COUP PERDU CLOCK

SP8 Assembly Notes

Instructions for building a 3D printed clock with
a Coup Perdu escapement and electric rewind

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Revision History

30-Oct-22 Initial Release

Description

This is the assembly guide for a 3D printed clock with a Coup Perdu escapement and electric rewind mechanism. Coup Perdu is French for “lost beat” allowing a half second pendulum to advance the second hand once per second. This gives the second hand a natural look with 60 ticks per minute. A remontoire mechanism uses a small electric motor to rewind the clock every few minutes.

An optional deadbeat escapement is included that beats 120 times per minute. This escapement is more efficient requiring less drive weight in the rewind mechanism. 120 small ticks per minute using less drive weight is quieter than 60 large ticks per minute with the Coup Perdu.

Two AA batteries should provide power for around 6 months. The frame is designed for either a desktop or wall hanging clock.

The overall size is around 10.5” (265mm) wide by 13.4” (340mm) tall and 6.1” (155mm) deep. Large components are segmented allow printing on any machine with a 175x175mm print area.

Components

The number of non-printed parts in this clock has been minimized as much as possible. The critical components are the N20 motor used to rewind the clock and a magnetic reed switch to trigger the rewind mechanism. The N20 bearing is readily available on Amazon or eBay. The magnetic reed switch is also relatively common.

If you have built any of my other clocks, then you likely already have most of the other components used in this clock. The pendulum support bearings are the same 623RS bearings used many of my other clocks. Many other components can be picked up at a local hardware store. The entire frame is assembled using a single size screw to minimize the number of items in the component list.

Motor

I tested many different motors to find one that was suitable for rewinding this clock. It needed to be relatively quiet and low power. The best option I have found is a very tiny N20 motor with metal gears. All other motors tested were larger, noisier, and required significantly more power. This clock uses a very small drive weight so a small motor is ideal.

The N20 motor is available from many places with eBay being the cheapest source at the moment. I used a motor with a high gear ratio of 1000:1 giving it around 20RPM at 5V. It is often listed as a 3-6V motor and continues to operate down to 1.5V. The tiny motor only consumes around 30mA when rewinding the clock. It is available with a huge range of gear reductions. I only tested the 1000:1 ratio, although the clock might still work with somewhere around a 300:1 to 500:1 reduction.

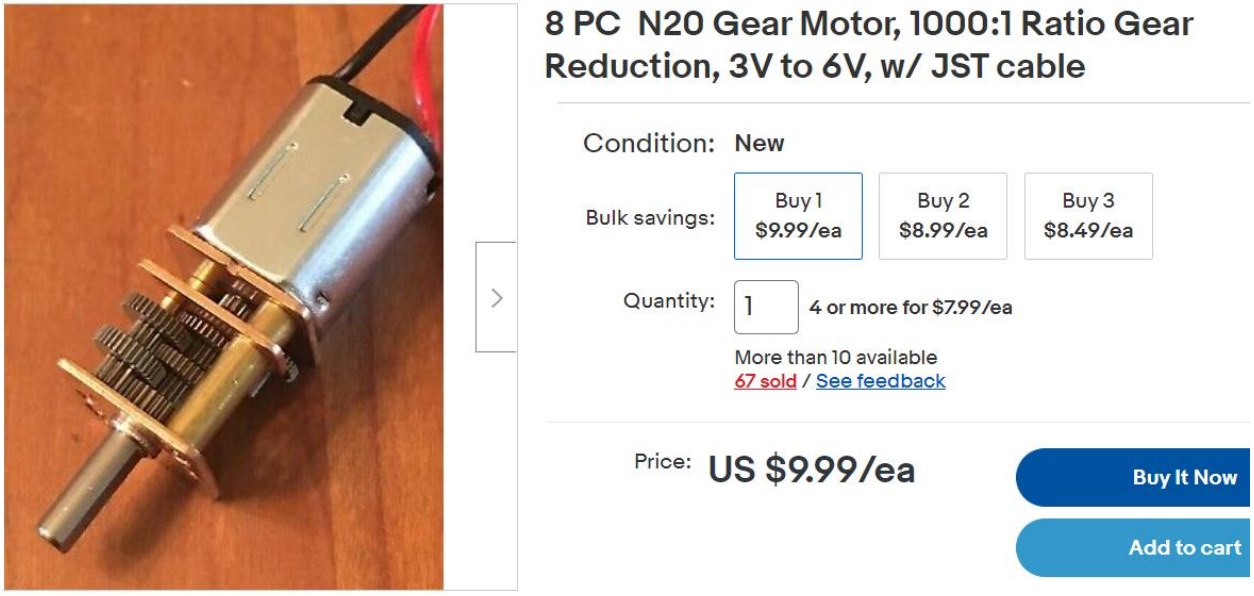

Figure 1: N20 Motor

Reed Switch

The rewind trigger is an important feature in this clock. It needs to be reliable and ideally only trigger occasionally. Some designs I tested engaged the motor every few seconds. This clock needed something that would trigger less often and lift the drive weight a few inches.

The solution evolved into a lever arm that flips when the clock needs to be rewound and flips back when the rewinding is completed. A magnet in the lever arm closes the reed switch contacts to turn on the motor. The motor module includes some additional weights that are lifted during each rewind cycle.

Below are the reed switches used in the clock. It is best to find switches that already come with magnets. Otherwise, you will need to find some 5mm diameter by 1mm thick magnets.

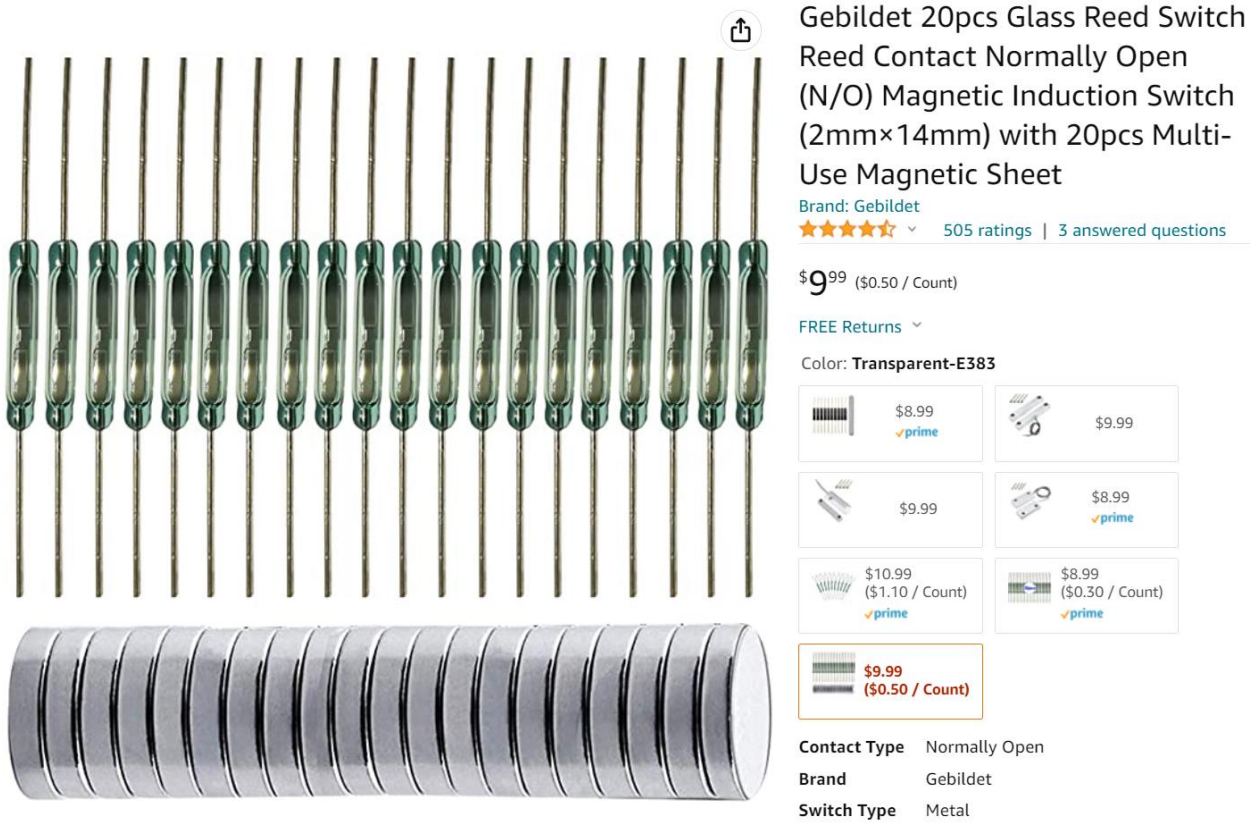

Figure 2: Reed Switches

There are also small plastic reed switches that appear to be around the same size as the glass ones. They are a few pennies cheaper and may be less fragile. I will test then to see if they are an acceptable alternative.

Battery Holder

The motor module includes an integrated battery holder for two AA batteries. The battery compartment was built around the following battery holder, although there is some wiggle room for many other styles. Integrated wires are nice to avoid having to solder next to the soft plastic case.

WAYLLSHINE? 12 Pcs/1 Dozen 2 x 1.5V AA Battery Holder Case Box Black Wire Leads

Brand: WAYLLSHINE

4.5 ratings | 962 ratings | 23 answered questions

Amazon's Choice in Battery Holders by WAYLLSHINE

$8.99

prime One-Day

FREE Returns

Earn 5% back on this purchase (worth $0.45 when redeemed) with your Prime Store Card.

Pattern Name: **12 PCS 2AA**

12 PCS 1AA | 12 PCS 23A | **12 PCS 2AA** | 6 PCS 1AAA | 6 PCS 2AAA | 6 PCS 3AA | 6 PCS 3AAA | 6 PCS 4AA | 6PCS 4AAA

- Body Size :2.303in x 1.276in x 0.575in /58.5mm x 32.4mm x 14.6mm (L*W*H)
- Cable Length(Each) : 14.5cm/5.7"
- Material:plastic ABS, Color : Black, Weight: 7g/0.247oz
- Package Content : 12PCS 2 x 1.5V AAA Battery Case Holder

Figure 3: Battery Holders

Did you notice that all of these main components often come in multiples of 8 or more? The prices are reasonable as well. You will have enough parts to make several clocks.

Complete Part List

This is a complete list of non-printed parts used in this clock. If you have built some of my other clocks, then you may already have many of the parts. The first three items are unique to this clock.

McMasterCarr parts numbers are included for some of the parts if you are in the US, but they are not always the cheapest source. Amazon or eBay usually have better prices. AliExpress is an option if you are willing to wait a few weeks. Most screws and the music wire can often be found locally.

Qty	Component sizes (alternate sizes in parenthesis)	McMC Part No.	Notes
1	N20 motor with 1000:1 gear ratio		see notes above
1	Glass reed switch with 5mm x 1mm magnet		see notes above
1	2AA battery holder		see notes above
5" (125mm)	Small gauge wire		Used for connecting reed switch to motor
2	623 bearing (3x10x4mm)	4668K103	Any quality of bearings will work, no seals are best, removable rubber seals are also good (McMC bearings are very expensive, try to find elsewhere)
4" (100mm)	3mm stainless or brass rod	1274T42	See cut metal parts list
30" (0.75m)	1.5mm (or 1/16") music wire	8908K62	See cut metal parts list
18 to 22	#6x3/4” flat head wood screws	90048A151	Metric equivalent is M3*20mm or M3.5*20mm wood screws
5	M3*10mm (#4-40*3/8") cap head screws	91292A113	Need one screw for time adjust knob, the rest are optional if printing parts that fit tight to the shafts, Phillips head is OK
2	M3*5mm (#4-40*1/4") flat head screw	92125A125	Optional screws for holding battery case in position
2 (3 for Coup Perdu)	1.5mm (or 1/16") shaft collars	6432K71	Optional parts to hold onto 1.5mm arbors. A printed substitute (shaft_collar.stl) can be used if desired. Can also be found in bulk as 6mm x 5mm pin keepers with a set screw
1	click pen springs		Remove from a common ball point pen
4	3/8" to 1/2"(or 10mm) adhesive felt pads		For dampening motor switch and Coup Perdu pallet noise. 1/32" (0.8mm) thickness or anything close should work fine
~100	pennies or small washers		For weights in pendulum bob and motor module

Table 1: Parts List

Cut Metal Parts

Cut the metal rod and music wire according to the lengths shown in the following diagram. The lengths are approximately to scale. The 3mm rod can be any material, brass, stainless steel, aluminum, or maybe even wood. It just needs to fit into the 623 bearings.

The music wire should be cut to the following lengths and burrs removed from the ends. The design works equally well with 1/16” or 1.5mm music wire since they are very close to the same size. Music wire comes in a hardened state which is great for the clock, but difficult to cut. A Dremel cut-off disk or cutters with hardened jaws will work well. Cheap wire cutters might not be tough enough.

