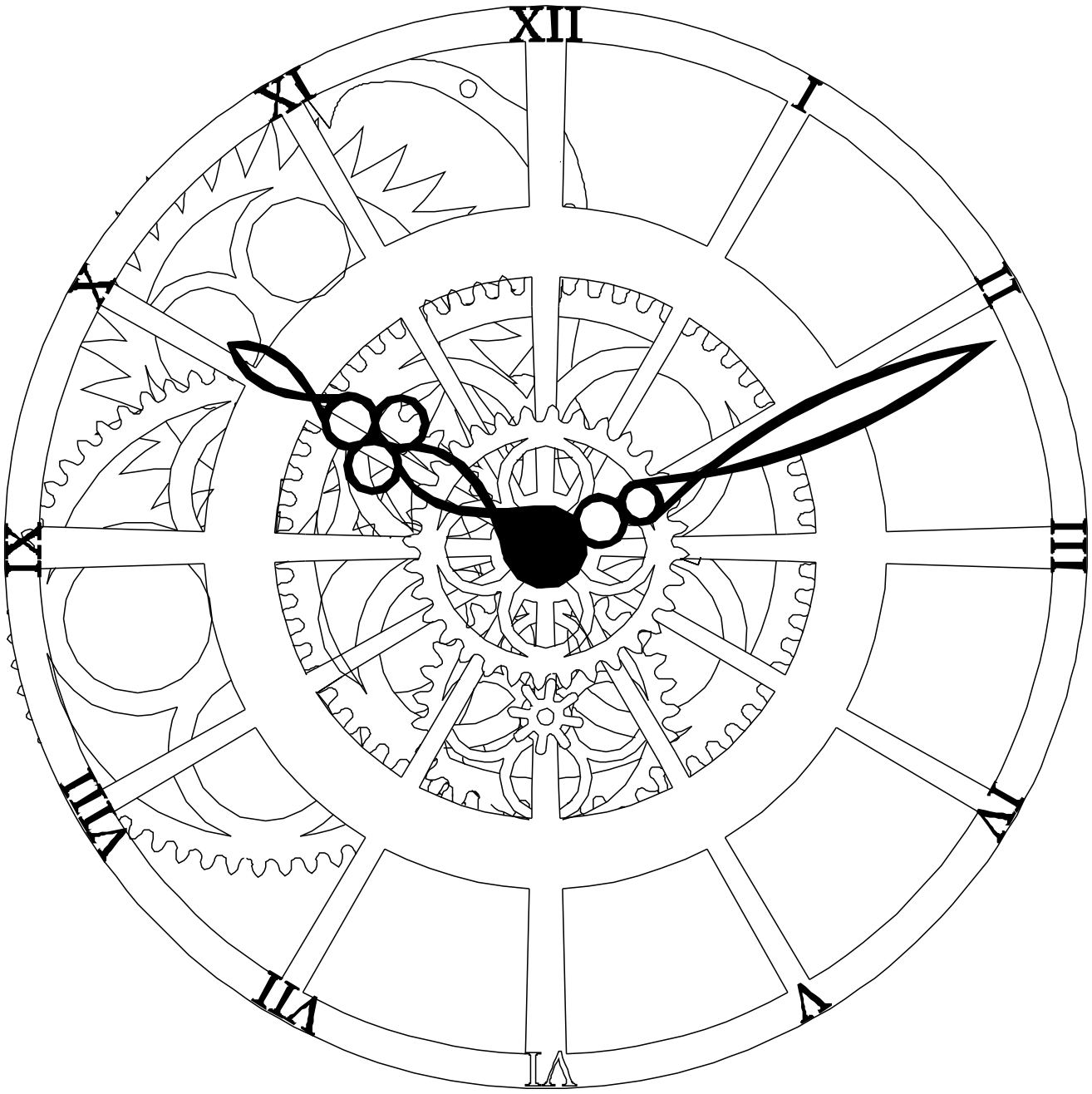
The Legacy Clock



Introduction

For hundreds of years, mechanical clocks have served as functional timekeepers. During that time, clocks have also been treasured for their artistic and aesthetic value. For most clocks, the artistry involves the shape and ornamentation of the clock's exterior case. However, these cases hide the inner beauty of the clock–the clockwork mechanism.

