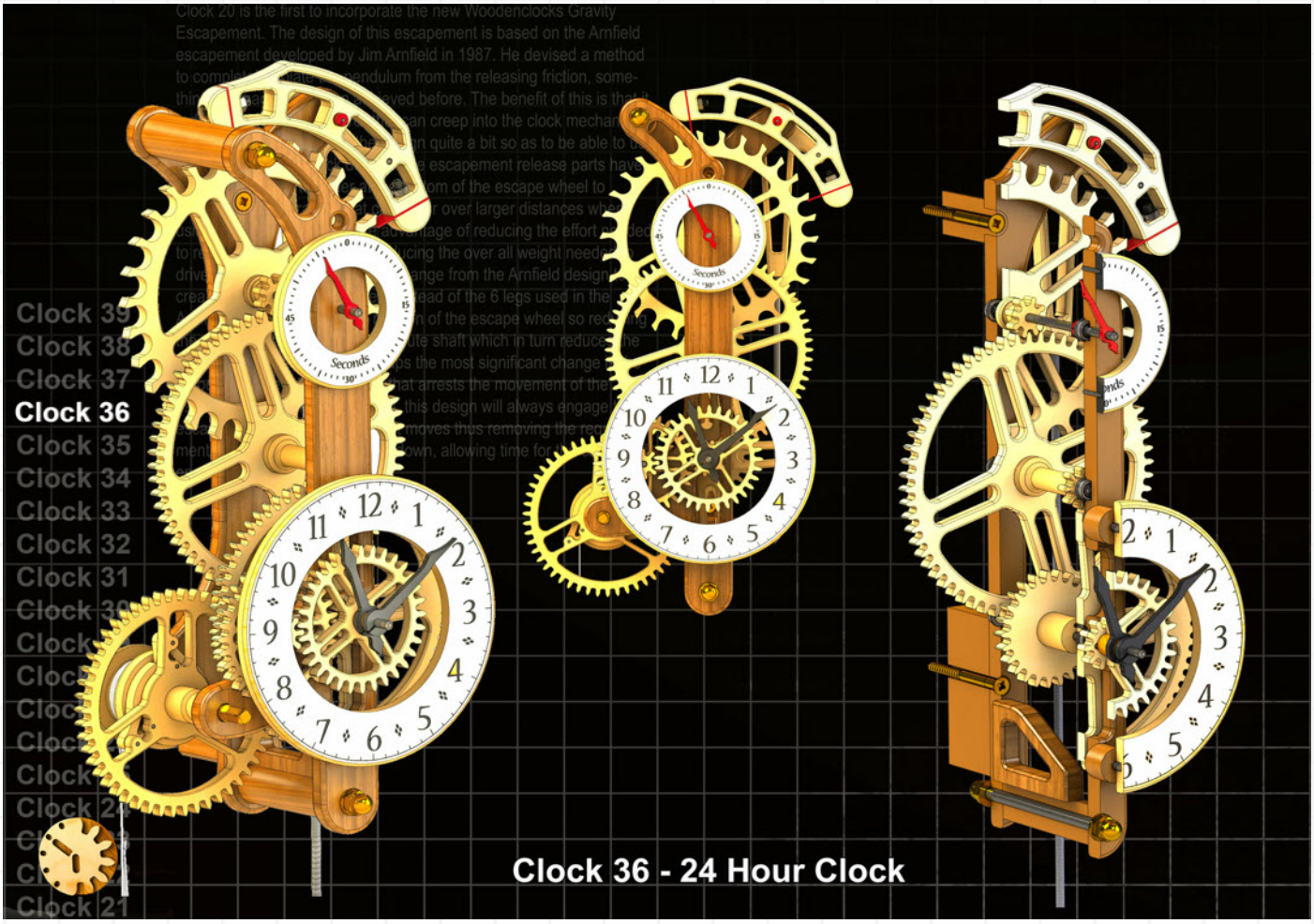
Clock 36 - 24 Hour Clock

Construction instructions for Clock 36



This clock has been designed from the outset to run for 24 hours, so a single wind is all that is needed to keep it running all day. There are other clocks in the range that will run for this time but only if incorporating a simple pulley, in this clock the gear train has been designed to achieve this with no extra complexities.
It is a relatively simple and compact clock to construct using a high ratio gear train to reduce the number of gears required, but still maintaining that typical wooden clock mechanical appearance. It is small enough to be cut on most CNC machines being 340 mm tall and 200 mm wide and can even be 3D printed if required. I know this first hand as I had to 3D print most of the prototype because my CNC machine was not available.
The appearance is slightly quirky as the top of the front frame is offset to give a better view of the Graham escapement working on the large escape wheel, and for the first time in a while I have incorporated a Seconds hand that actually turns the right way without extra gearing.