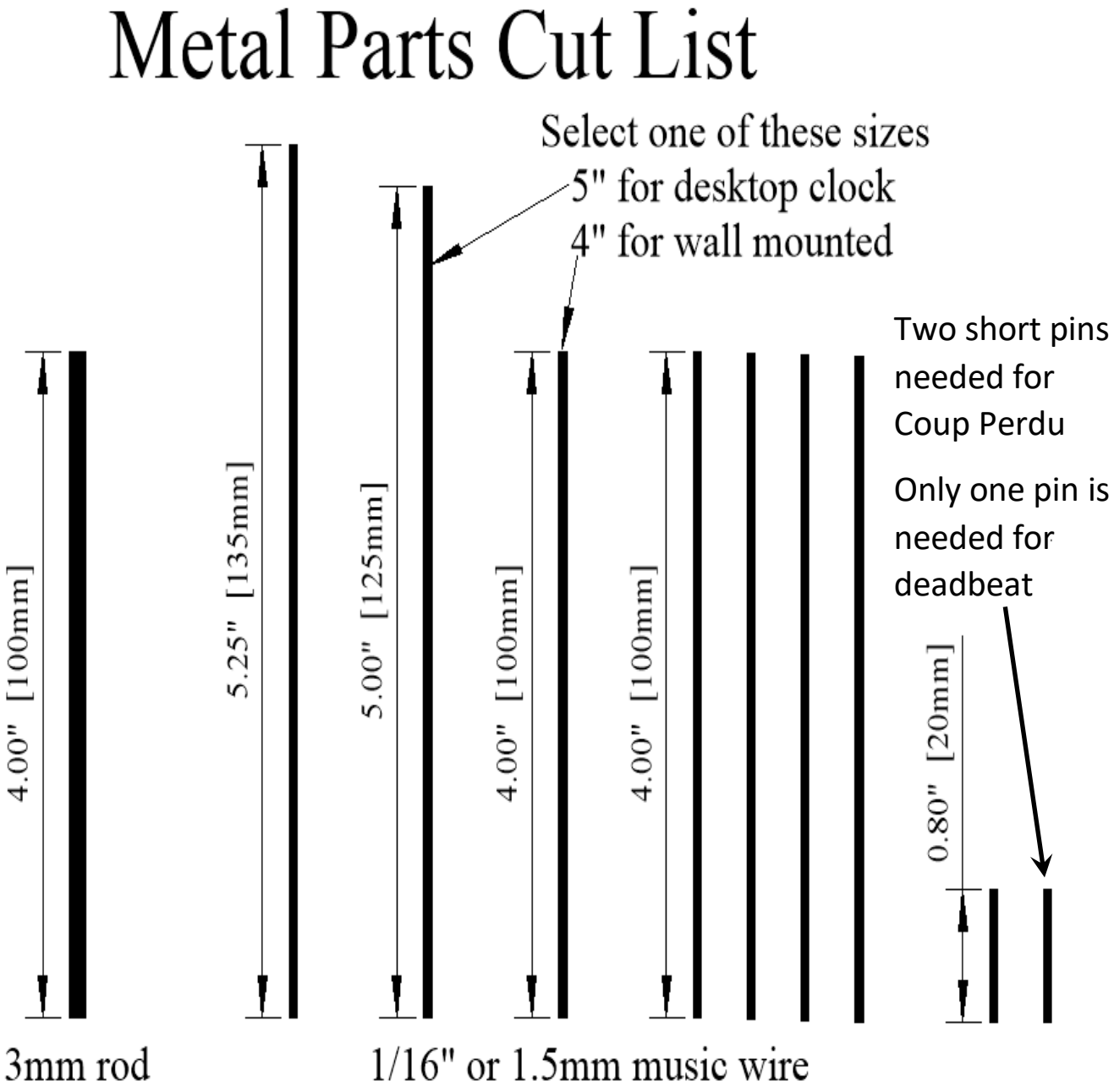

Figure 4: Cut metal parts

Design Options

There are a few design options to be made when printing this clock. A few printed parts are slightly different depending on which options are selected.

Here are the choices to make:

1) **Coup Perdu or deadbeat escapement:** The Coup Perdu escapement looks natural with 60 ticks per minute on the second hand. The downside is that the pendulum needs a larger amplitude and the escapement makes 60 large ticks per minute. This requires more drive weight and produces more noise than a deadbeat escapement. If you want a quieter clock, then print the deadbeat escapement option and don't use as much weight in the motor module. The escapement will make 120 small quiet ticks per minute. The downside is a second hand with 120 ticks per minute. The deadbeat escapement should be slightly more reliable. Both escapement options are included in the release.
2) **Desktop or wall mounted:** The clock is designed to work equally well sitting on a desk or hanging on the wall. A desktop clock can have a time adjustment knob in the back if desired. This requires a slightly longer arbor to stick out the back. An adjustment knob in the back will not work on a wall hanging clock, so you would simply not print the knob and use the shorter arbor.
3) **Roman numeral or simple number dial:** Two dial faces are available, a traditional Roman numeral dial and a simple number dial. Use either one. The Roman numeral dial has second markers that would work great when using the Coup Perdu escapement option.
4) **Gothic or spade hands:** Two hand styles are provided, fancy Gothic hands or simple spade style pointers. The Gothic hands look good with the Roman numeral dial and the spade pointers look good with the simple number dial. You can mix and match them any way you wish.
5) **Motor flipper options:** The rewind motor module has a limited range of motion before it starts running into other gears. There are a few different style motor flippers with different trip points to use if needed. Start with the default or try others to adjust the trip locations if needed.

Printing the Parts

Print one of each clock part from the following table.

I print most parts in PLA with a 0.4mm nozzle, 0.2mm layer heights, 4 perimeters, 6 bottom layers, 7 top layers, 30% cubic infill, random seams, and 0.12mm elephants foot compensation. A few parts listed in the table will print better with 5 perimeters. The default orientation is usually optimal with the largest surface already facing down. Supports are never needed.

The dial is the largest component with a 173mm diameter. It can be printed on a Prusa Mini or any machine with at least a 175mm by 175mm print area.

The colors listed will match the clock on the front cover. You are free to use any colors you like and please post pictures of your clock.

Printed Parts List

File Name	Color	Print	Time	Filament	Notes
frame_back_center	tan, purple	1	10h 50m	44.98m	Add a color change at 12.80mm
frame_back_lower	tan	1	8h 4m	35.21m	
frame_back_spacer	tan	0	0h 32m	1.84m	Optional part for desktop clock to add a time adjust knob at the back
frame_back_upper	tan	1	4h 50m	18.57m	
frame_back_weight	tan	0	2h 30m	8.13m	Optional part to help balance weight in a wall hanging clock
frame_dial_numbers	tan, ivory, purple	1	7h 42m	36.94m	Print one of either style, add color changes at 10.40mm and 12.20mm
frame_dial_roman	tan, ivory, black		7h 48m	37.17m	
frame_front_lower	tan	1	3h 49m	18.73m	
frame_front_upper	tan	1	2h 22m	10.22m	
gear1_esc_coup_perdu	purple	1	2h 31m	5.20m	Classic slicer, 5 perimeters, select either Coup Perdu or deadbeat
gear1_esc_deadbeat	purple		2h 5m	4.22m	Classic slicer, 5 perimeters, select either Coup Perdu or deadbeat
gear2_60_16	purple	1	2h 39m	6.83m	Classic slicer, 5 perimeters
gear3_64_24	purple	1	3h 17m	8.83m	Classic slicer, 5 perimeters
gear4_72_36	purple	1	5h 20m	16.74m	Classic slicer, 5 perimeters
gear5a_72	purple	1	3h 8m	10.42m	Classic slicer, 5 perimeters
gear5b_24	purple	1	1h 28m	3.77m	Classic slicer, 5 perimeters
gear5c_knob	purple	0	0h 24m	1.64m	Optional part for desktop clock to add a time adjust knob at the back
gear6_60_16	purple	1	2h 45m	7.00m	Classic slicer, 5 perimeters
gear7_64_20	purple	1	2h 18m	6.94m	Classic slicer, 5 perimeters
gear8_60	purple	1	1h 43m	5.14m	Classic slicer, 5 perimeters
hand_hour_gothic	copper	1	0h 24m	0.91m	Select one hand style
hand_hour_spade	ivory, copper		0h 15m	0.78m	Select one hand style, add a color change at 2.20mm
hand_minute_gothic	copper	1	0h 22m	0.77m	Select one hand style
hand_minute_spade	ivory, copper		0h 17m	0.87m	Select one hand style, add a color change at 2.20mm
hand_second	copper	1	0h 14m	0.64m	
motor_battery_cover	purple	1	0h 25m	0.11m	
motor_flipper	purple	1	0h 22m	1.13m	5 perimeters, default motor flipper
motor_flipper_optionX	Purple	0	various	various	Optional motor flippers with various trigger positions to use if needed
motor_holder	purple	1	5h 40m	18.27m	
motor_idle_wheel	purple	1	0h 8m	0.22m	
motor_pinion_20	purple	1	0h 49m	3.17m	
motor_switch_cover	purple	1	0h 51m	3.25m	
motor_washer	purple	1	0h 3m	0.14m	
pallet_arm_coup_perdu	tan	1	0h 17m	0.50m	Select either Coup Perdu or deadbeat. Print with 5 perimeters
pallet_coup_perdu	tan		3h 54m	10.72m	
pallet_deadbeat	tan		3h 34m	9.95m	
pallet_spacer	tan	1	0h 21m	0.55m	
pendulum_arm	tan	1	1h 1m	3.90m	
pendulum_bob_back	copper	1	0h 33m	2.33m	
pendulum_bob_front	copper	1	2h 27m	7.58m	
pendulum_nut	tan	2	0h 12m	0.60m	
shaft_collar	purple	0	0h 5m	0.14m	Optional part to use in place of metal shaft collars
	Total	**32**	**88h 53m**	**355.09m**	

Table 2: Printed Parts List

Notes on Arachne Slicer

Recently Cura and PrusaSlicer have received upgrades with a new Arachne slicer engine. It is a huge improvement for making variable width inner walls and eliminating gap fills in many parts. Most parts in this clock see improvements when printed using Arachne.

However, there is one very limited use case where I believe printing works better **without** Arachne. The gear tooth profiles have a modified cycloidal tooth profile that has been heavily optimized to print using continuous filament flows. This requires very few retractions and produces very smooth running gears. I developed these tooth profiles specifically for clean printing using slicing software that was available several years ago. Below is a picture showing the smooth lines generated with the classic slicing software.

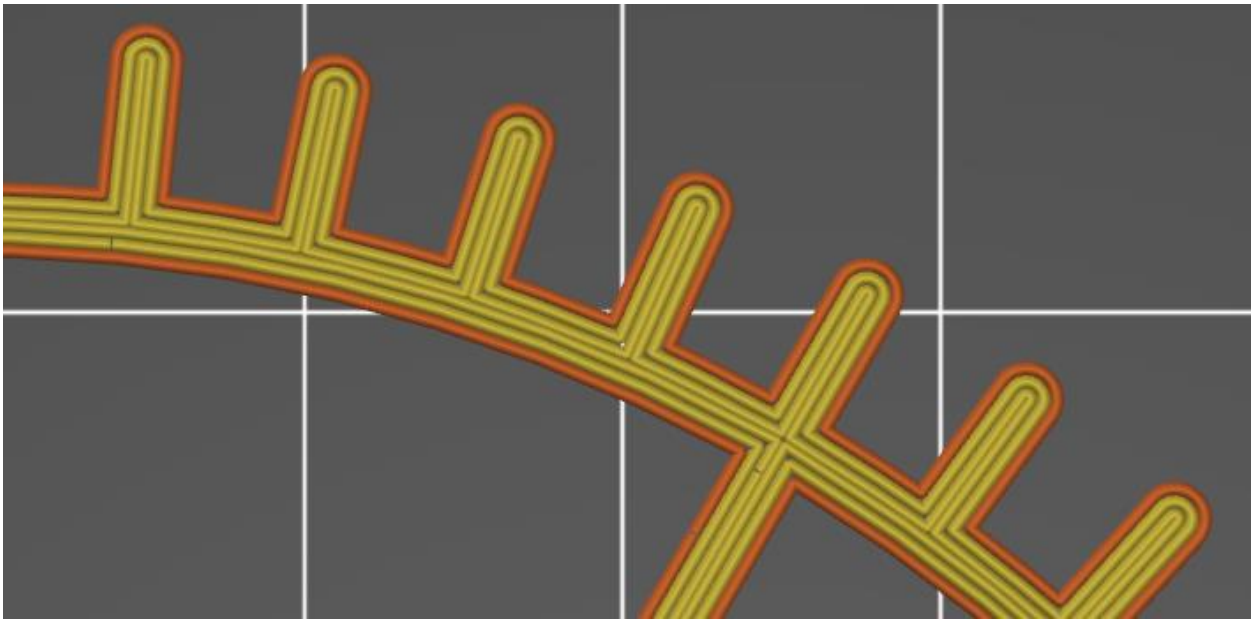

Figure 5: Gear tooth profiles using "classic" slicing mode

The Arachne slicing algorithm is designed to improve print quality of most objects. It changes extrusion widths as needed to help fill narrow gaps fully. It also generates rounded corners along the inner perimeter layers. A side effect is that the rounded corners leave a small gap at the root of each gear tooth that must be filled in. This adds back all the additional retractions that the optimized gear tooth profiles are attempting to avoid. These retractions take extra time and produce a lot of stringing resulting in rougher gear teeth.

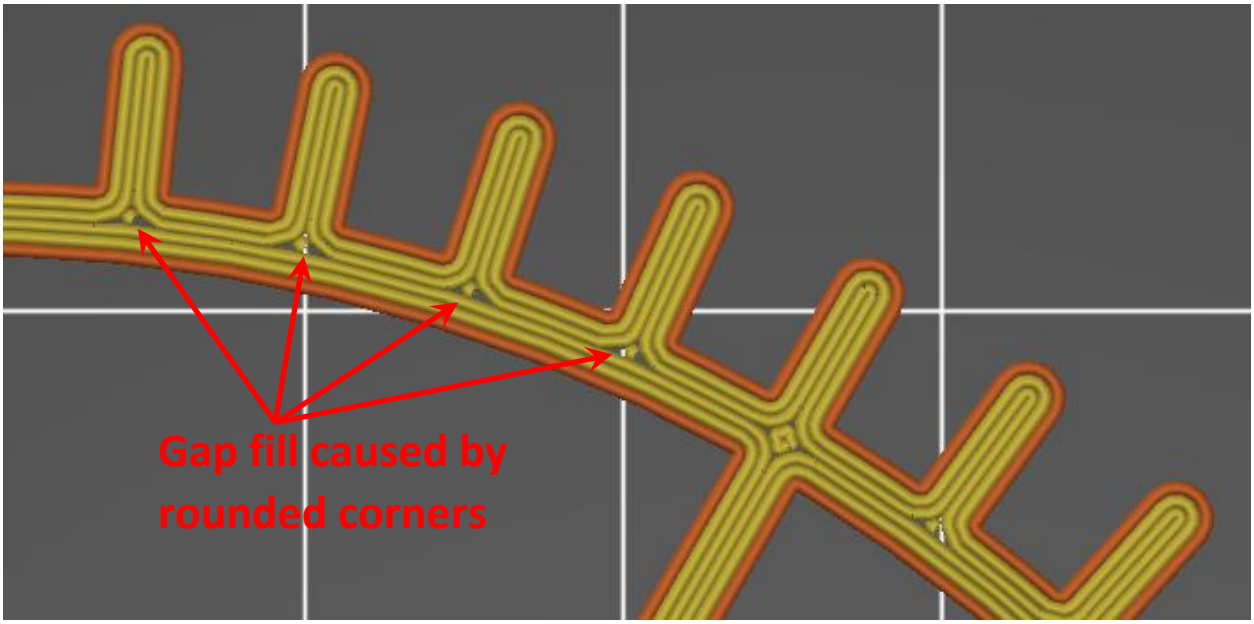

Figure 6: Gear tooth profiles using Arachne slicing

The latest version of Cura (5.x.x) enables the Arachne slicing engine by default. As far as I can tell, Arachne mode cannot be disabled in the newer versions of Cura. The best way to slice the gears with Cura would be to use an older version (4.x.x or older) that does not have Arachne. PrusaSlicer added the same Arachne slicing engine into version 2.5.0, but they also have a print setting to use “classic” mode to generate perimeters. I recommend PrusaSlicer and slice the gears in classic mode. All other parts are optimized better with Arachne.