The Legacy clock is a wooden gear clock that is a functional timekeeper with an open frame which exposes its mechanical elements. All the moving parts are clearly visible. Instead of small gears, it features lantern pinion. This design element create visual interest and also simplifies the construction process.

It is nice to see and hear this clock running. However, the most enjoyable part of this clock is the satisfaction gained by assembling the clock yourself, perhaps adding your own creative touches. And, through the process of building the clock, you will gain an understanding of the principles that govern how a clock works.

We truly hope you enjoy building your clock. Please contact us if there is any way that we can help you with your clockmaking project.

Tools and Supplies

The following items will be necessary to build your clock:

- Phillips screwdriver
- small slot screwdriver
- knife
- hammer
- clamps (small spring clamps work well)
- 3 - 4 lbs of metal shot (available from sporting goods or firearms stores)
- wood glue
- CA glue (superglue)
- sandpaper (150 grit, 220 grit, 400 and 600 grit suggested)
- pencil
- toothpicks

Safety

It is your responsibility to use the proper tools and techniques to accomplish this project, including consulting all owner manuals and label directions for any tools or products used.

This package contains small parts, and should be kept away from young children.

Assembly Tips

1) To remove precut parts from the original board, carefully bend the parts back and forth to break the small sliver of wood that is holding them in place. If necessary, use a knife to free any pieces that were not completely scored by the laser. Remove the parts as needed rather than removing them all at once.

2) You may stain your clock if desired. The assembly instructions include suggestions for which parts should be stained and when they should be stained.

3) Some components require gluing. Glued parts should be clamped while the glue cures.

4) Follow the instructions in order. Carefully complete one step before moving on to the next.

5) For the laser-cut parts: some of the parts might benefit from some light sanding, especially at the breakaway points where the pieces were attached to the original board. Do not sand the mating surfaces of the gear teeth. The back sides of some pieces may show residue from the laser cutting operation. A light sanding will remove this residue, although for nearly all parts this is not necessary because the residue will not be visible once the clock is assembled. If desired, the edges of the non-gear pieces can be sanded to remove the residue left by the laser. The assembly instructions indicate at what point the various pieces should be sanded.

6) Some of the parts fit together tightly. It may be necessary to gently tap them together with a hammer. (Plywood thicknesses can vary slightly. If the fit seems too tight, some light sanding may be necessary to insure a proper fit).

7) Once the clock is assembled and mounted, some adjustments will likely be required to get your clock running properly. Follow the suggestions found in the *Regulating and Adjusting* and the *Troubleshooting* sections of the instructions.

8) Take your time and enjoy the process! Please do not hesitate to contact us if you have any questions during assembly.