I learnt a lot from this build and found some 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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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 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 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 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 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 mm Drill Rod or Silver Steel 660 mm Long for all the shafts and numerous pins.
Ø3 mm Drill Rod or Silver Steel 100 mm Long
Ø2 mm Drill 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
Ø8 mm Brass Rod 100 mm for the Drive Shaft and Pendulum Bob Pins
Ø8 mm Acetal Rod 100 mm for the Pendulum and Escapement Bearings
1 mm, 2 mm, and 3 mm Plastic sheet for hands and pallets, ABS or HIPS
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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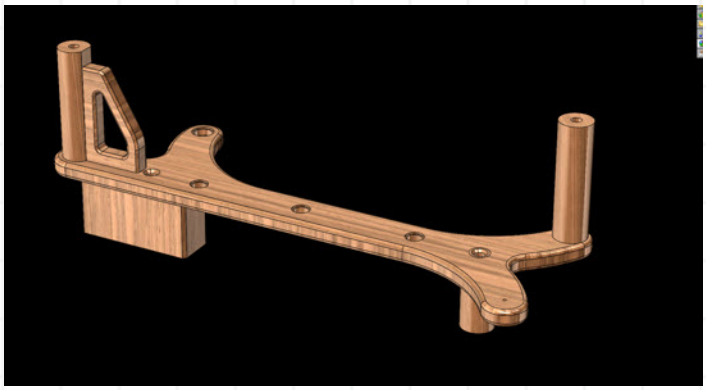
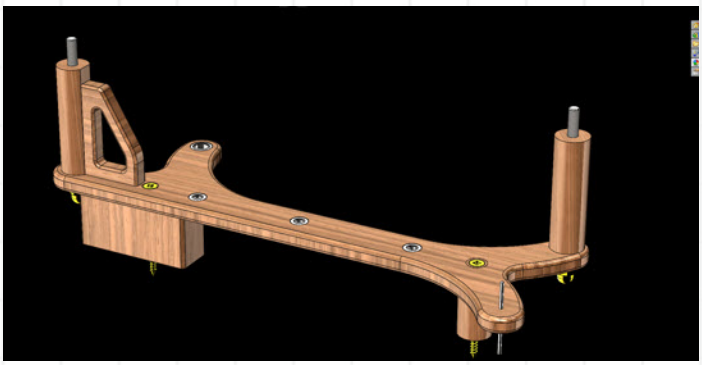
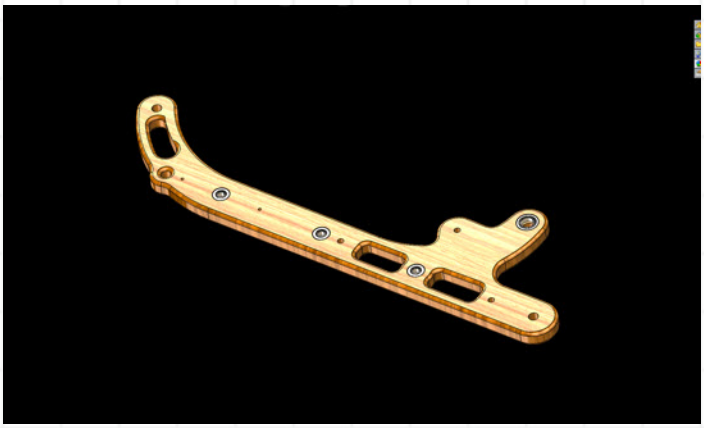
Step 1 Preparation of the sub assemblies



Back Frame
With the Back Frame laying on its back, glue all the Frame spacers in position.



Insert the Threaded Rod and Dome nuts and washers.
Now insert the three Ø10 diameter bearings and the one Ø12 diameter into their pockets as shown.