Color Changes

A few parts are designed to look better with layer based color changes. Specifically, the dial needs some color changes to add some contrast. Both the Roman numeral dial and the simple numbered dial have layer changes at the same heights. The layers below 10.40mm can be the same color as the rest of the frame. I like to add a lighter color between 10.40mm and 12.20mm and then a dark contrasting color above 12.20mm.

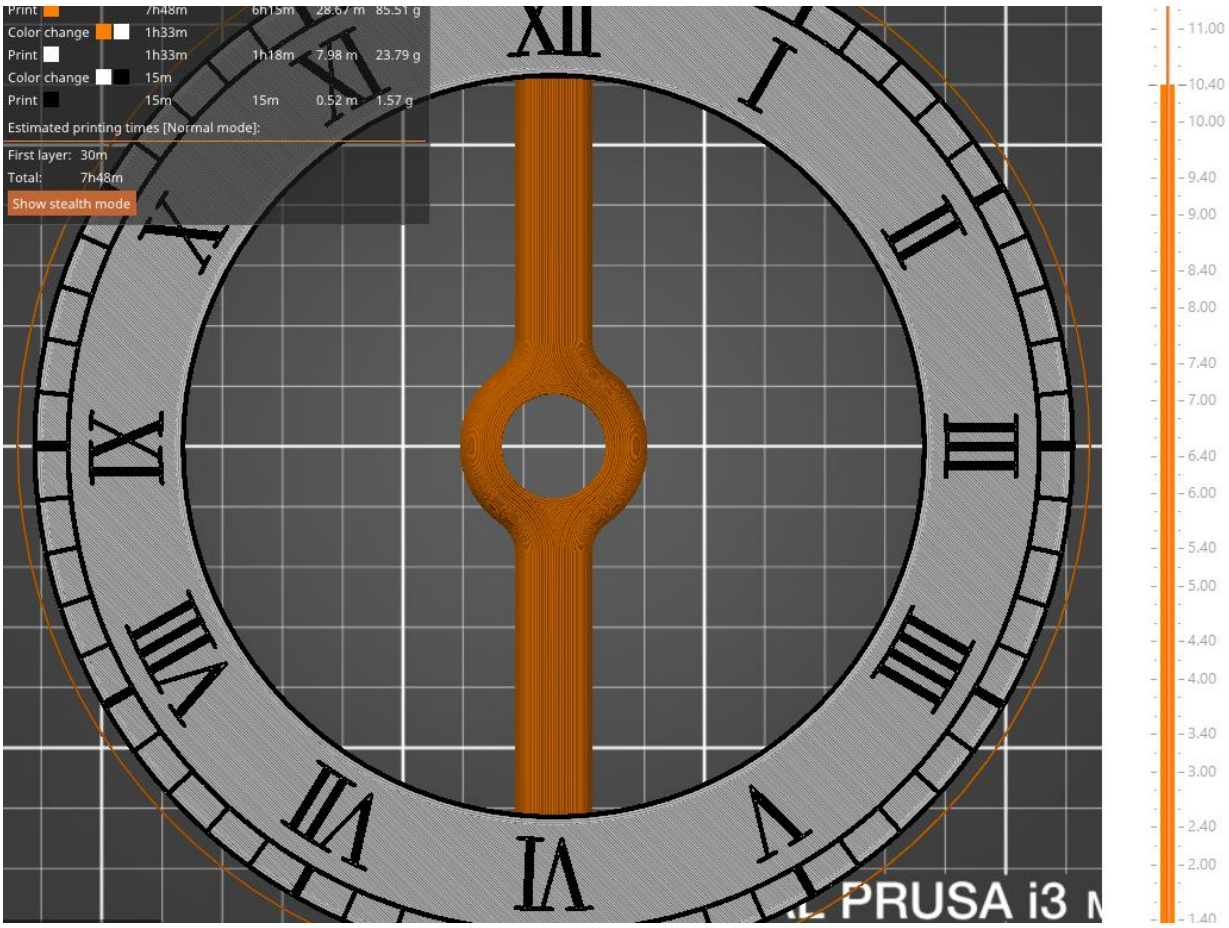

Figure 7: Front frame color changes

The back frame has integrated columns to position the gears to the proper heights. The clock looks best with a color change at 10.40mm to match the gear color.

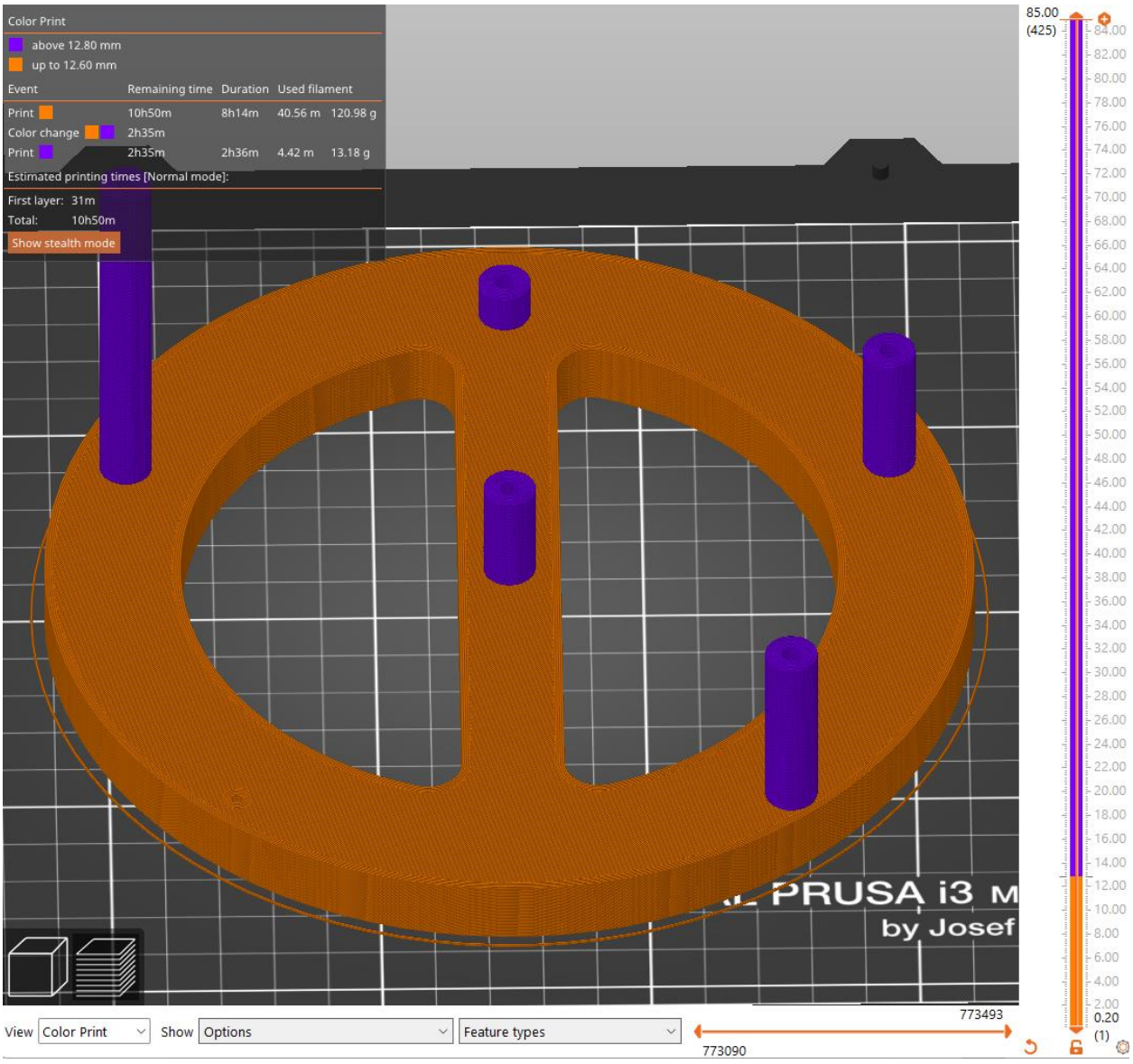

Figure 8: Back frame color changes

The spade hour and minute hands can have a color change at 2.20mm to add some highlights. The gothic hands do not need any color changes.

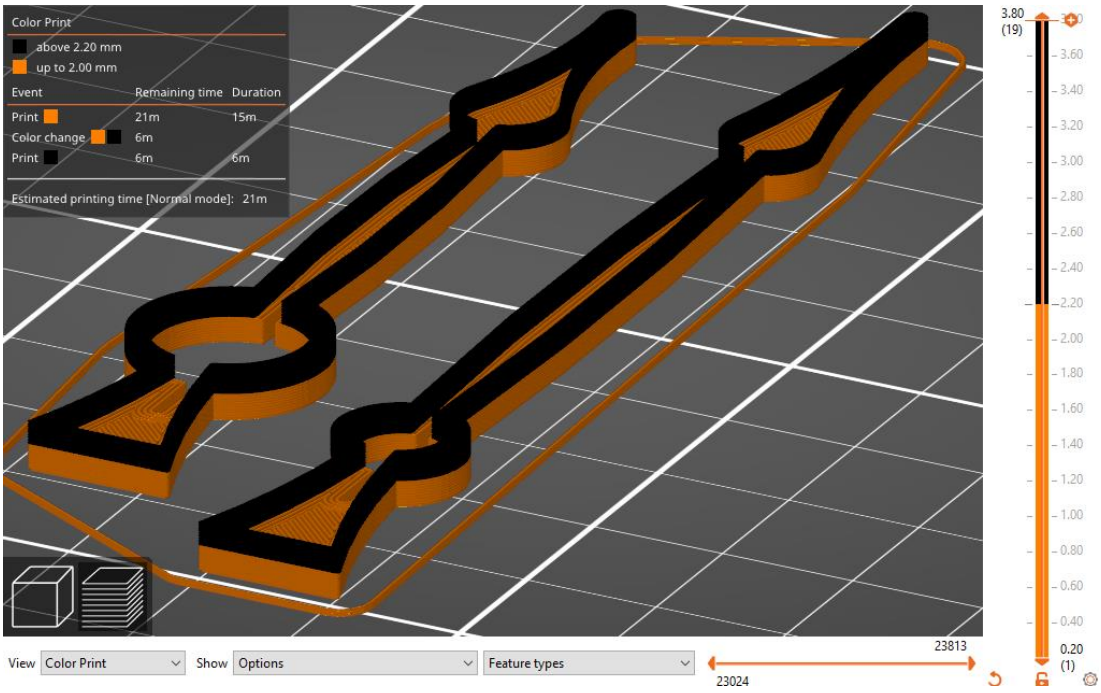

Figure 9: Color highlights on hands

Gear Reference Diagram

Here is a diagram showing the various gears used in the clock.

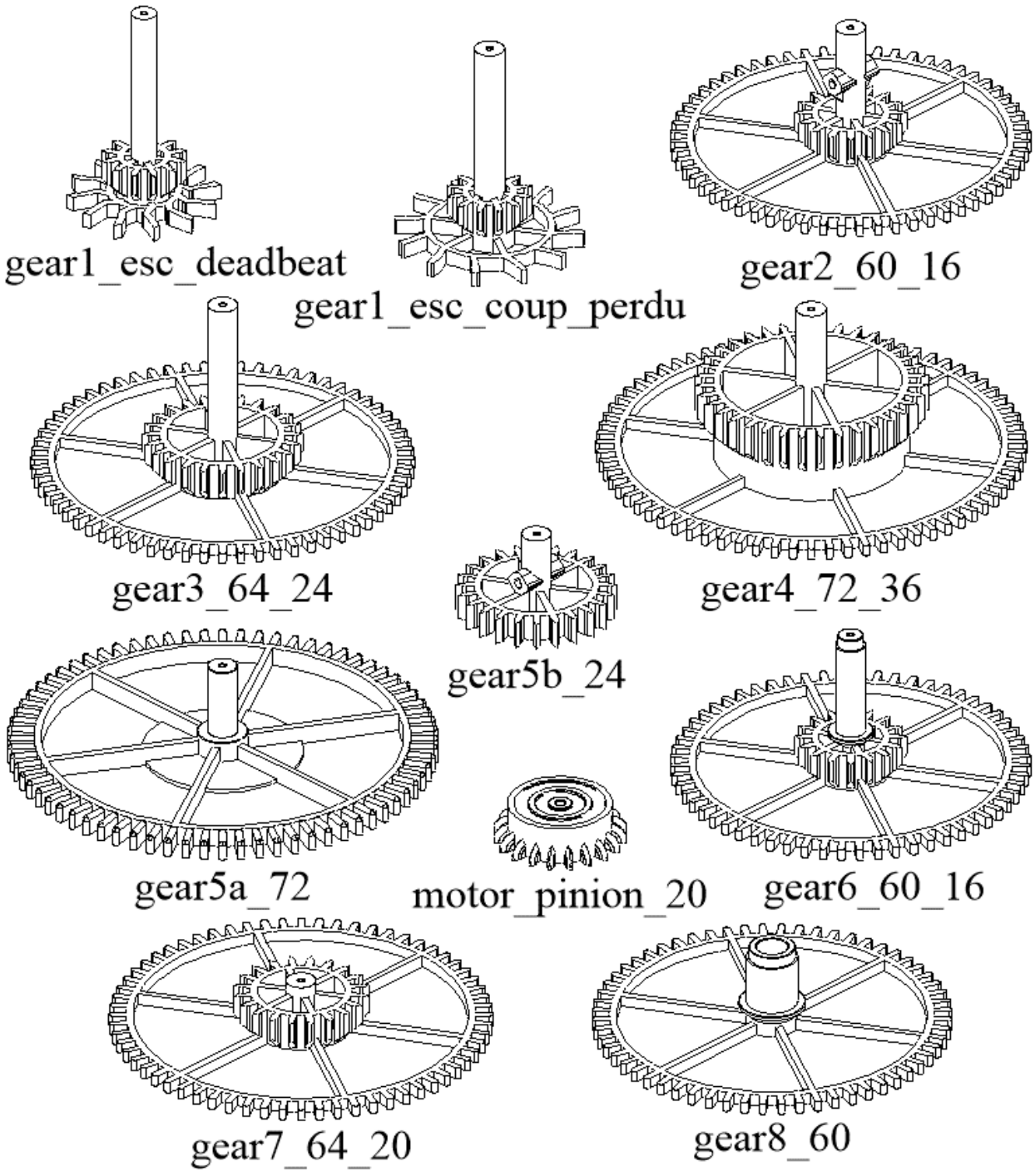

Figure 10: Gear reference diagram

Building the Clock

Start by printing all the parts as described earlier. A few components need pre-assembly before being placed into the clock.

