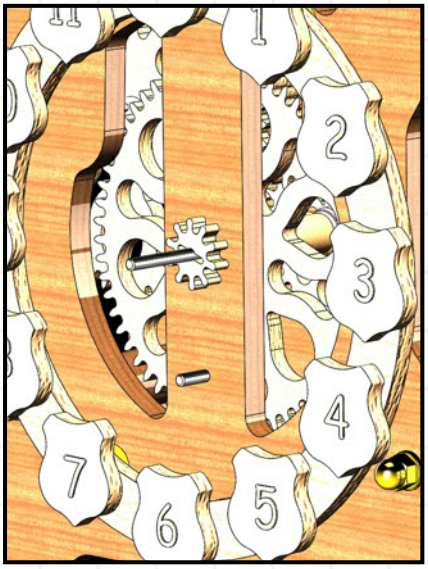

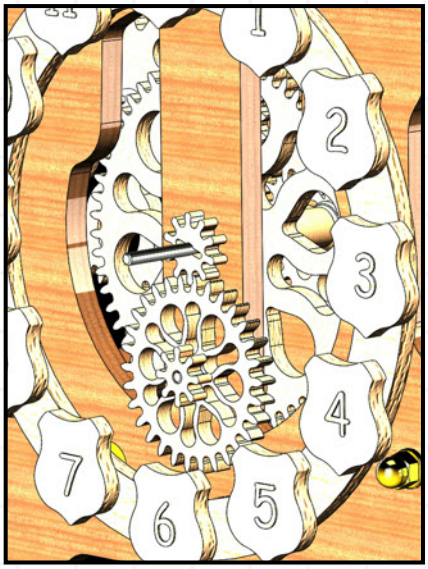

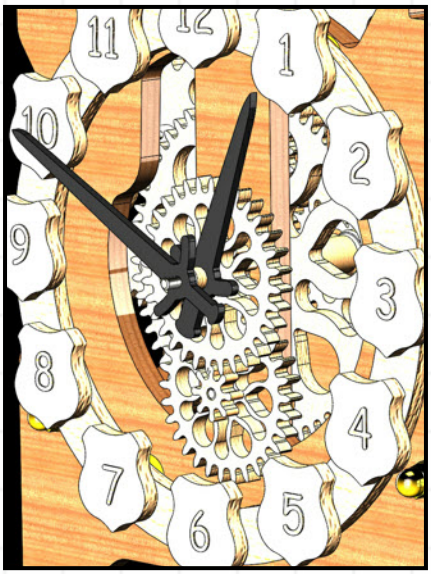

The Assembled dial can now be fitted to the Front Panel, line up the 4 pins protruding from the back of the Dial with the 4 holes in the Front panel and press home.
Fit the Ø4 mm pin into the hole just below the Minute Shaft, now fit the 10 toothed gear to the Minute shaft, this should be a tight fit on the shaft.
Glue the 30 tooth gear and the 8 toothed Gear together and then mount on the lower pin, this should be a loose fit.
Glue the Hour tube into the 32 Toothed Gear and fit to the Minute Shaft, this should be a loose fit.
Finally, fit the two hands in place, note these should be a fairly tight fit but able to turn when the time is adjusted. The hands should be slit with a sharp knife to enable the holes in them to stretch when pushed onto the shaft, this ensures the hands do not lose their grip on the shaft.