Front Frame

Now insert the three Ø10 diameter bearings and the one Ø12 diameter into their pockets as shown.

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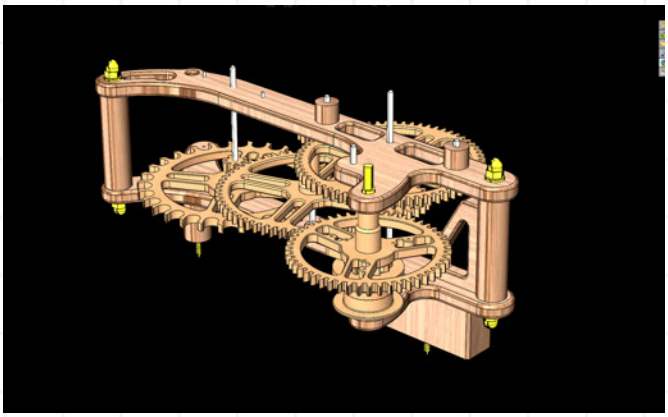

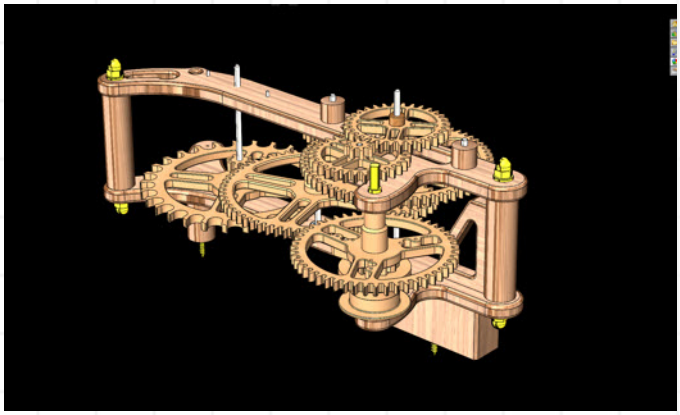

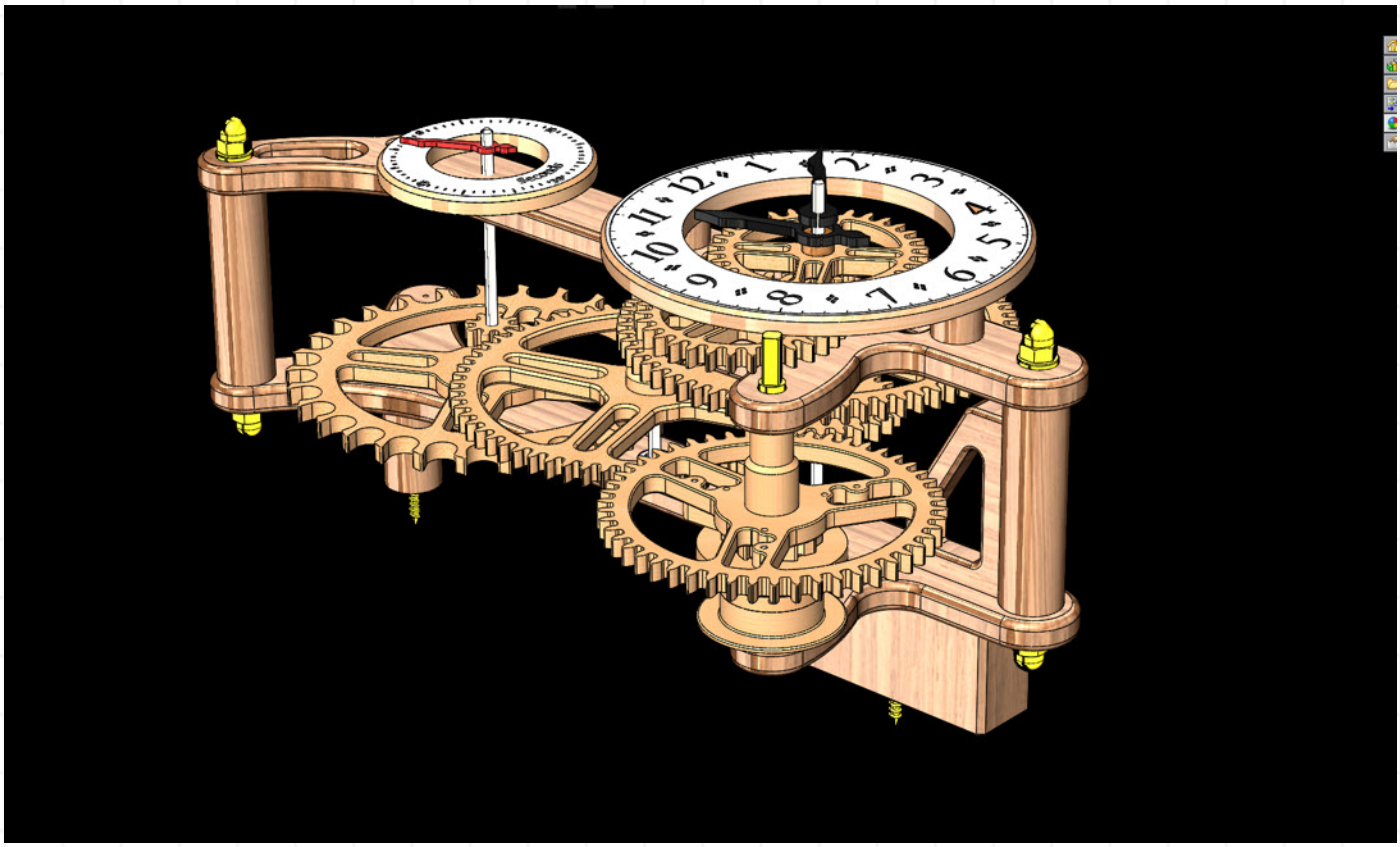

Now fit the Front frame over the Gear shafts and onto the top and bottom spacer pillars and secure with Domed nuts and washers. Fit the pins and spacers used to locate the two dials and the pivot pin used by the pair of Hour gears.