Checking the fit

It is a good idea to double check how well the components fit before assembling the clock. Most parts should go together with minimal adjustment. At most, only some light sanding or drilling of holes should be needed. Check the fit of the following components and adjust as needed.

1) 1.5mm arbors should fit loosely through all the gears and into the frame. The gears should spin on the arbors with minimal resistance. They can be drilled with a 1.6mm or 1/16” drill bit if needed. The clock can be built using 1/16” music wire for the arbors which is slightly larger than 1.5mm and it is likely that some holes would need to be enlarged. There is plenty of room if everything was printed with 4 perimeters. Long aircraft drill bits are best for drilling the back frame holes. Most gears have a recess down the center of the shaft, so only the ends need to be drilled.
2) The motor_flipper and pallet_arm_coup_perdu components also need to spin freely on a 1.5mm (or 1/16”) arbor. Drill these out if needed, but don’t let them get too sloppy.
3) 3mm arbors need to fit through the pallet and pallet_spacer. Drill the pallet and pallet spacer center holes if needed. The 623 bearings also need to fit over the ends of the 3mm arbor. Sand or file the ends of the arbor so the bearings can slide over the ends.
4) The motor_holder needs to fit over gear5a_72 and spin easily. Sand of file either part so they fit.
5) The motor_pinion_20 needs to fit over the N20 motor shaft.
6) The minute and hour hand gears need to fit into each other and into the frame. Check that gear6_60_16 fits into gear8_80. Also check that gear8_80 fits into the hole in the center of the dial.

Component Pre-Assembly

Assembling a few components ahead of time makes the assembling the rest of the clock easier. Gear 2 is a simple module to hold the arbor into the gear. The motor module includes the motor, reed switch, batteries, and some additional weights. It requires a small amount of soldering. Next it will get added into the completed gear 5 assembly along with the friction clutch used to allow setting the time. The frame only has a few components.

Gear 2 Assembly

The gear 2 assembly uses two M3x10mm screws to fix the second hand arbor tight into gear 2. It uses two M3x10mm socket head screws to hold the 5.25” (135mm) second hand arbor in place. The bottom end should stick out 1.05” (27mm). It doesn’t need much strength. Two screws were used to apply even pressure from both sides to help prevent the arbor from bending.

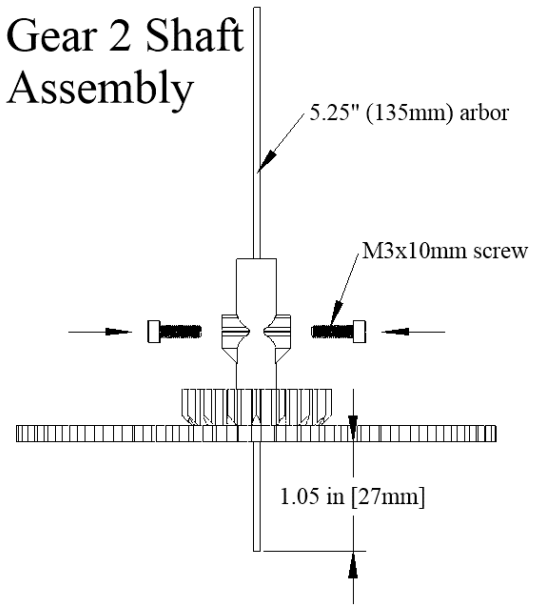

Figure 11: Gear 2 assembly

Motor Module

The motor, battery case, and reed switch need to be wired and inserted into the motor_holder. Wire everything up to match the picture below.

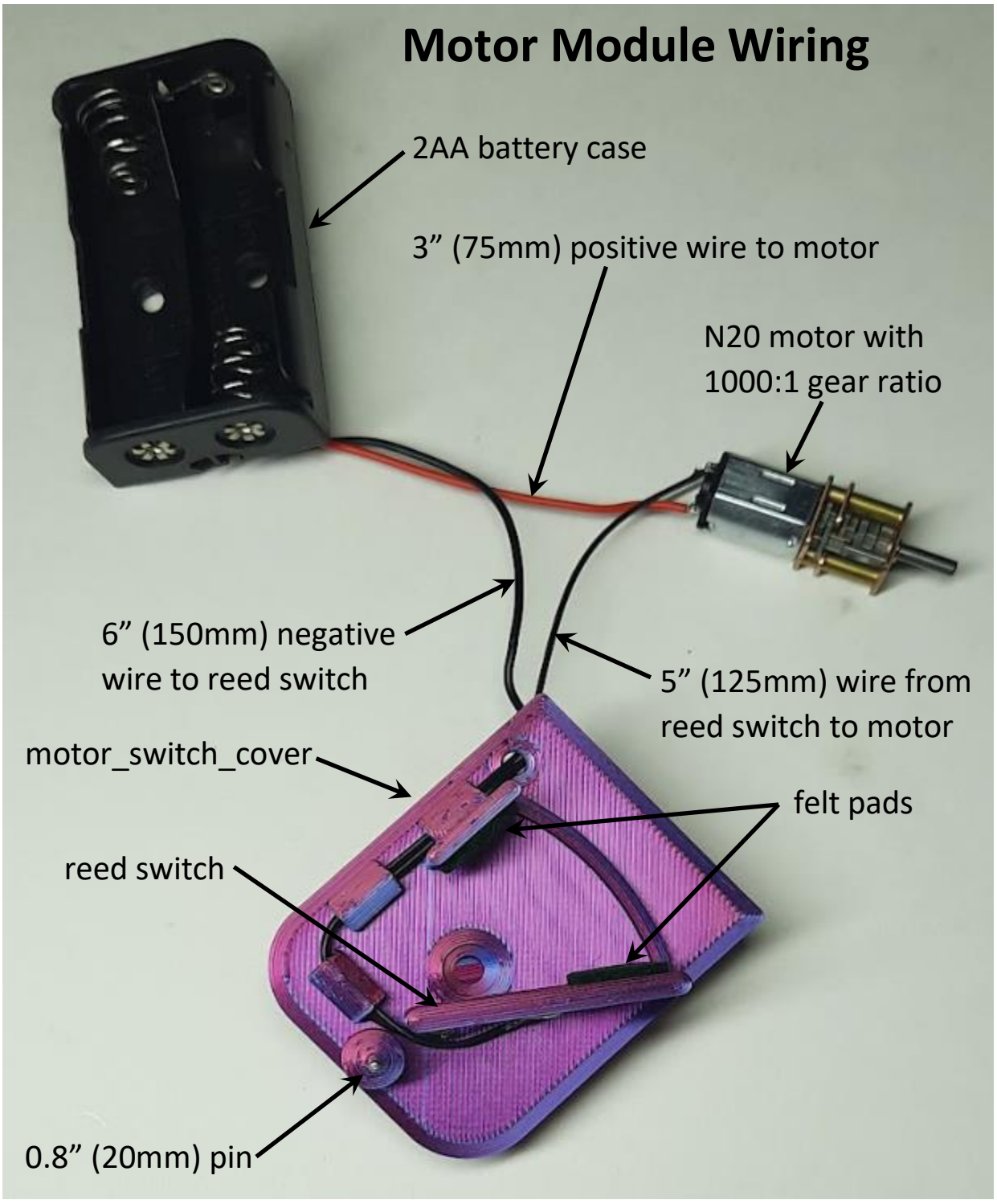

Figure 12: Motor wiring

Here are the steps for wiring the motor module:

1) Add the 1.5mm by 0.8” (20mm) music wire into motor_switch_cover. It is best to add this component now in case it needs to be tapped into position. If it is too loose, it should be glued in place using epoxy.
2) The glass reed switch is a little bit delicate. Gently bend the wires and insert them through the holes in the motor_switch_cover. Feed the negative (black) wire from the battery case through the holes in the motor_switch_cover and solder it to one end of the reed switch. The battery holder I used have 6” (150mm) leads which is a great length.
3) Solder a 5” (125mm) length of small gauge stranded wire to the other end of the reed switch and feed it through the motor_switch_cover next to the other wire.
4) Solder the other end of the 5” wire to the negative (black) N20 motor lead. All the motors I purchased have red and black wire leads and they rotate in the correct direction with the red lead connected to the positive battery terminal. If your motors do not have colored leads, then you may need to experiment so the motor winds the clock properly. If it “unwinds” the clock, then the motor leads will need to be swapped.
5) Connect the positive (red) wire from the battery case to the positive (red) N20 motor lead. The original motor wire can be removed and replaced by the battery case wire. This new wire only needs to be about 3” (75mm) long.
6) Add some small adhesive felt pads to the motor_switch_cover to help dampen the noise of the motor_flipper hitting the end stops. Any diameter of pads will work. A thickness of 0.050” (around 1.5mm) is ideal.

It is a good idea to test the wiring before assembling everything into the motor_holder. Add two AA batteries into the battery case. The motor should spin when the magnet is brought near the reed switch and it should stop spinning when the magnet is removed.

If everything works as expected, insert them into the motor_holder.

7) Remove the batteries before proceeding.
8) Add the N20 motor into the motor_holder and attach motor_pinion_20 using a M3x10mm cap head screw. The pinion holds the motor in place. I like to add a small amount of light grease to the end of the pinion where it rubs against the motor_holder.
9) If you are building the clock with a Coup Perdu escapement, then fill the holes in the motor_holder with pennies or small washers. The Coup Perdu seems to need all or most of the weights to be added, while the deadbeat option can often run using only the weight of the batteries. Extra weight can be added or removed later if needed.
10) Add motor_switch_cover over the motor_holder and stuff the excess wiring into the hole behind the motor. Attach the cover using a #6x3/4” wood screw.
11) Add the battery holder into the motor_holder. The excess wires can be tucked under the battery holder. The battery case can be held down using two M3*5mm or #4-40x1/4” flat head screws if desired. This is optional, but it makes it easier to replace the batteries later.
12) Add the batteries into the case and attach motor_battery_cover using a #6x3/4” wood screw.

The motor module can be tested again at this point. The motor should spin when the magnet is brought near the reed switch.

Complete the motor module assembly

13) Insert the 5mm diameter by 1mm thick magnet into the motor_flipper. Epoxy works best, but it is also OK to just tape it down with a small piece of masking tape. The reed switch does not seem to care about magnet polarity. Any magnet orientation is fine.
14) Add the motor_flipper onto the small post on motor_switch_cover. The motor should spin when the motor_holder is tilted one way and it should stop spinning when tilted back.
15) Add a 1.5mm (1/16”) shaft collar to hold the motor_flipper in place. Metal shaft collars are the most convenient since they can be easily removed when taking things apart. They can be difficult to find, so there are some small printed shaft_collar components that can be used instead. The printed versions may need to be drilled out so they are a snug fit.

Gear 5 Assembly

The completed motor module can be added to gear 5 along with the friction clutch used to allow setting the time. The wall mounted clock option uses a 4” (100mm) arbor. A desktop clock can use a longer 5” (125mm) arbor that will pass through the back frame to allow an adjustment knob for setting the time. The assembly is identical except for the arbor length.

1) Start by attaching gear5b_24 to the arbor using two M3x10mm socket head screws. The arbor should stick through about 0.25” (6mm).
2) Add gear5a_72 onto the arbor.
3) Add motor_idle_wheel to the previously completed motor module using a #6x3/4” wood screw. The idle wheel should be allowed to spin easily.
4) Add the motor_washer, pen spring, and a shaft collar to the arbor. Position the shaft collar with 0.25” (6mm) sticking through the bottom. The 5” arbor for the desk clock would project 1.25” (32mm). The complete stack of components is 3.5” (89mm) tall. There is a printed substitute for the shaft collar if you want to avoid sourcing this tiny component. It would need to be pressed or glued onto the arbor.
5) Test that gear5b_24 can rotate independently from gear5a_72 and the motor module. This is what allows the time to be changed. Gear5a_72 drives the pendulum and second hand. Gear5b_24 drives the minute and hour hands.