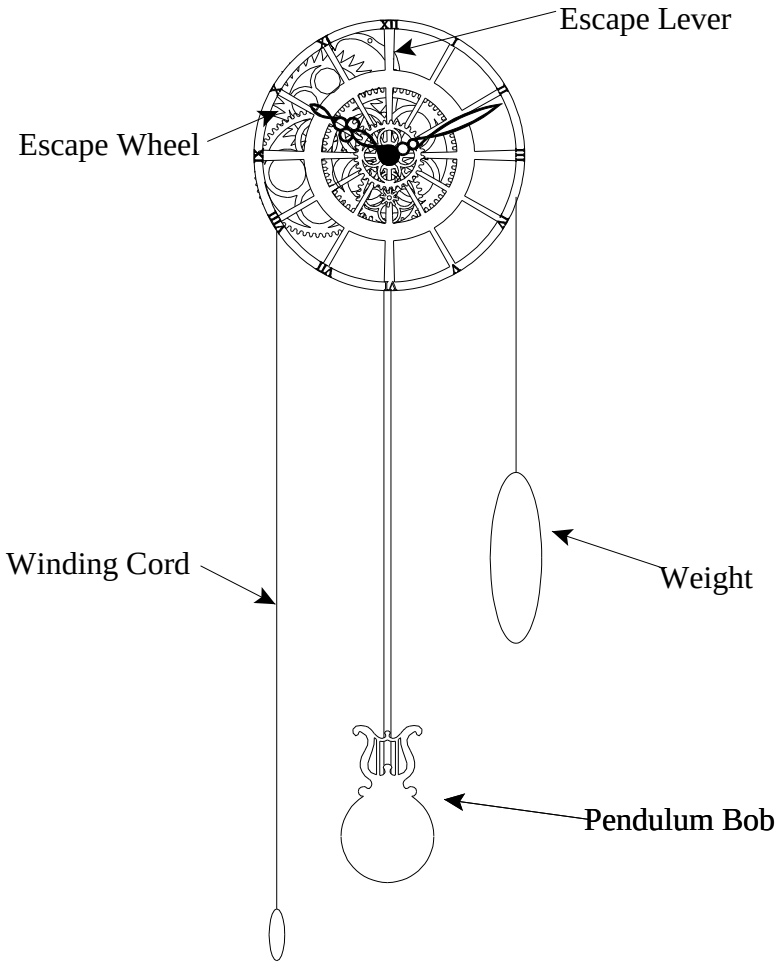
How the Legacy Clock Works

It will be helpful to have an understanding of how the Legacy clock works. This insight will be especially beneficial if troubleshooting is necessary.

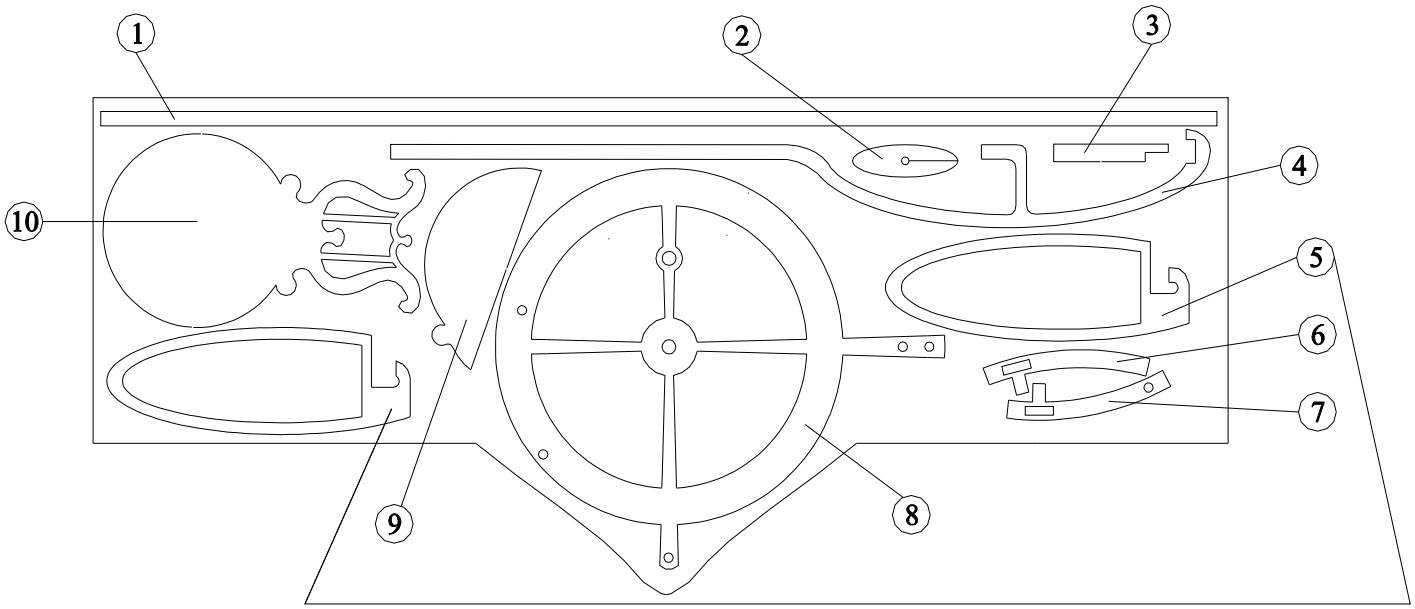
The Legacy clock is driven by weight. The weight is hung from a cord that is wound around a spool on the great wheel arbor (shaft). The weight unwinds the cord from the spool, causing the arbor to rotate. The gears that are attached to this arbor mesh with a train of other gears, which causes these gears to rotate. The clock is wound by pulling down on the winding the cord to wind the weight cord back around the arbor.