Fit the Hour bush into the 32 toothed gear and glue together the 30 toothed gear to the 8 toothed gear.
Now fit the 10 toothed gear onto the Minute Shaft, it should be a fairly tight fit and fit the 30t-8t pair to its adjacent shaft and finally the locate the 32 toothed gear onto the minute shaft.
Fit the dials onto their location pins and fit the hands onto their respective shafts.

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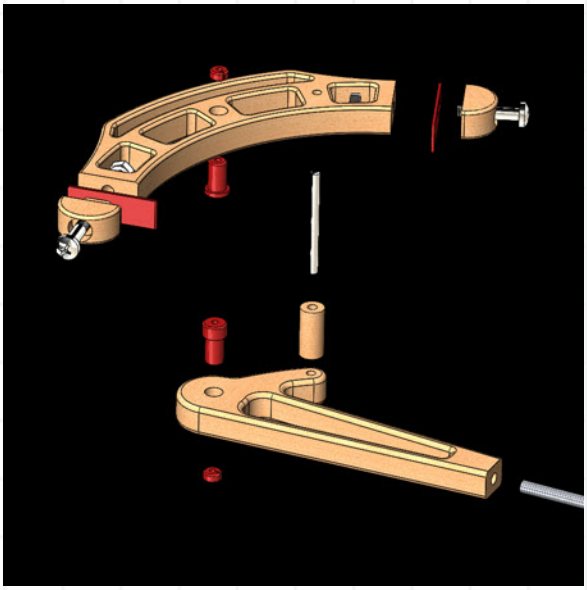