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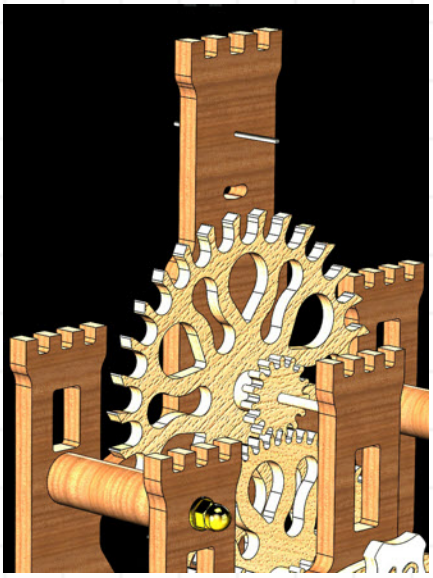
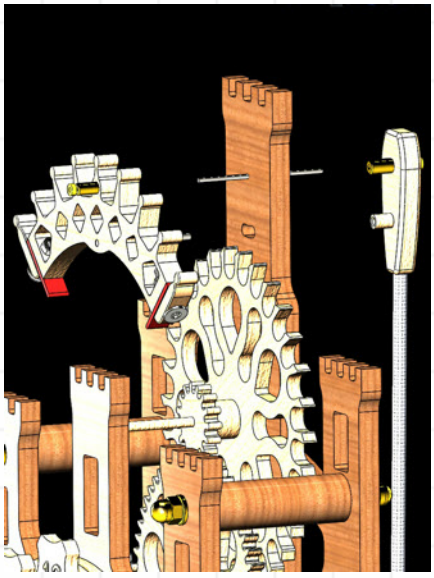
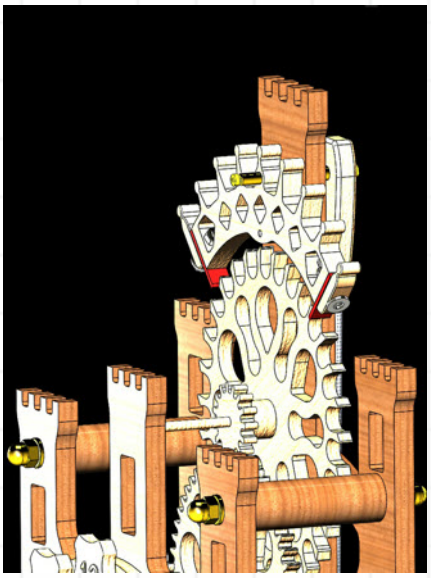
Construction instructions for Clock 35







Fit the Pendulum Pivot Pin to the Ø2 mm hole in the top of the Back Panel.
Now fit the Escapement on to the Pin at the front with the Connecting pin passing through the radial slot.
Fit the Pendulum to the Pivot Pin at the Back of the Back frame and engage the Connecting Pin into the boss protruding forward from the Pendulum head.
Finish this stage off by pressing the End stops onto each end of the shaft, this prevents them working their way off the shaft. The combined Escapement /Pendulum should run absolutely freely When this assembly is complete.