The speed at which the weight is allowed to rotate the gear train is regulated by the pendulum. As the pendulum swings back and forth, it causes the escape lever to rock back and forth along with the pendulum. The escape lever alternately stops and then releases one of the gears in the train (called the escape wheel). These contacts with the escape lever and the escape wheel teeth generate the "tick-tock" sound of the clock.

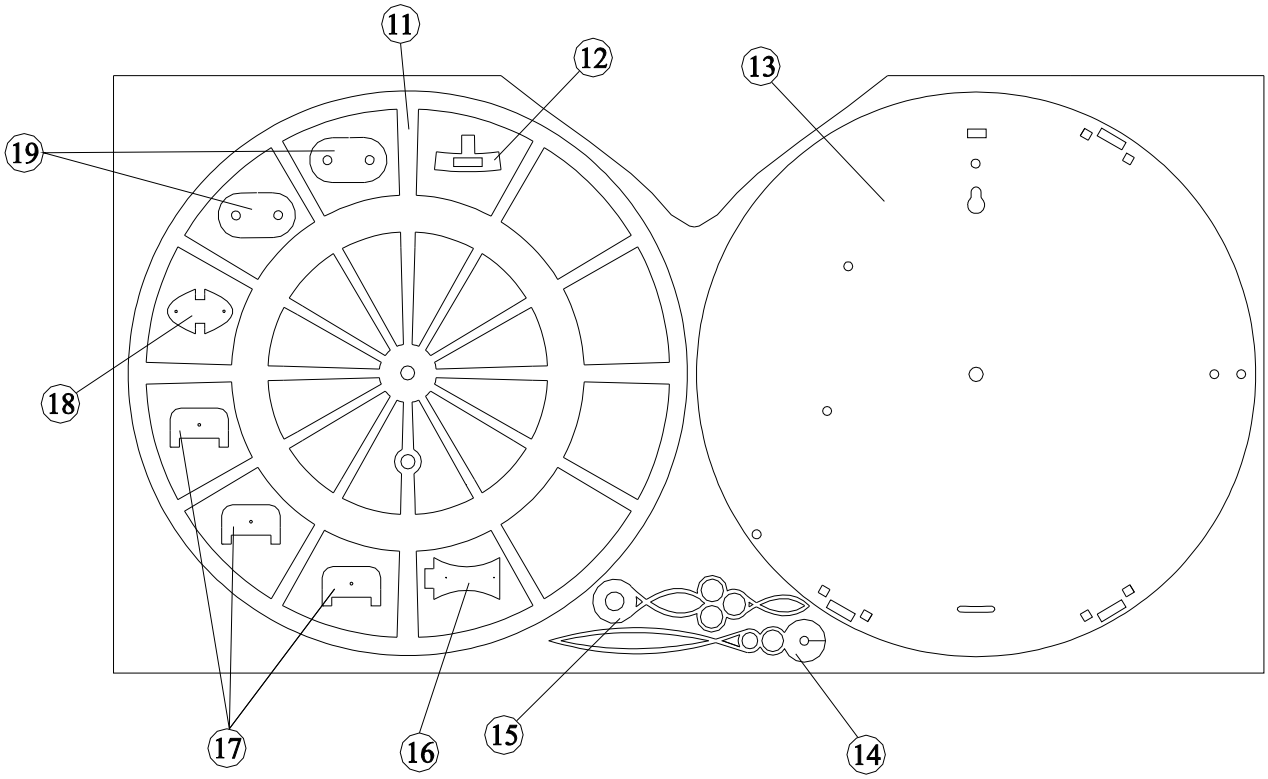
The faster the pendulum moves back and forth, the faster the escape wheel (and the entire gear train) will be allowed to advance. The pendulum swing period is determined by its length (or, more precisely, the length from its pivot point to its center of gravity). Increasing the pendulum length increases the time it takes the pendulum to complete its swing. This makes the clock run slower. Decreasing the pendulum length decreases the time it takes the pendulum to complete its swing, making the clock run faster. Therefore, adjusting the position of the pendulum bob along the pendulum shaft controls whether the clock runs fast or slow and provides a means by which the clock can be made to run "on time."