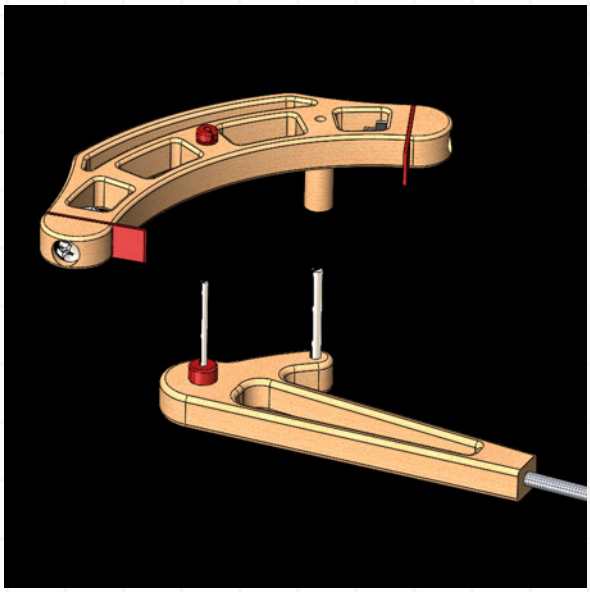

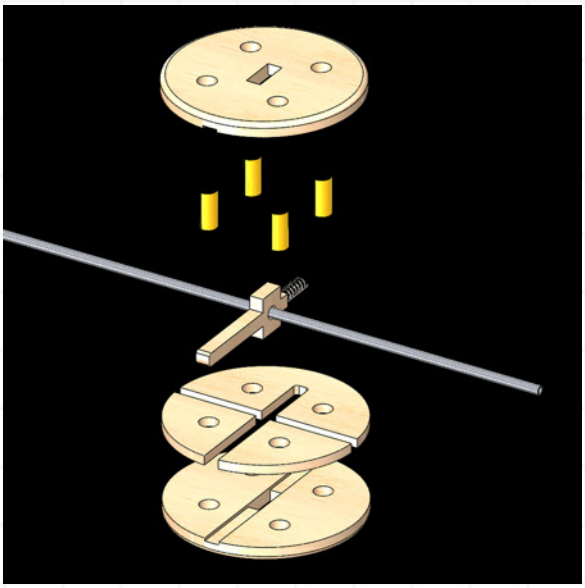

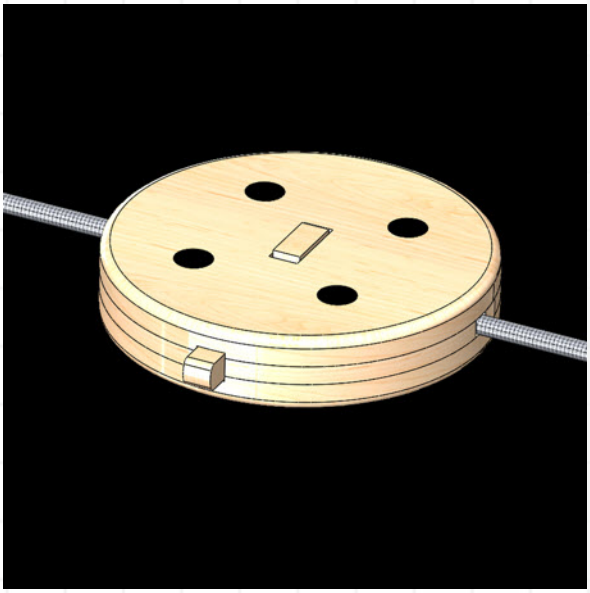

First, assemble the Pallets and their clamps to the ends of the Arm using the Ø4 mm nuts and Bolts, ensure that the top of the pallet is fitted level with the top of the Escapement Arm . This is the starting position and you may need to adjust one or both the pallets to get the clock to tick evenly. Now fit the Acetal Escapement Sleeve to the hole in the centre,
Fit the two pins, the Pendulum Bush and the Sleeve to the Pendulum head. The Carbon fibre Pendulum Rod should now be glued into the hole in the bottom of the Pendulum head.

Next assemble the parts for the pendulum Bob, the four Brass pins fitted to one of the outer plates then insert the Lock and the small spring that loads the lock against the Pendulum Rod. Now fit the other outer plate. These may be glued together, but make sure first that the lock is working when the assembly is fitted to the Pendulum Rod.
The assembled Pendulum bob should weigh around 65 grams.