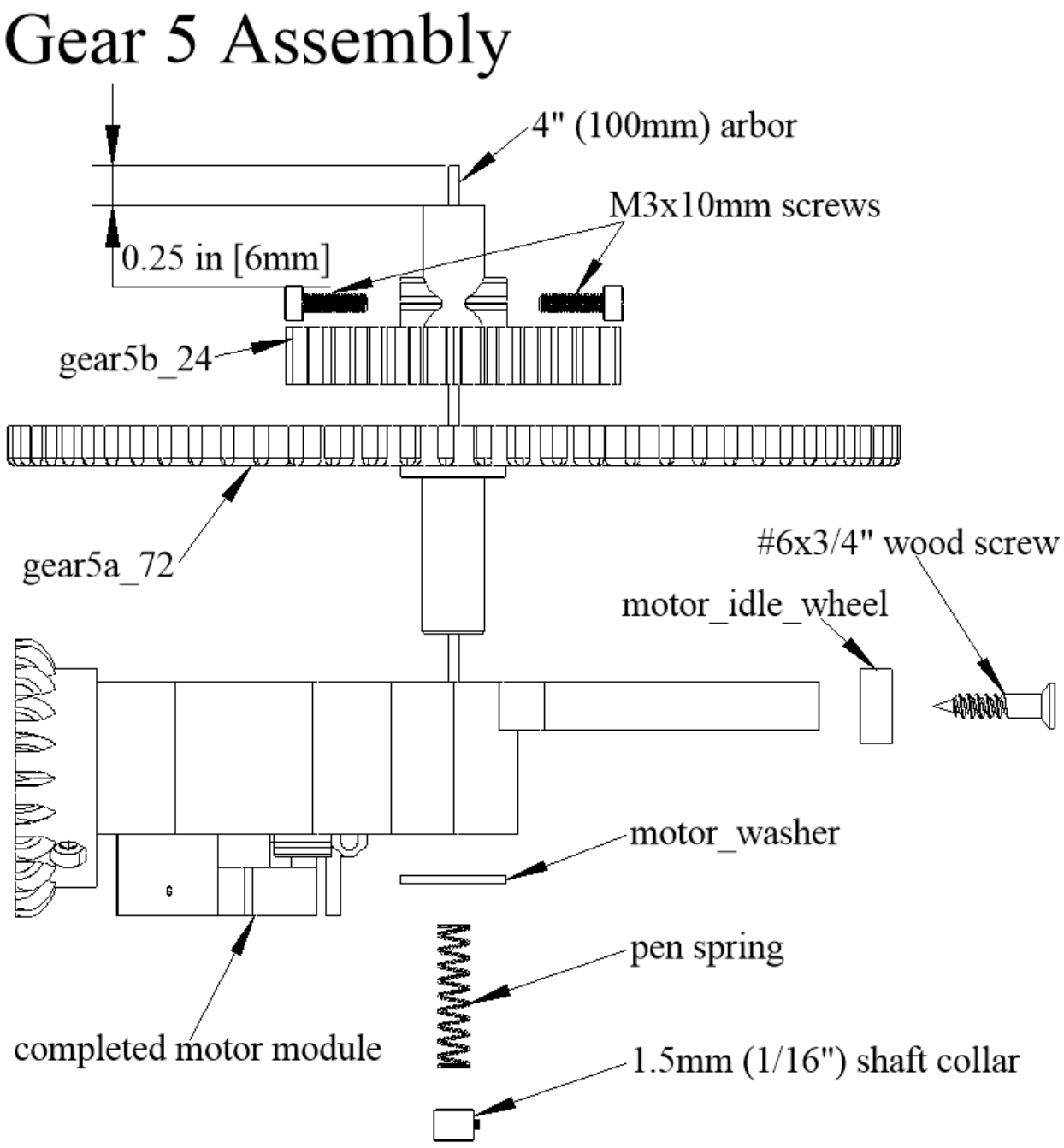

Figure 13: Gear 5 assembly

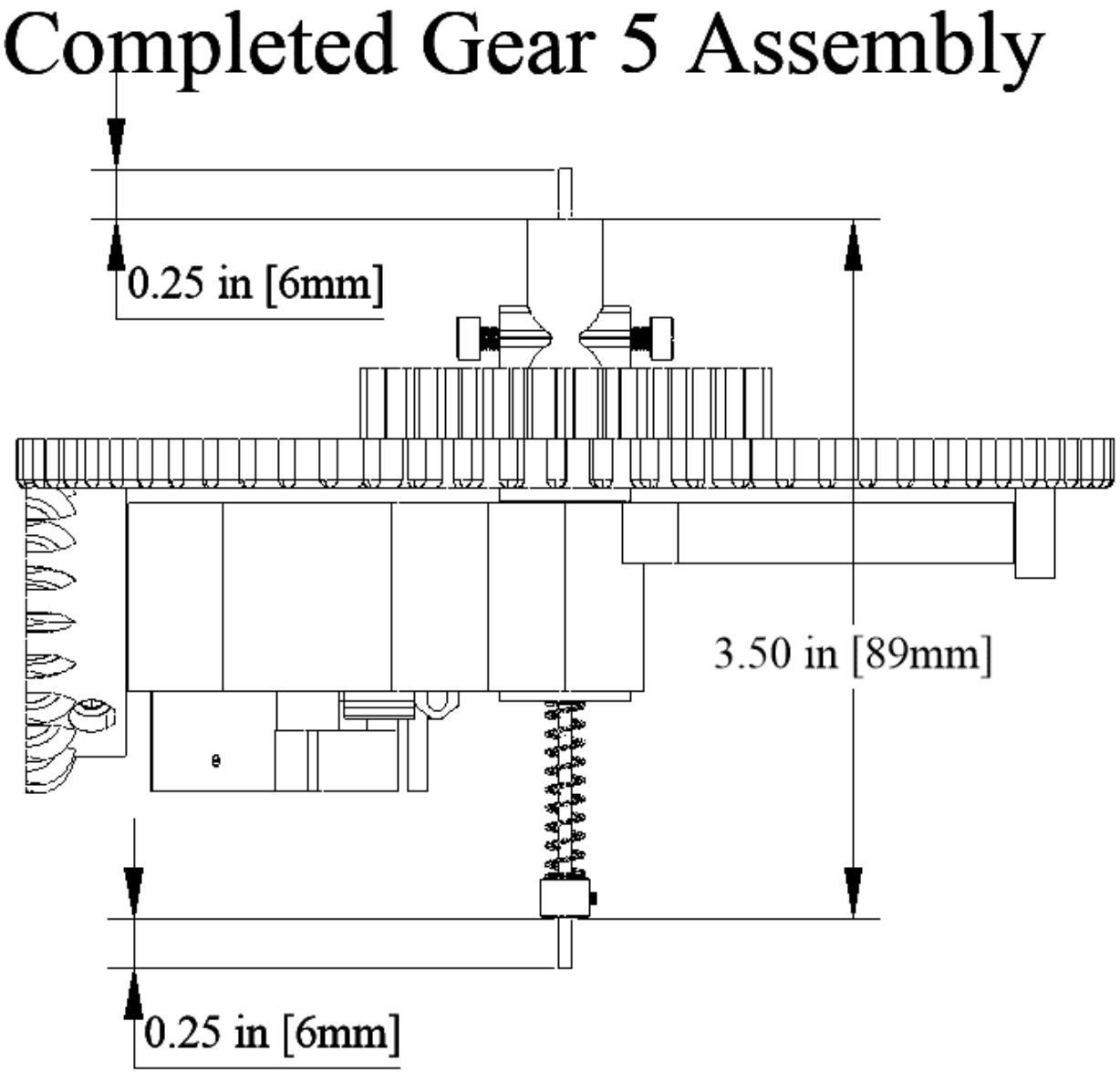

Figure 14: Completed gear 5 motor module assembly

Pendulum Bob

The pendulum bob is a simple structure to add a small amount of weight to the pendulum. Fill the holes in pendulum_bob_front with pennies or small washers and secure the pendulum_bob_back using four #6x3/4” wood screws. The pendulum_arm slides through the center and is held in place using two pendulum_nuts. If the nuts are too tight, then scale them up slightly and print them again.

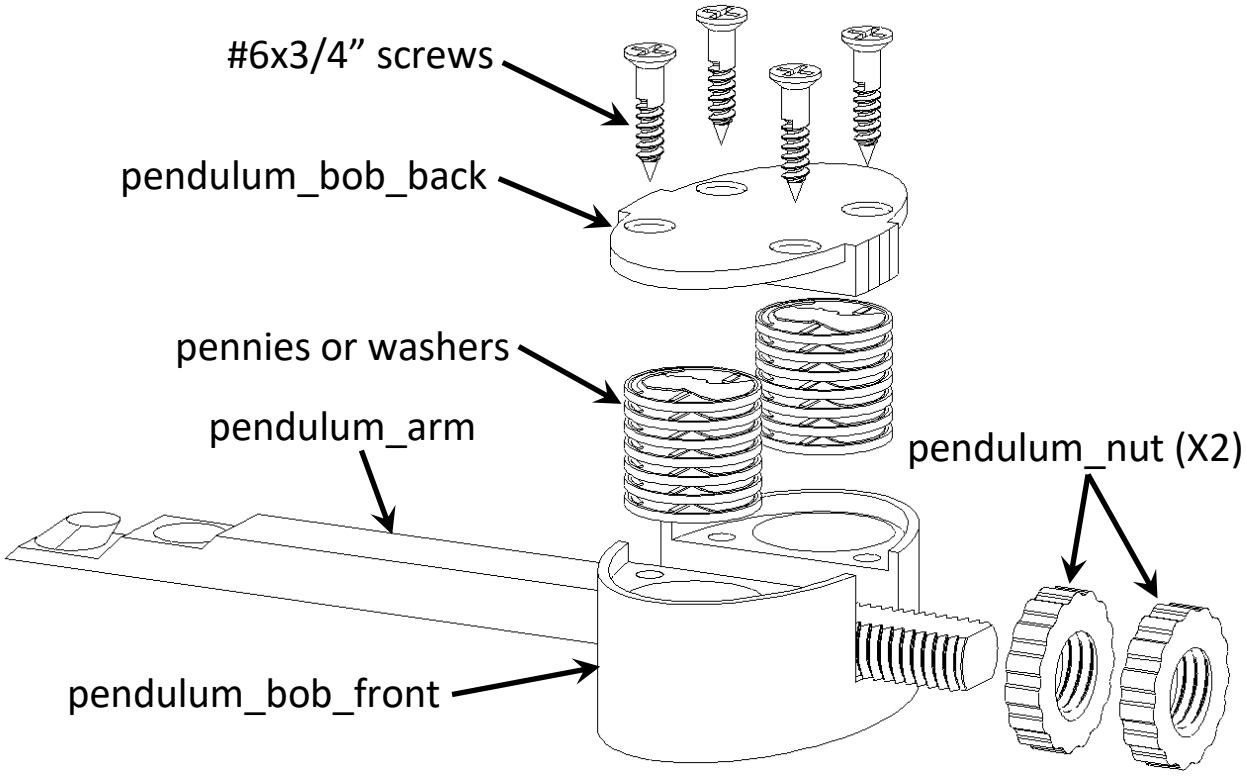

Figure 15: Pendulum bob

Frame Assembly

The frame is held together using #6x3/4” or M3x20mm wood screws. All the alignment pins are built-in. The front frame gets assembled using either frame_dial_roman or frame_dial_numbers and four wood screws. The back frame also uses four wood screws. The two frame halves will be connected later using three more wood screws.

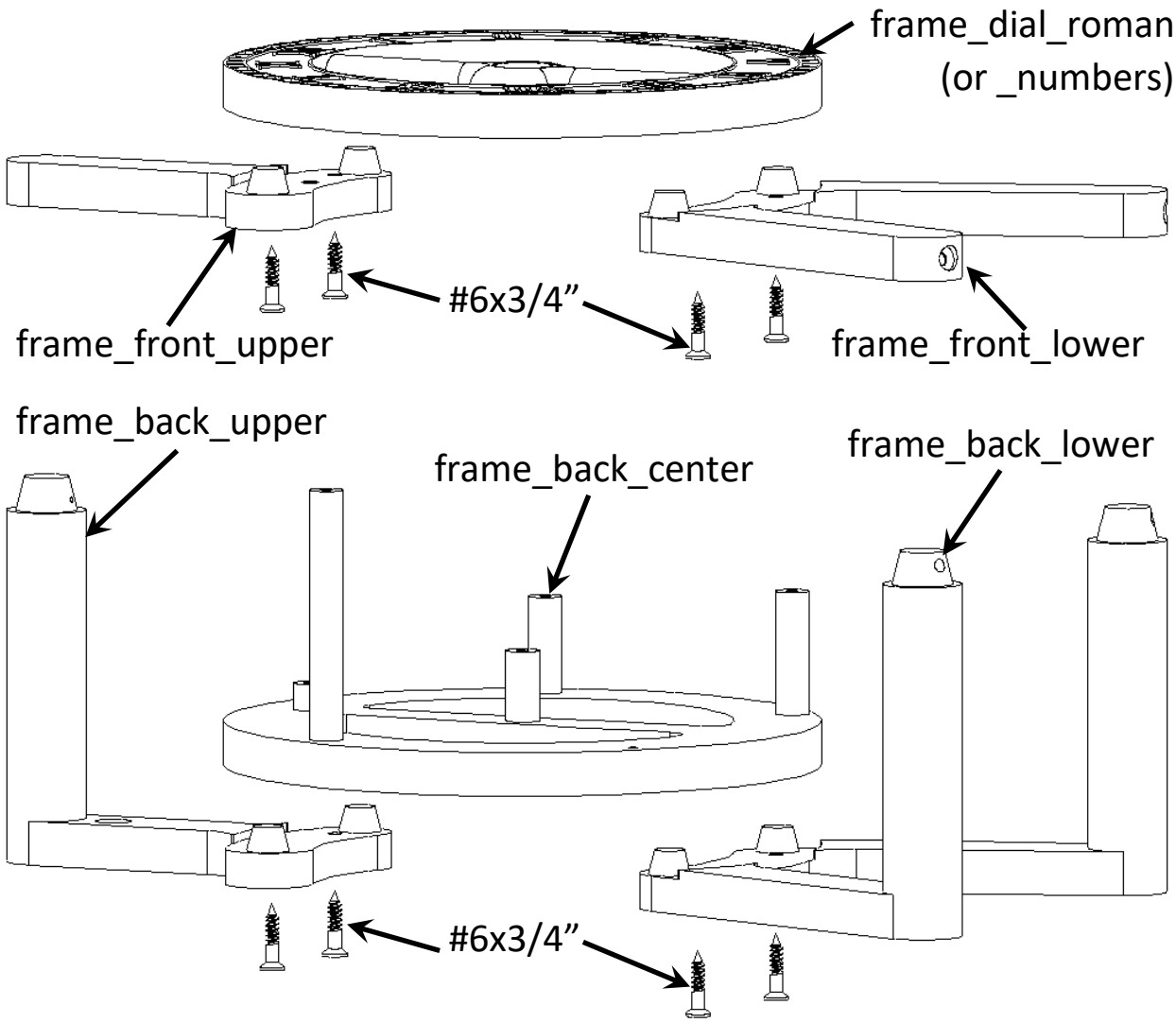

Figure 16: Frame assembly

There are two options that can be added later. The wall mounted clock has an optional dummy weight (frame_back_weight) that might be helpful to keep the clock balanced on the wall using a single mounting screw. It has pockets that can be filled with pennies or small washers. Alternatively, a second mounting screw can be used to hold the clock steady on the wall.

The desktop clock option has a small spacer (frame_back_spacer) that can be added where the gear 5 arbor passes through the back frame.

Coup Perdu Pallet

If you are building the Coup Perdu version of the clock, a small lever arm needs to be added to the pallet frame. This step is only needed for the Coup Perdu. The deadbeat escapement can skip this step.