Part List

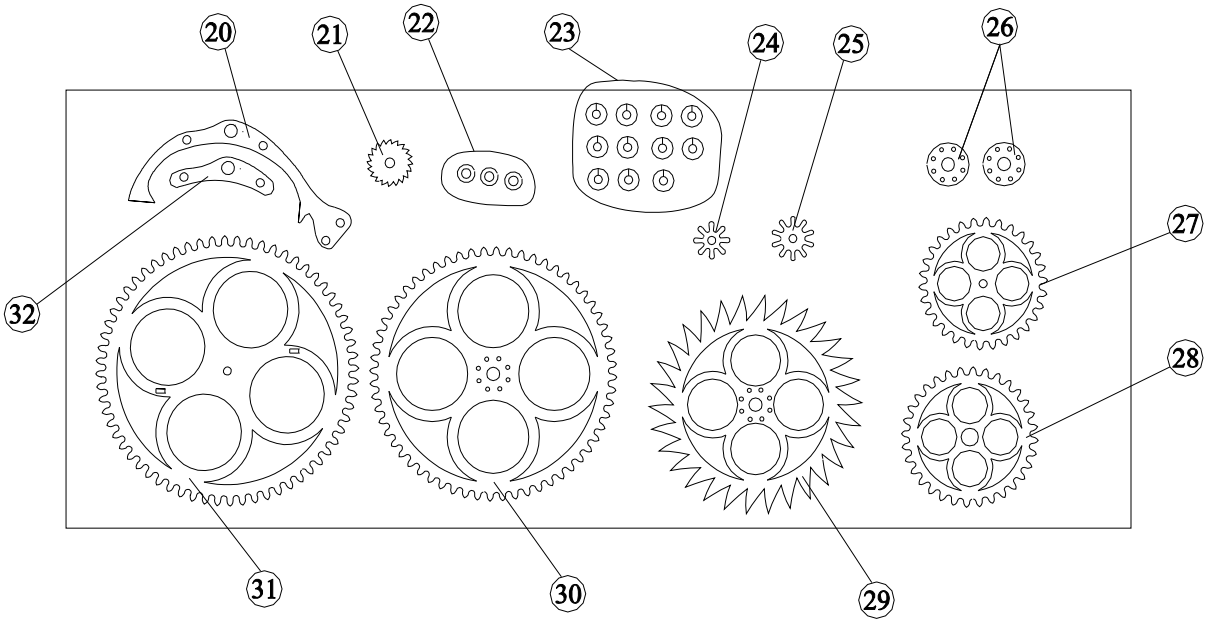


1. Pendulum shaft bottom
2. Winding pull middle
3. Pendulum clamp
4. Pendulum shaft top
5. Weight shell hook pieces [2]
6. Lower right pillar seat
7. Lower left pillar seat
8. Dial backer
9. Pendulum bob rear piece B
10. Pendulum bob front