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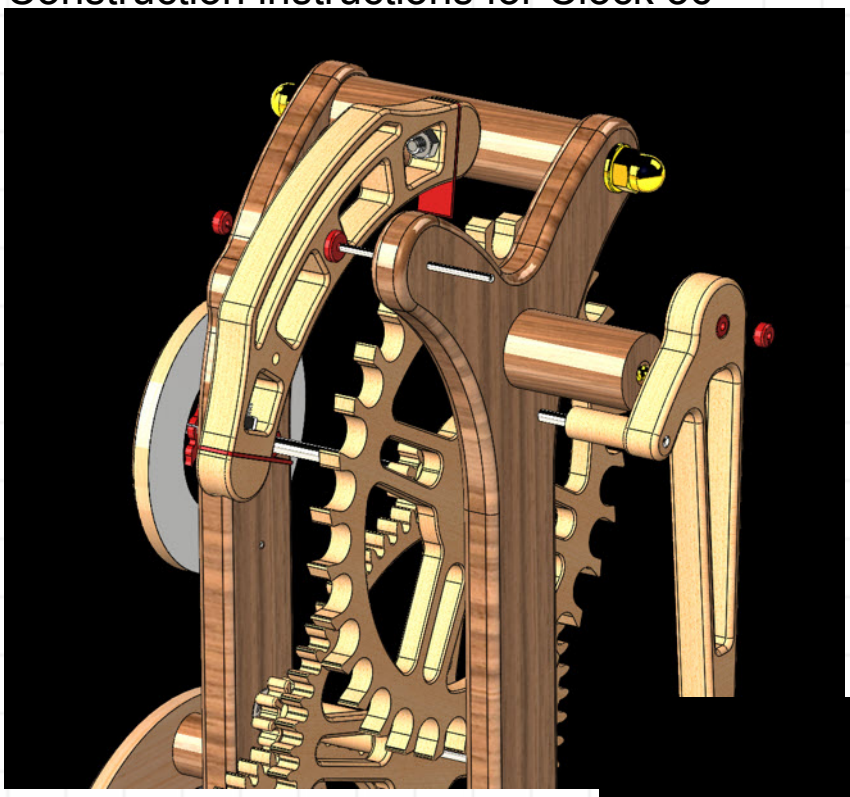

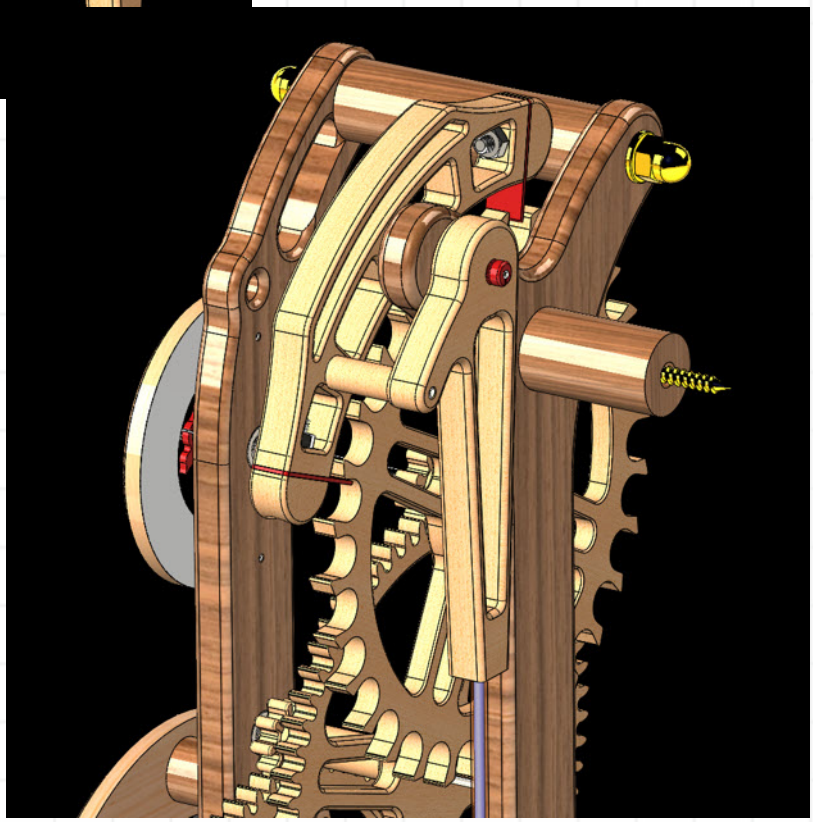

Fit the Escapement assembly and the Pendulum assembly onto the Pivot pin mounted at the top of the back frame , slide them together either side of the Back Frame until the spacer touches then attach the two end stops so at to prevent them moving off the pivot pin, but do not fit too tightly they must be free to swing freely.