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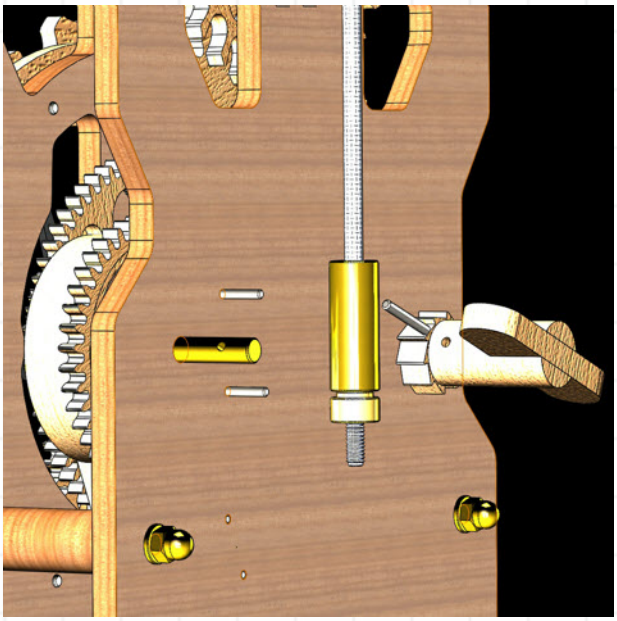
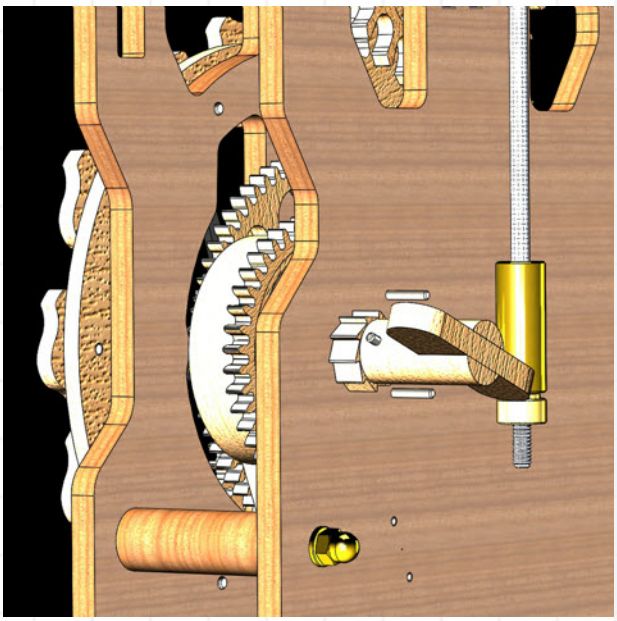
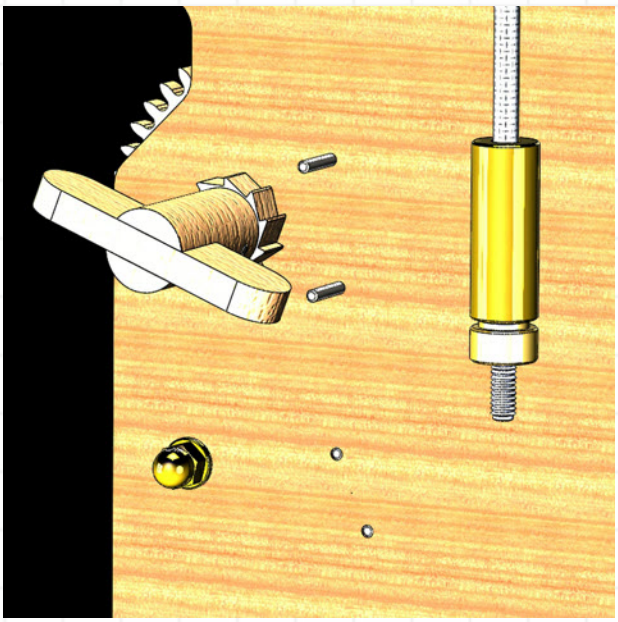
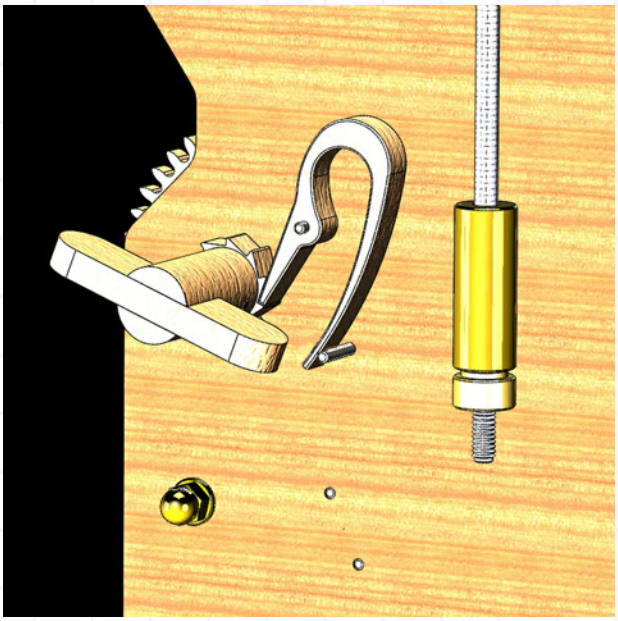




First glue and pin the 3 parts of the handle together, and when dry fit onto the Arbor shaft protruding from the Back Panel ensuring a small gap, and then drill through the Winder and Arbor and secure with a Ø3 mm pin





Fit the Pawl to its Pivot pin ensuring that the back face of the Pawl's tail is fitted inside the pin as shown.