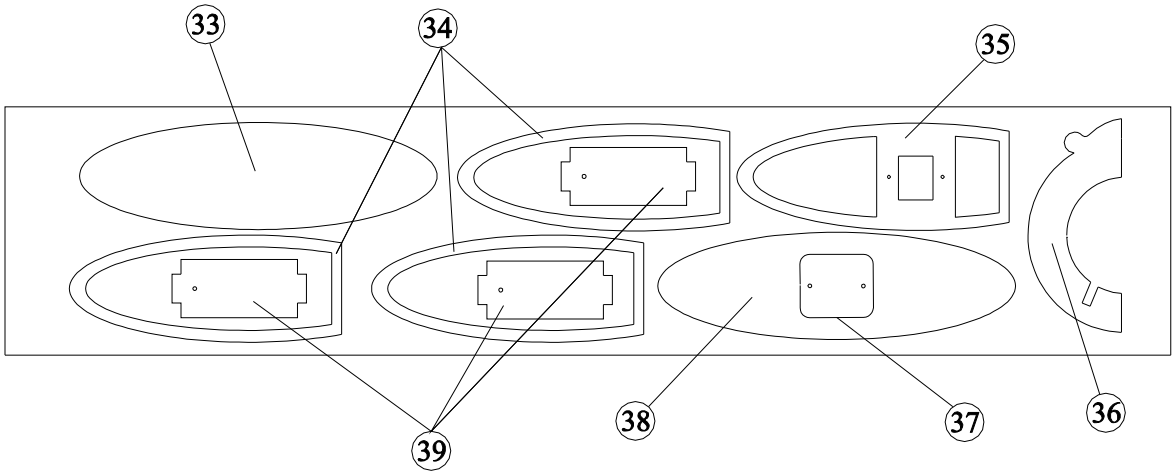


11. Dial
12. Upper right pillar seat
13. Back
14. Minute hand
15. Hour hand
16. Pendulum support plate
17. Pillar anchors [3]
18. Pendulum bracket
19. Weight pulley sides [2]

Part List (continued)



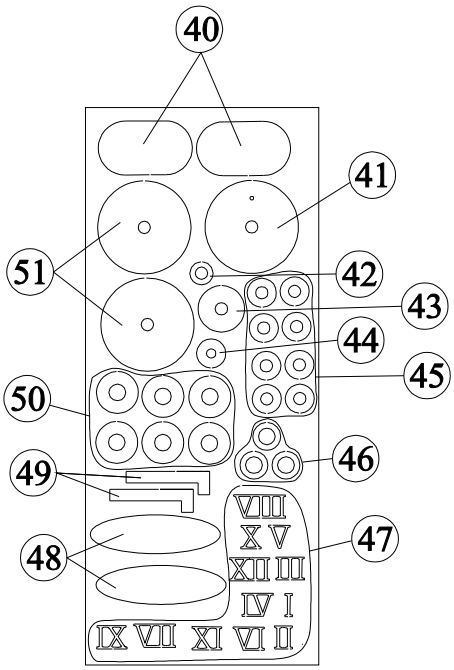
20. Escape lever/crutch
21. Rachet
22. Hour pipe sections [3]
23. Set washers [11]
24. 8-tooth gear
25. 10-tooth gear
26. Pinion hubs [2]
27. 30-tooth gear
28. 32-tooth gear
29. Escape wheel
30. 60-tooth mid wheel
31. 64-tooth great wheel
32. Escape lever extension bar



33. Weight shell front face
34. Weight shell inner pieces [3]
35. Weight shell rear piece
36. Pendulum bob rear piece A
37. Weight shell cover plate
38. Weight shell rear face
39. Pillars [3]

Part List (continued)

40. Weight pulley side covers [2]
41. Weight spool divider
42. Winding spool hub
43. Weight spool hub
44. Mounting washer
45. Spacer washers [8]
46. Pulley wheel hubs [3]
47. Roman numerals
48. Winding pull sides [2]
49. Pawl [2]
50. Pulley wheel sides [6]
51. Outer spool sides [2]



1/4" Diameter Dowels

3 3/4" Escape lever arbor
3 3/4" Escape wheel arbor
3 3/4" Mid wheel arbor
3 3/4" Winding guide arbor
3 3/4" Weight guide arbor
3 3/4" Weight tie-off rod
5 5/8" Great wheel arbor
1 1/2" Minute wheel arbor
1" Crutch forks [2]
1" Pulley posts [2]
1" Escape lever connectors [2]

1/8" Diameter Dowels

1 ½" Pinion rods [16]

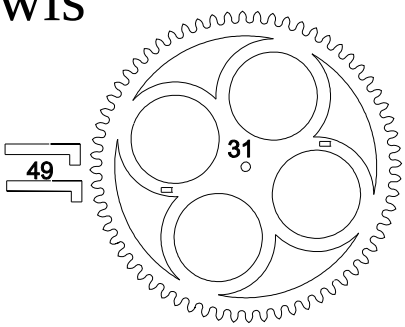
Hardware and Miscellaneous

Nylon shoulder washers [16]
19' braided cord
#4 x ½" screws [7]
#8 x 1 5/8" screws [2]