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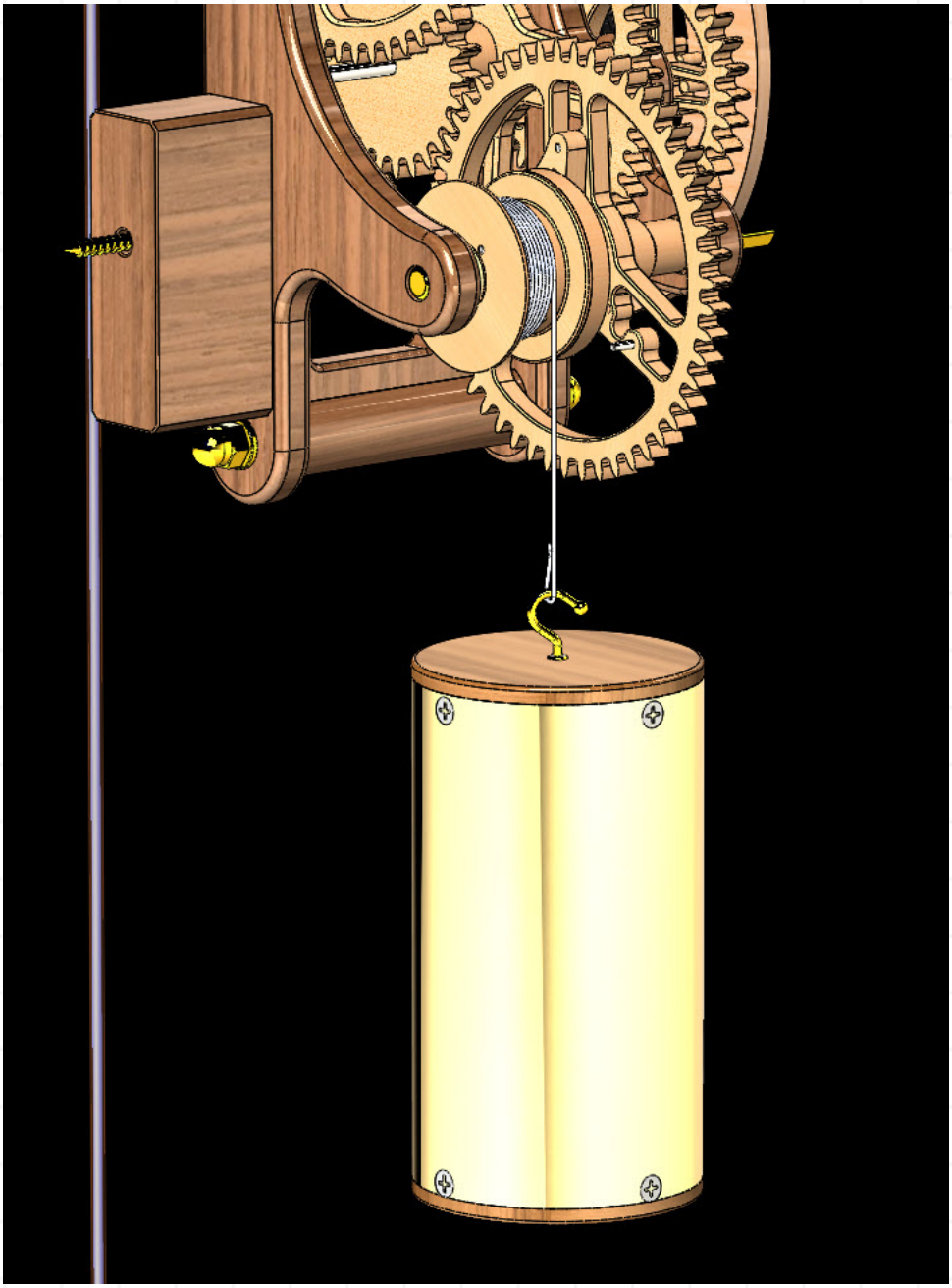

Wrap the cord around the Drum making sure the end is secured to the drum with tape, and then form a loop in the end using a Bow Line knot. Hang the weight using the hook to fit into the loop. The clock should now be able to run.