1) Insert the 0.8” by 1.5mm pin into the Coup Perdu pallet body.
2) Add small felt pads on both sides of the pallet as shown below.
3) Add the pallet arm onto the small pin.
4) Attach a shaft collar (or printed shaft_collar equivalent) to the small pin.
5) The pallet arm is designed so the left side is slightly heavier than the right side. Test that it moves easily with a small push on the right side and falls back to the natural position when released.

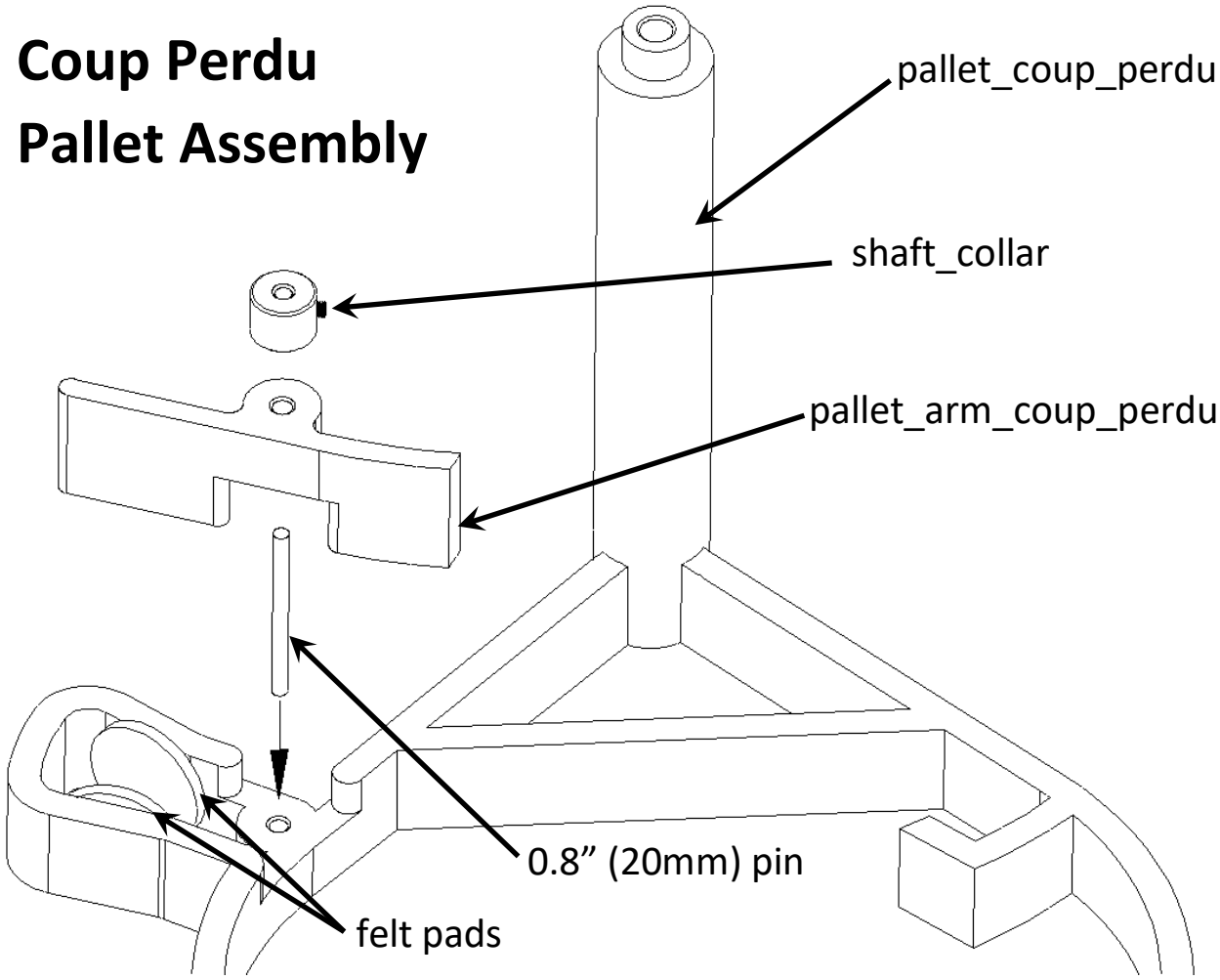

Figure 17: Coup Perdu pallet assembly

Completing the Clock Assembly

Now that all the components are assembled, it is time to put everything together into a complete clock. This starts with the pallet followed by each gear in numerical order from 1 through 8. The front frame, hands, and pendulum complete the clock.

Pallet

The pallet is supported by two 623 ball bearings. These bearings have been used in many of my other clocks with great results. They work best without the heavy factory grease. Remove the rubber seals using a small pin. Soak the bearings in solvent or alcohol until the grease has dissolved. A small drop of dry silicone lube or very lightweight oil can be added for some protection.

1) Start by laying the back frame on the table.
2) Insert a 623 bearing in the large hole near the top of the back frame.
3) Add the 3mm arbor into the bearing.
4) Place the pallet_spacer over the arbor with the narrow end facing the bearing.
5) Add the desired pallet (Coup Perdu or deadbeat) onto the arbor. The hole for the arbor is a tight fit. It might need to be drilled out.
6) Add the upper 623 bearing.
7) If you want, you can add the front frame and lower pendulum arm to test the pendulum bearing functionality. The pendulum should swing freely for several minutes before stopping. The bearings in this clock are not as sensitive as some of my other weight driven clocks.

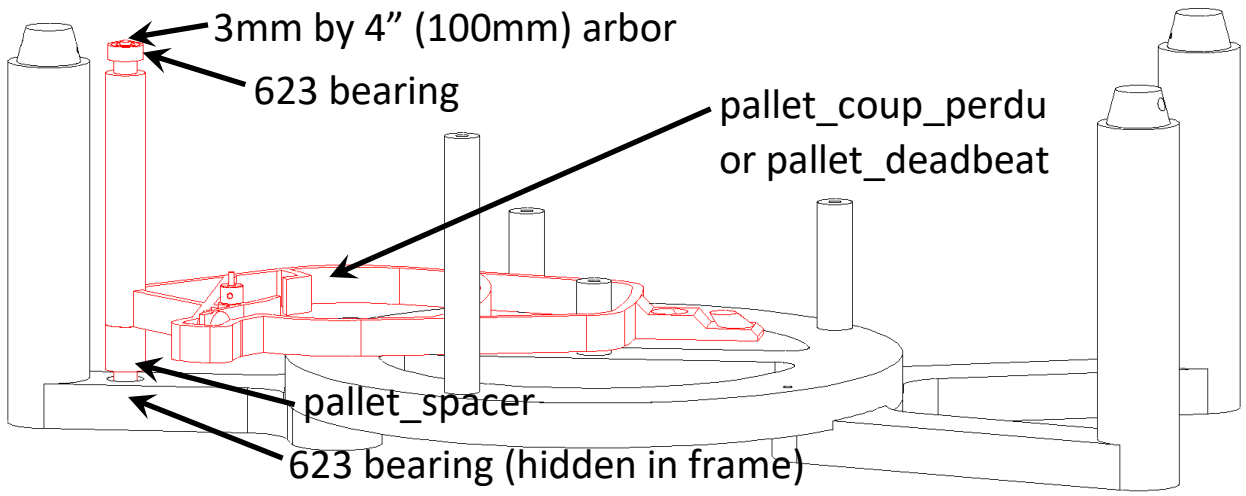

Figure 18: Pallet and bearings

Gear 1 Escapement

The Coup Perdu or deadbeat escapement and a 4” arbor get added into the center of the pallet arm.

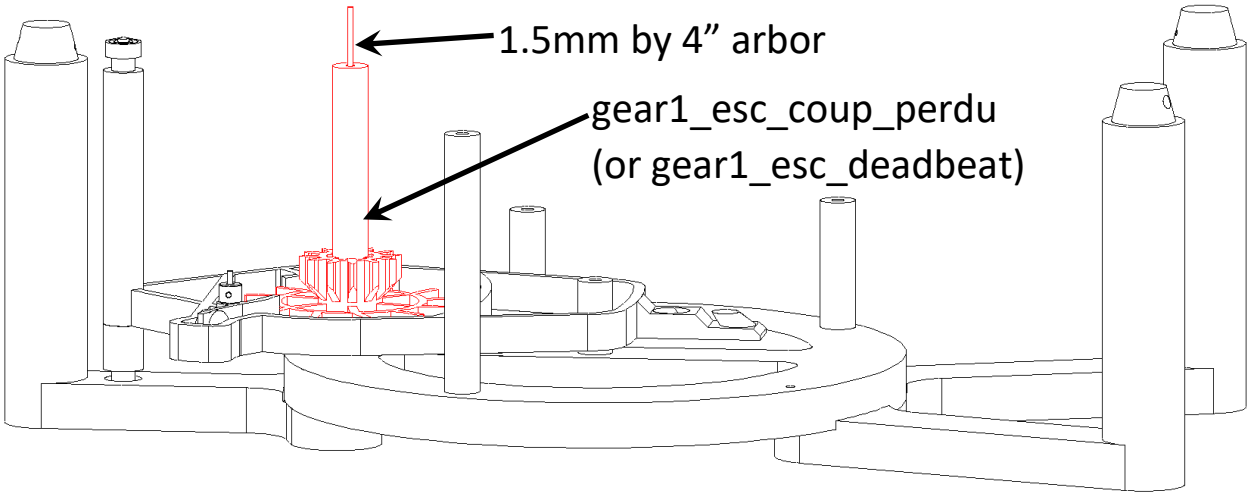

Figure 19: Escapement gear 1

Gear 2

The previously assembled gear 2 assembly is inserted into the center of the back frame. The large gear should mesh with the escapement pinion.

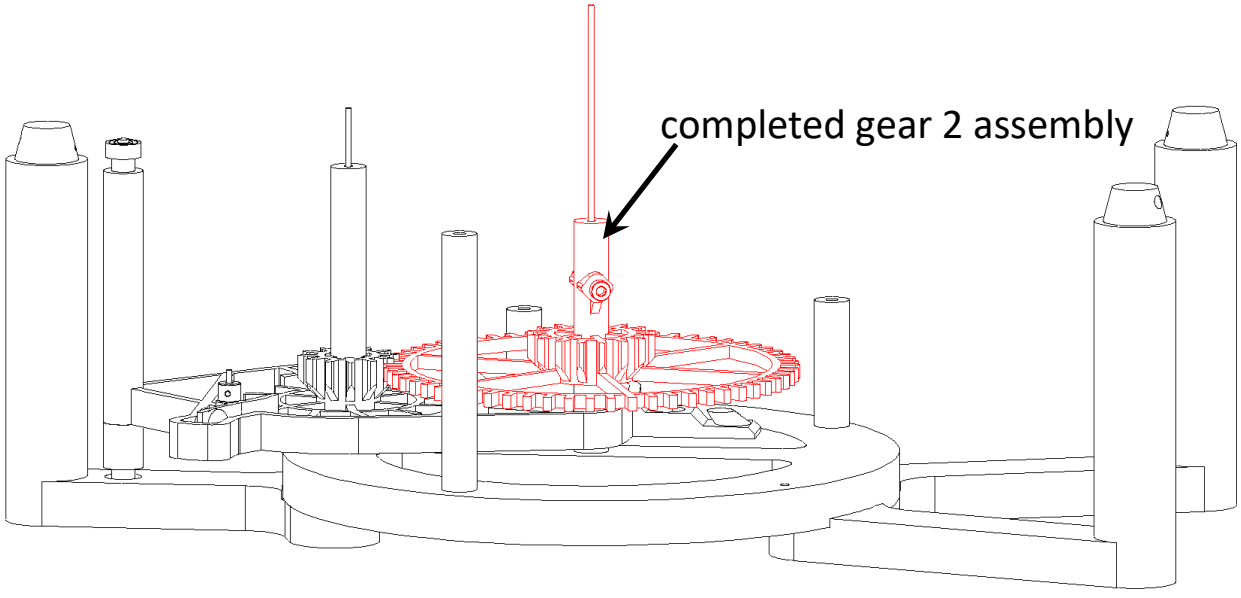

Figure 20: Gear 2

Gear 3

Gear 3 and a 4” arbor get added to the upper right position.

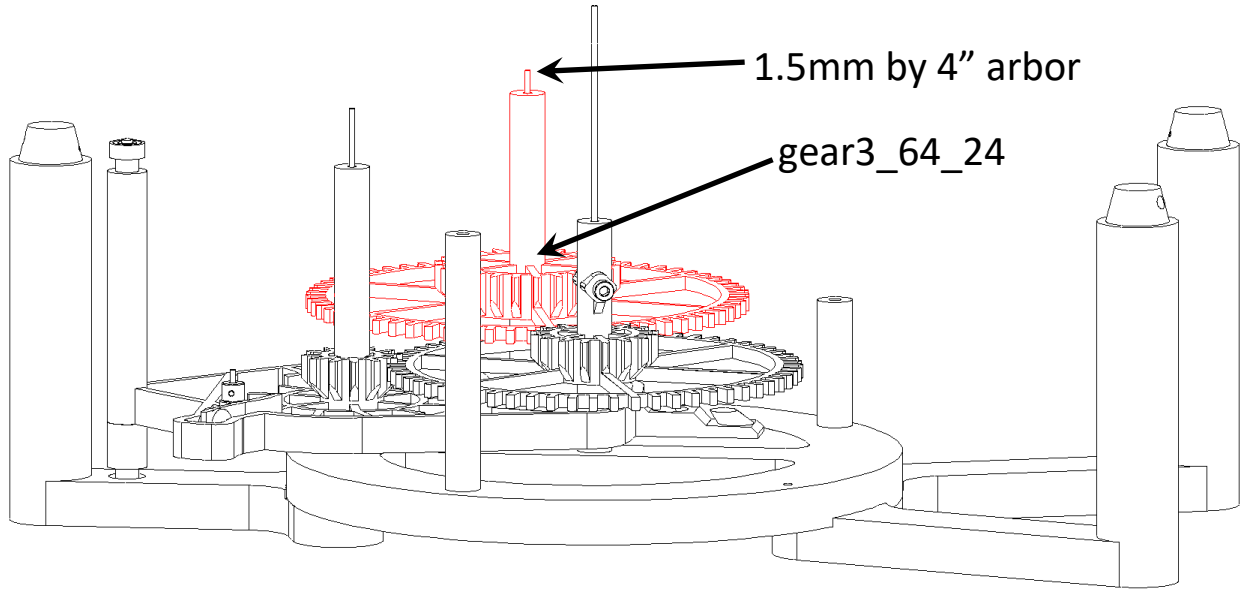

Figure 21: Gear 3

Gear 4

Gear 3 and a 4” arbor are added to the lower right position. The pinion is very tall on this gear to provide clearance for the motor module thickness.