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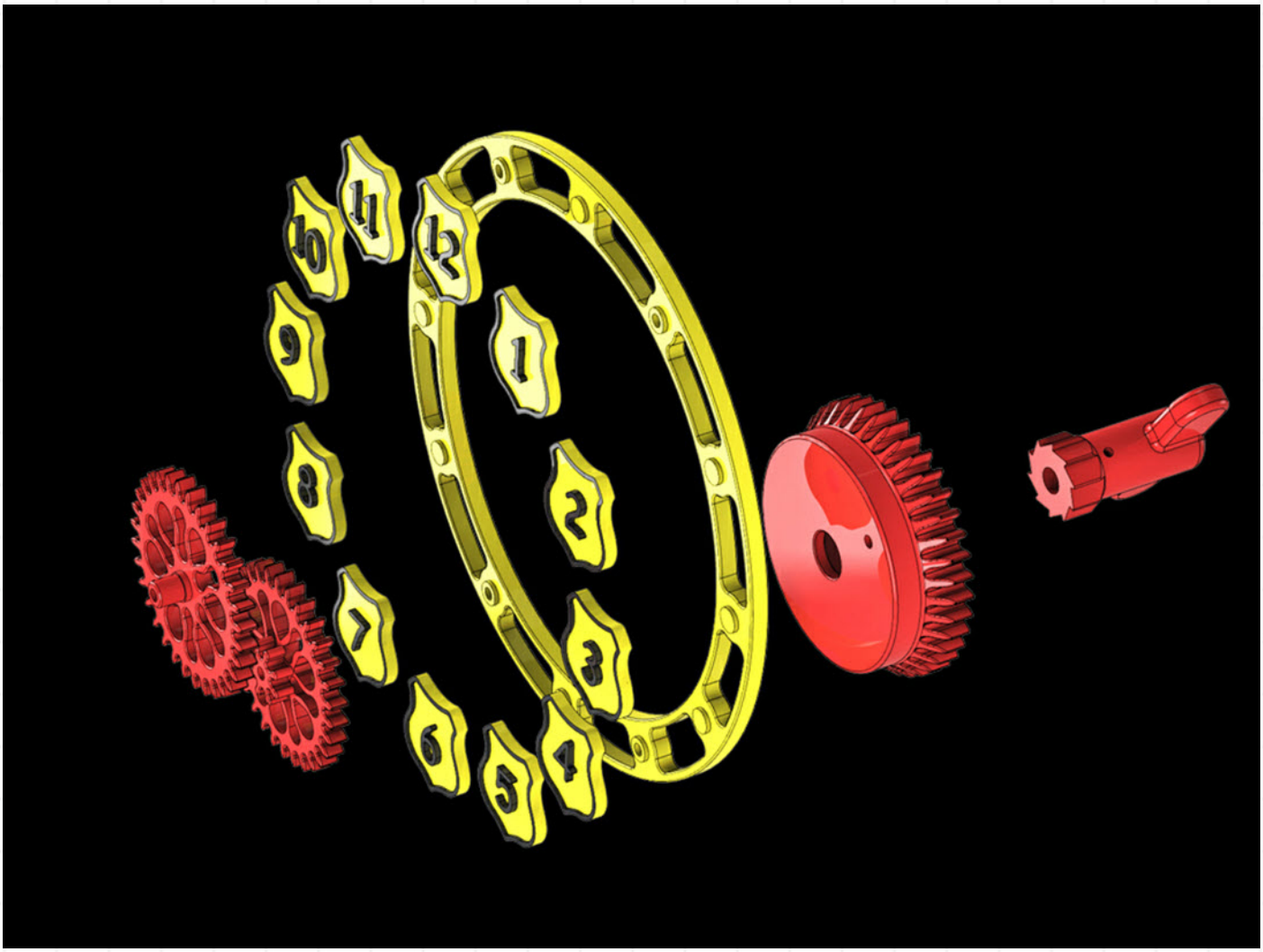

When I built the prototype I used a combination of build techniques, the Front and Pack panels were cut from 9 mm MDF and then spray painted, first with a primer and then with a Light blue finish coat. The rest of the parts were 3D printed in ABS with a mixture of colours.
The use of ABS worked well for the gears as it produced low friction running and cut down on the finishing needs to produce the working prototype.

If you want to try this approach you can use the STL files I supply for all of the flat parts in this clock.

I changed some of the parts to make them easier to print, those that you see illustrated above. The STL files for these parts are included with the files.

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Construction instructions for Clock 35

HINTS AND TIPS

- The DXF files are on a single sheet, with the inside and outside cuts set on separate layers. Pockets are also included on yet another layer so 2.5D cuts can be made.

- 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 used 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,

- 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 and Escapement may not be running freely on the Ø2 shaft they are fitted to. The parts should be a running fit in the Ø 2 mm shaft, and the connecting pin just below the pivot should be a tight fit in the Escapement and slightly loose fit 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.

- In this same area I have capped the two ends with the 2 End Stops as shown here, but it is also possible to use a couple of short Rod Magnets to serve the same purpose.