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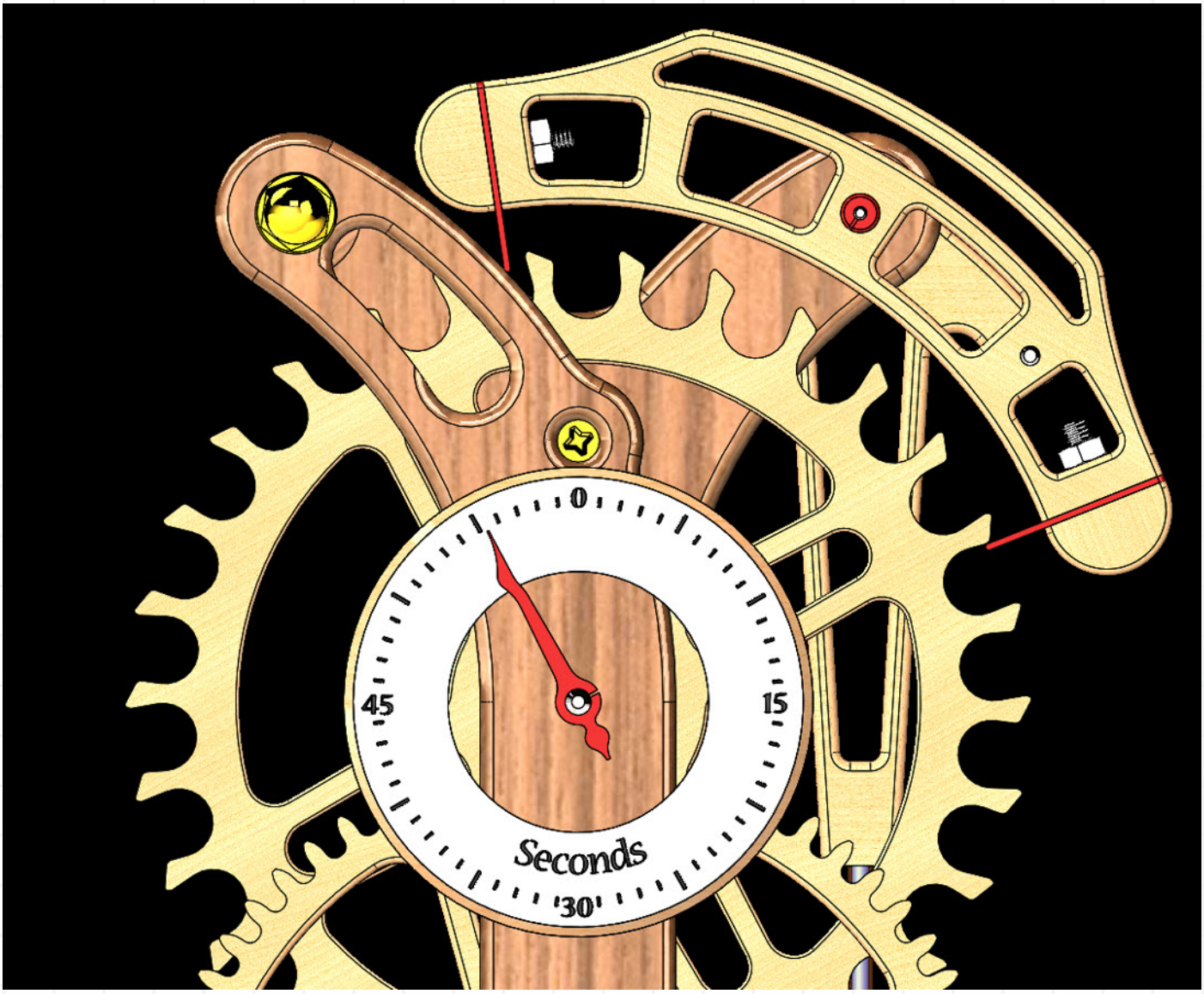

To adjust the clock to an initial starting position Set the pallets so that when the pendulum swings you get an even penetration of the pallets into the teeth on the escape wheel. If everything is OK that should be when the Back end of the Pallets are level with the top edge of the Escapement , but that may not be the case so if there is an uneven ticking or if the clock refuses to keep running after you give the initial swing you may have to adjust one or other of the Pallets.
When the clock is running you will need to adjust the rate at which it runs to do this move the Pendulum Bob UP if it is running too slow and push it down if it is moving too fast.

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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 2.5 D 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 to the right of 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.