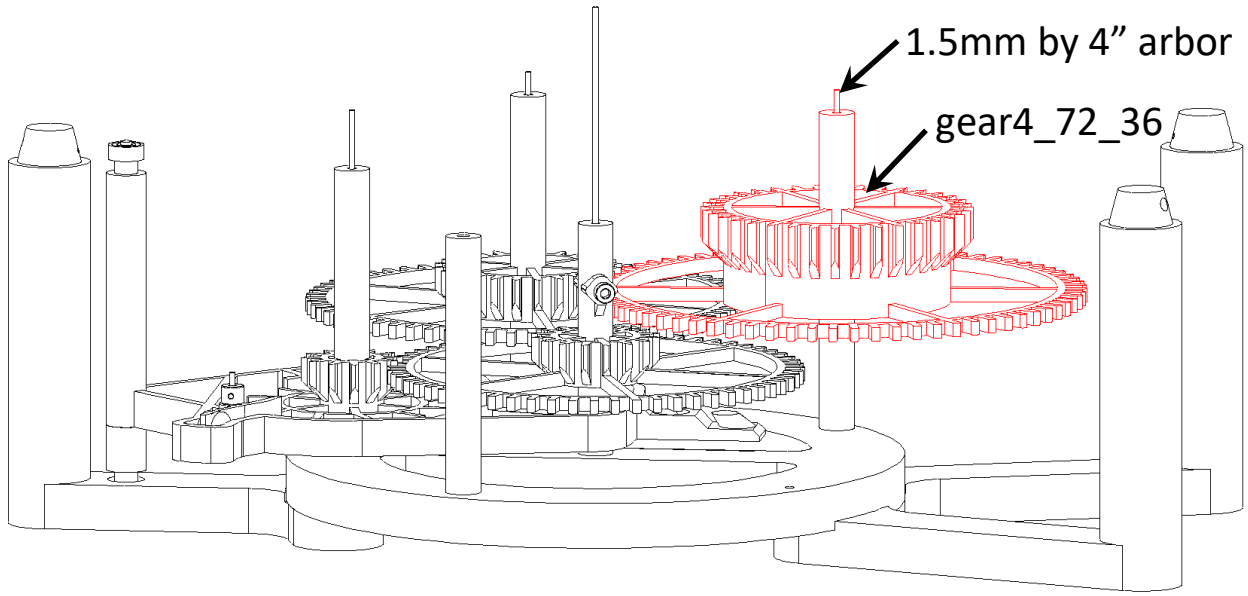

Figure 22: Gear 4

Gear 5 and Motor Module

The previously assembled gear 5 and motor module is inserted into the lower left position. It is best to remove the batteries or the motor_flipper so the motor will not trigger while you are working.

The arbor will stick through the back frame if you are building the desktop clock with the long arbor. Support the clock on an empty filament spool.

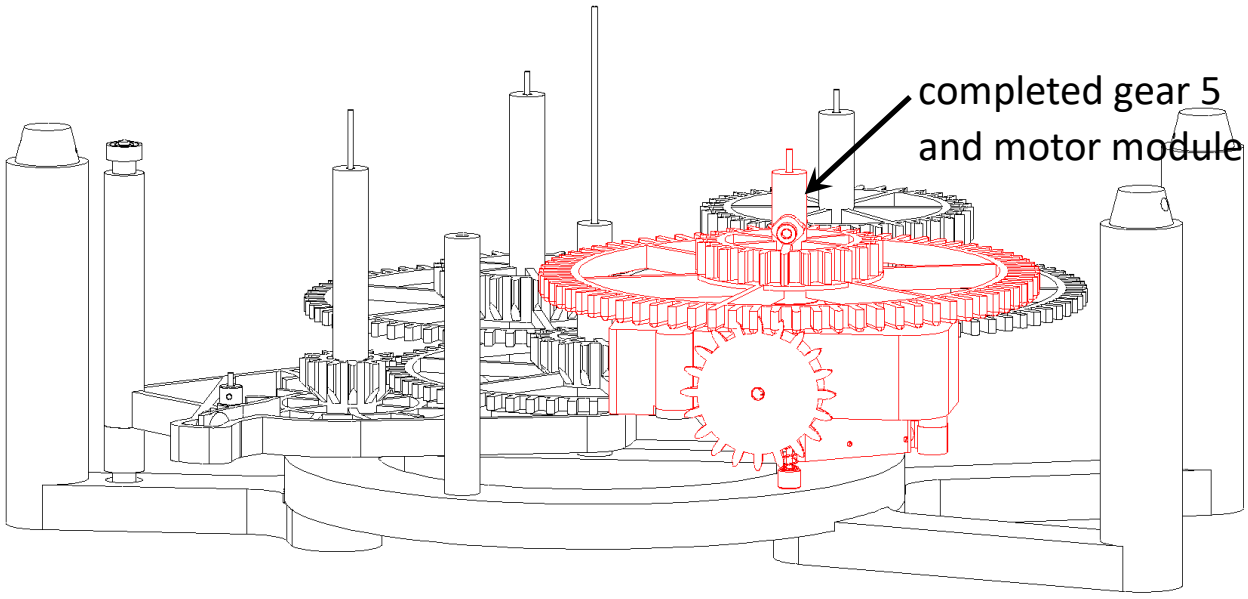

Figure 23: Gear 5 and motor module

Gear 6

The minute hand gear 6 gets positioned in the center of the clock onto the gear 2 arbor.

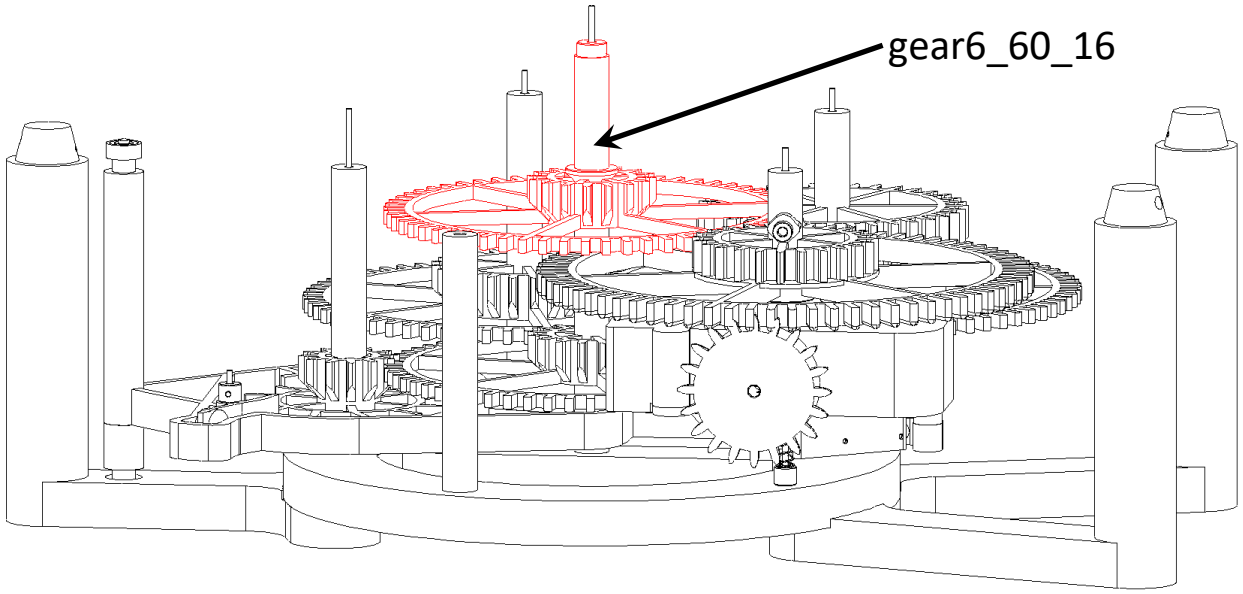

Figure 24: Gear 6

Gear 7

Gear 7 and a 4” arbor are positioned into the last remaining hole at the upper left.

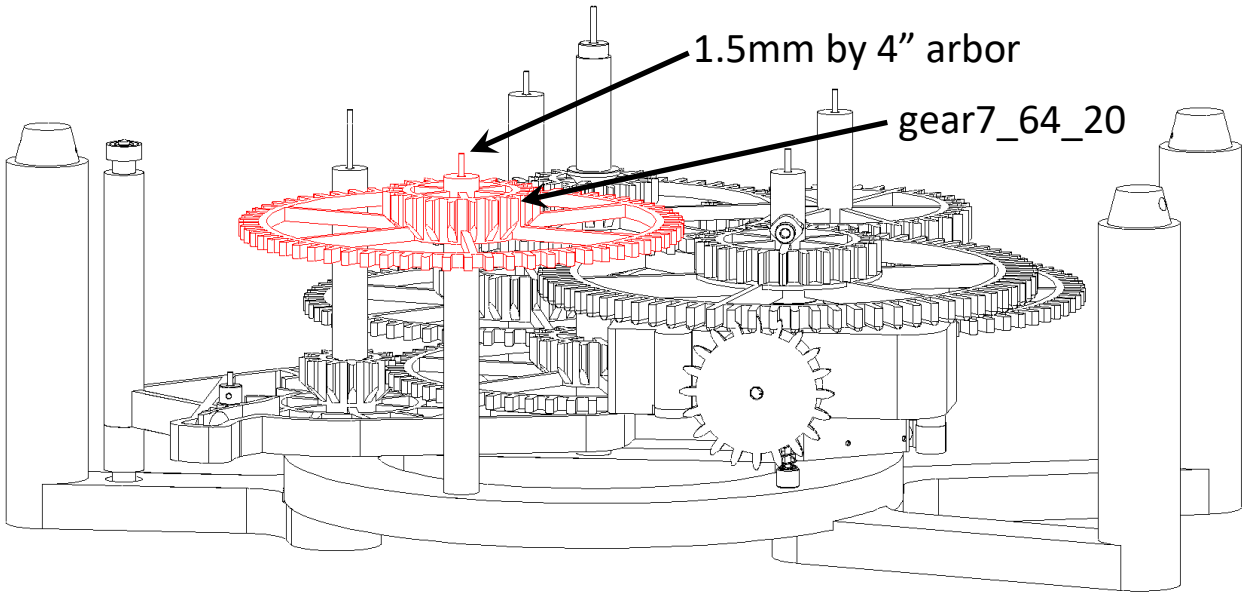

Figure 25: Gear 7

Gear 8

The final gear to place is the hour hand gear 8 that sits on top of gear 6.

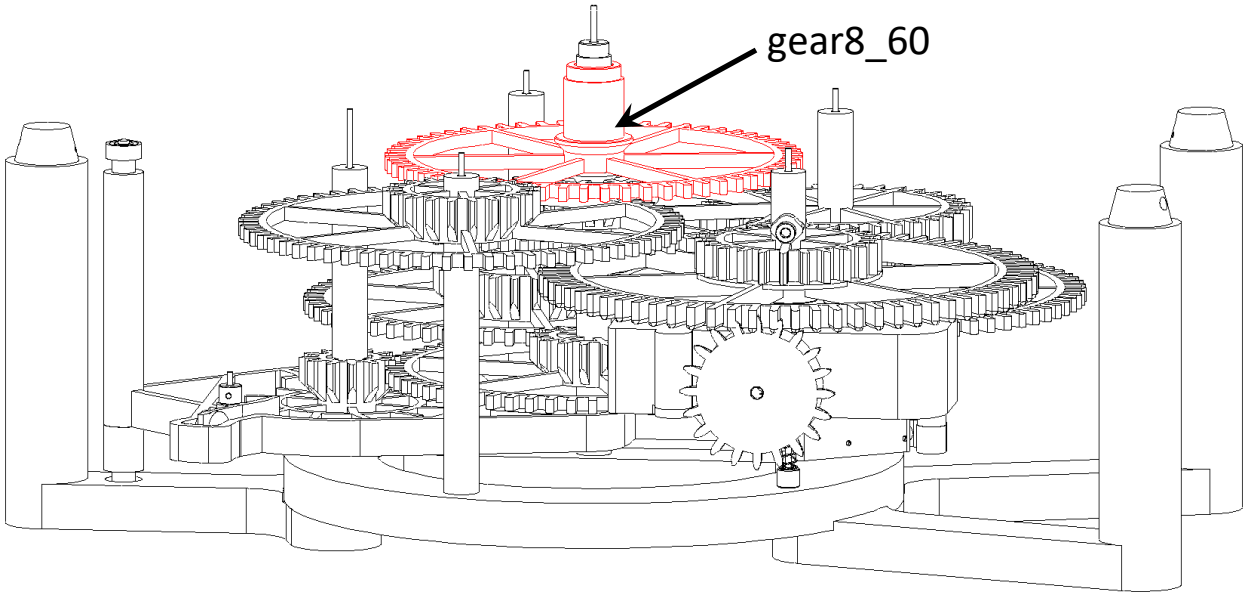

Figure 26: Gear 8

Front Frame

Assembly is completed by adding the front frame. All of the arbors need to be positioned into the proper holes in the front frame. The holes have a tapered start to make it easier.

Start by placing the front frame over the center arbor with the hour and minute hand gears. Gently move each arbor until it is in position.

The front frame should drop lower as each arbor is lined up. Add the three #6x3/4” wood screws to secure the frame.

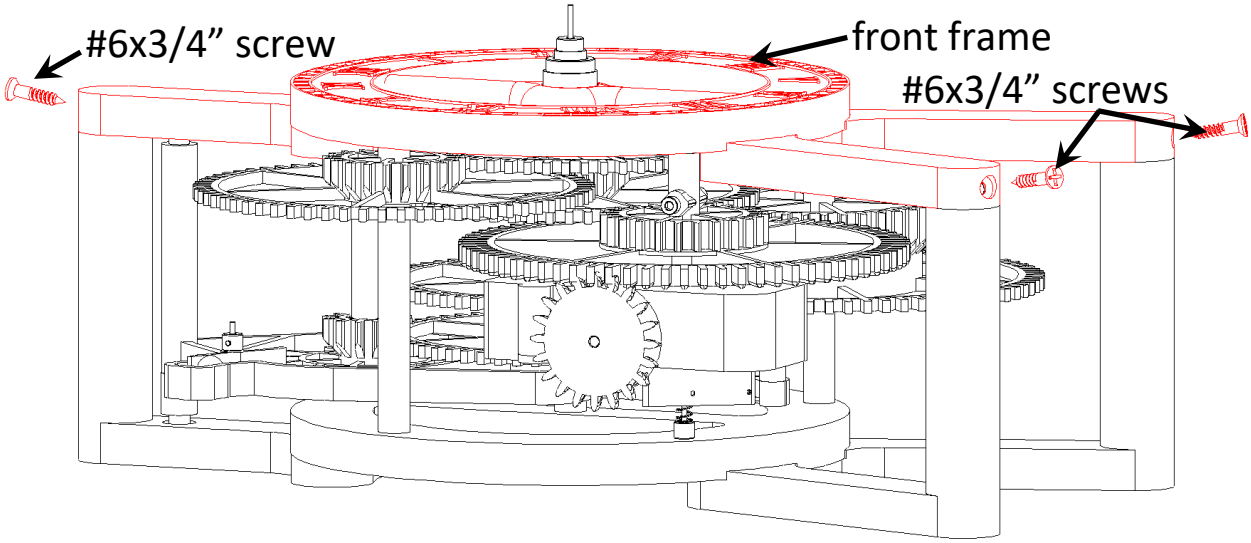

Figure 27: Add front frame

Hands and Pendulum

The hands can now be added. A slight amount of sanding might be required for a good press fit.

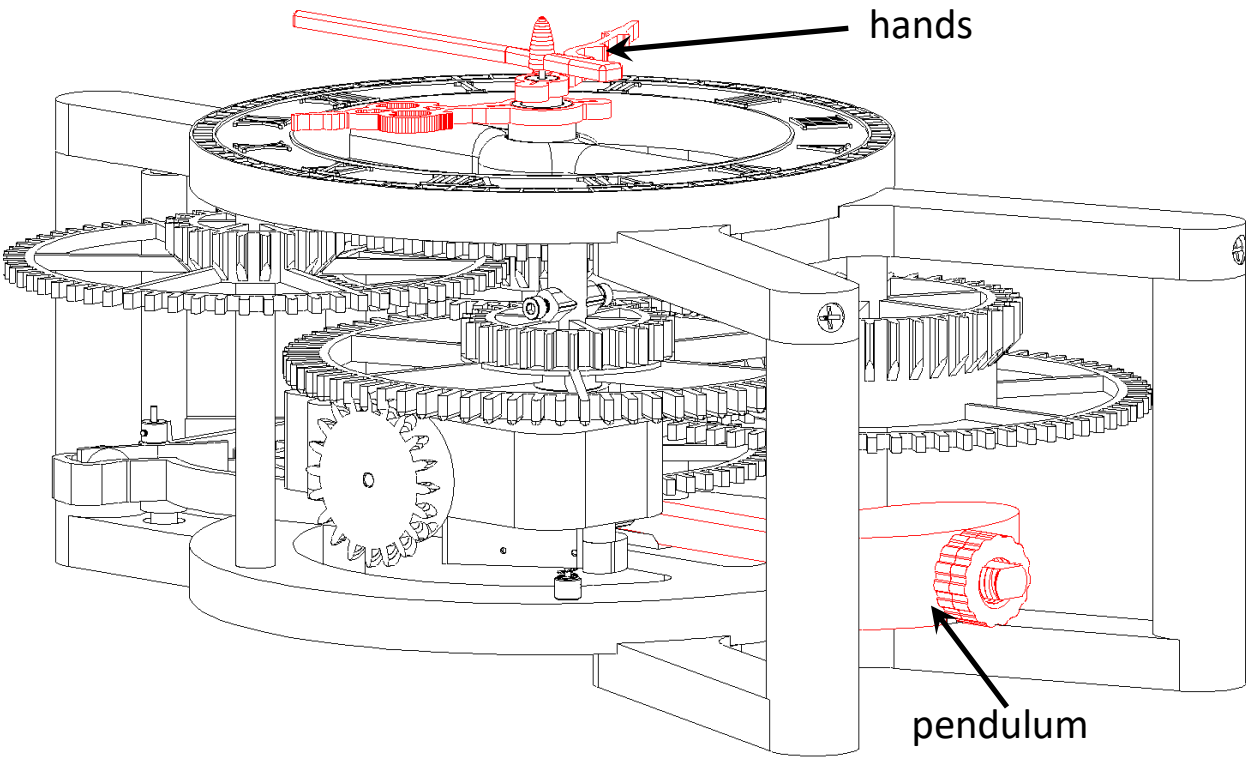

Figure 28: Add hands and pendulum

Stand up the clock and drop the pendulum arm onto the pins on the pallet. Push the pendulum and the clock should start ticking. Add the battery or motor_flipper back in to the motor module and the clock should rewind itself every 4-5 minutes.

Attach the gear5c_knob to the back of the clock using a M3x10mm screw if you have desktop clock option. This knob can be used to adjust the time. The wall mounted clock is adjusted by turning the gear closest to you in the upper left corner.

Running the Clock

Congratulations, you should now have a working clock. This is one of my most reliable clock designs.

If the clock ticks a few times and stops, it might need a tiny bit more drive weight in the motor module. The Coup Perdu escapement seems to need most or all of the weights (pennies) installed in the motor module. If you can't get the Coup Perdu clock option to run using all of the available weight options, then you might consider switching to the deadbeat option that runs using significantly lower drive weight.

The deadbeat option should run with just the weight of the battery or maybe one of the holes filled with pennies. It will be quieter than the Coup Perdu and will likely become the default option in my home.

The wall hanging clock can hang by a single screw in the wall. The motor module shifts the weight to one side, so you can add frame_back_weight filled with pennies to help balance the weight. Or you can use a second screw on the wall at the lower portion of the frame to stabilize the clock.

The desktop clock option can use frame_back_spacer and gear5c_knob with a M3x10mm set screw to add a time adjustment knob to the back of the clock. The time can be adjusted by turning the knob on the back.

The wall mounted clock does not have room for the knob, so set the time by turning gear 7. This is the gear near the front of the clock in the upper left corner.

Adjust the rate by turning the nuts below the pendulum bob. One full rotation of the nuts should change the rate by about 5 minutes per day. A longer pendulum will run slower and a shorter pendulum will run faster.

My estimate is that the clock should run for around six months of runtime per pair of AA batteries.

Wrap Up

Thank you for purchasing this clock design and supporting my work. I enjoy fine tuning each design until I feel everything is perfect. This clock took a lot of experimenting to find the best motors and a reliable rewind trigger. I am quite pleased with how it turned out.

Feel free to message me with questions during the build or just to say hi. You can reach me at MyMiniFactory, YouTube, or the forum on my web site at https://www.stevesclocks.com/forum

Happy clock building,
Steve

Appendix: Some of my Other Clock Designs

Here are a few of the other clocks I have built. Many of them will eventually be released for others to build. The first is a grasshopper escapement to replace the deadbeat escapement in my one of my earlier clocks. It needs a bit of fine tuning before it can be released. The second image is a rendering of one of my designs as it may look after porting to use wooden gears.

Figure 29: Grasshopper clock and wood clock rendering

These are some sample wooden gears cut from solid wood using a new method to prevent expansion from humidity changes. They will eventually be used to create the rendered clock on the previous page.

Figure 30 Wooden gear experiments

Here are some of the prototypes before settling on the final design in this release. The largest size is physically impressive, but the larger gears are noisy. It took a lot of fiddling before finding a motor control circuit that was quiet enough to release.

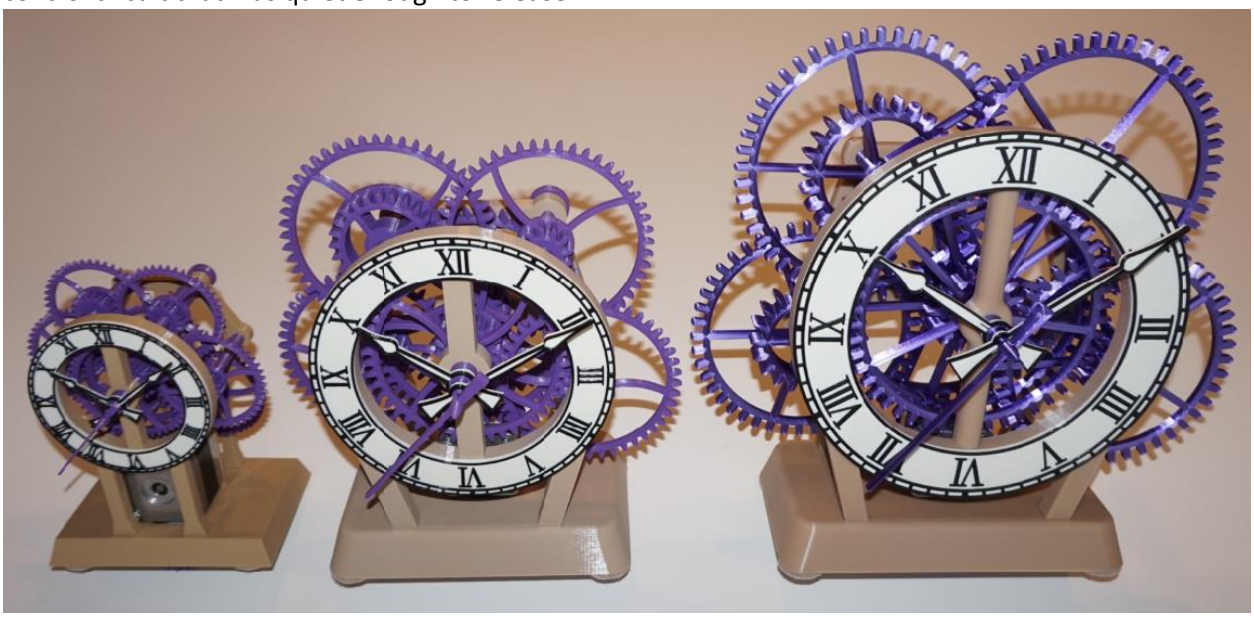

Figure 31 Desk clocks

Here is the clock that started it all. It is posted to https://www.thingiverse.com/thing:3524448

Figure 32 Original Thingiverse design

This is my second clock posted to https://www.myminifactory.com/object/3d-print-137009

Figure 33: Large pendulum clock

A clock posted to https://www.myminifactory.com/object/3d-print-32-day-clock-easy-build-156759 with a runtime up to 32 days between winding. It is one of my easiest clocks to build. Some of the features making it easier to build also make it more efficient so the runtime was increased to 32 days.

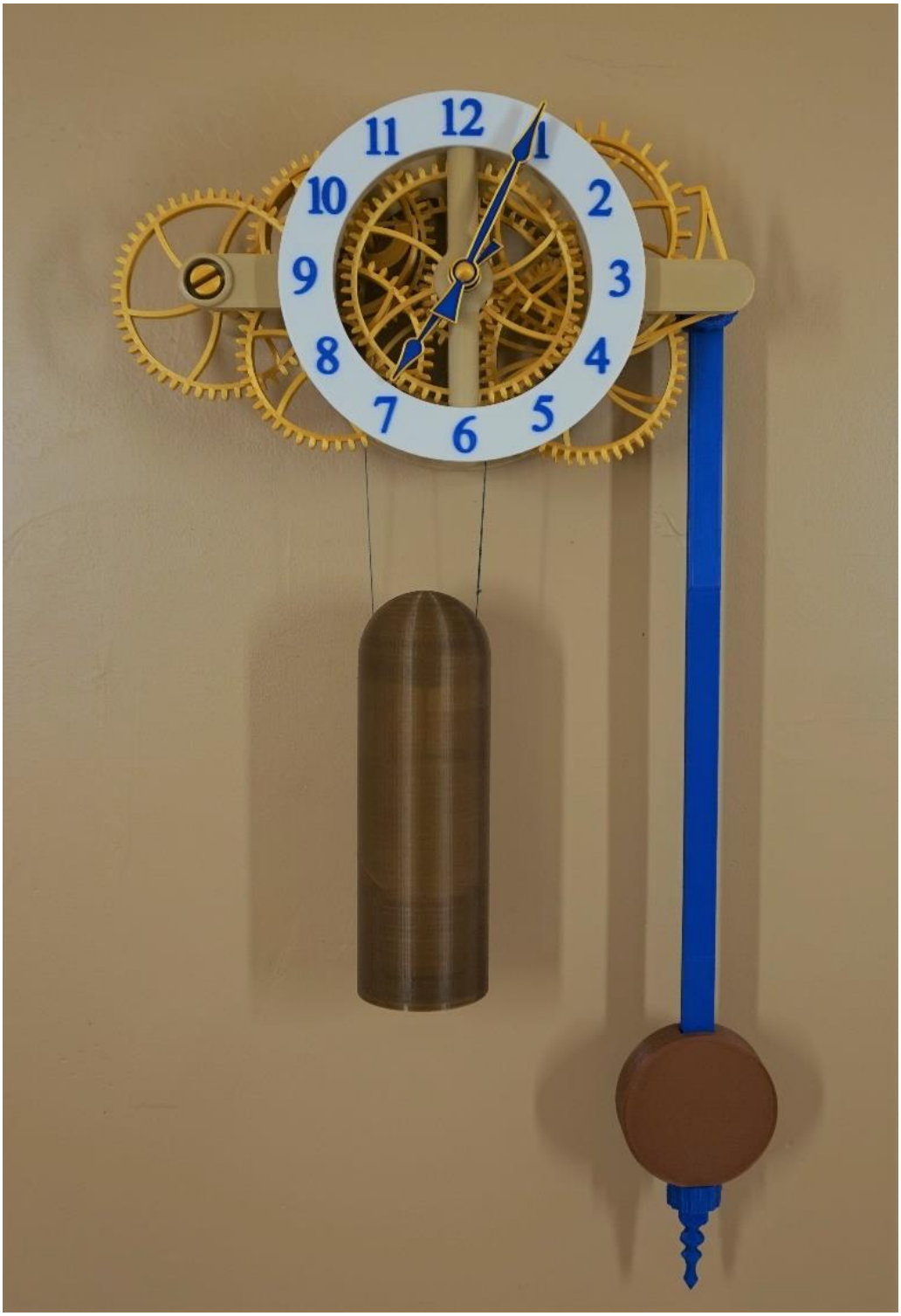

Figure 34: Easy build clock with 32 day runtime