Great Wheel Pawls

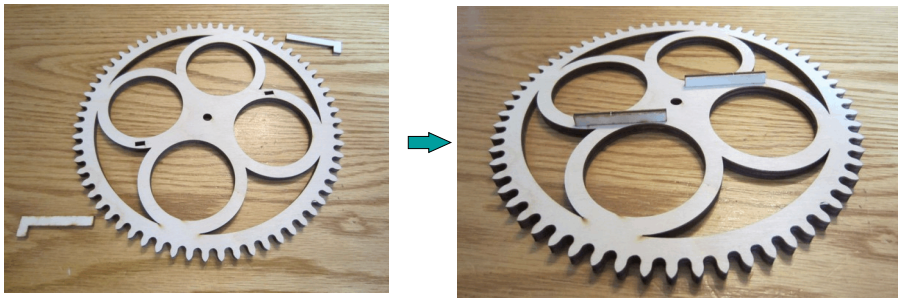
Parts

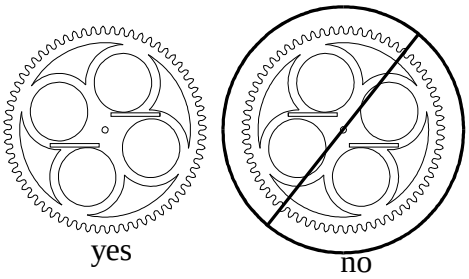
2 - Pawls (#49)
1 - 64 tooth great wheel (#31)



Assembly Procedure

Glue the short tabs of the two pawls into the two slots in the great wheel gear spokes. **Make sure they are oriented as shown in the photo and diagram below.** Glue only the tabs into the slots; do not glue the long edge of the pawl to the gear.

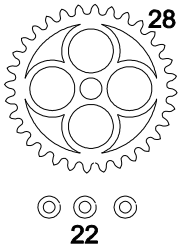




Hour Pipe

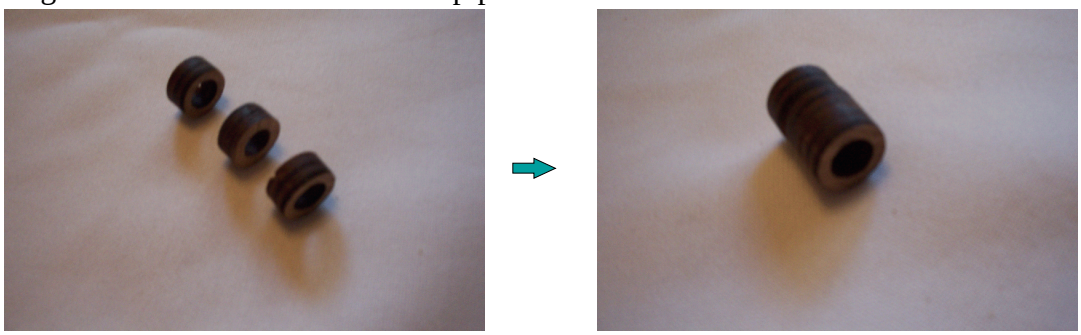
Parts

3 - Hour pipe sections (#22)
1 - 32 tooth gear (#28)

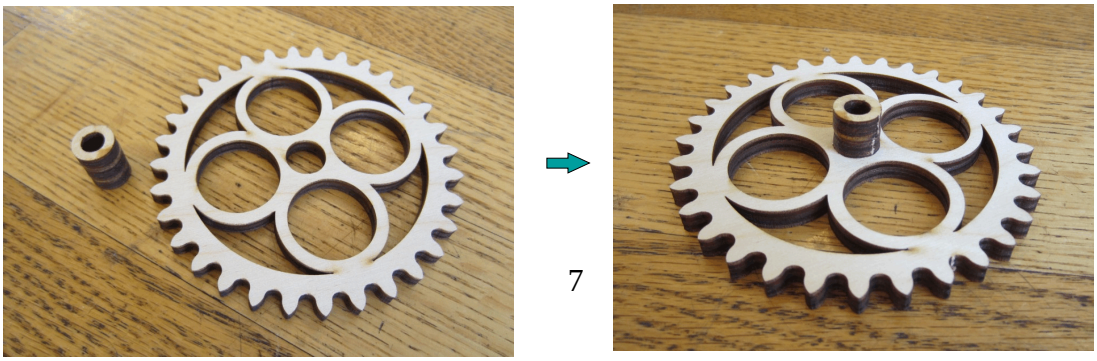


Assembly Procedure

1) Glue together the three hour pipe sections. Use a drill bit or a piece of 1/4" dowel to clear any excess glue from the inside of the hour pipe.

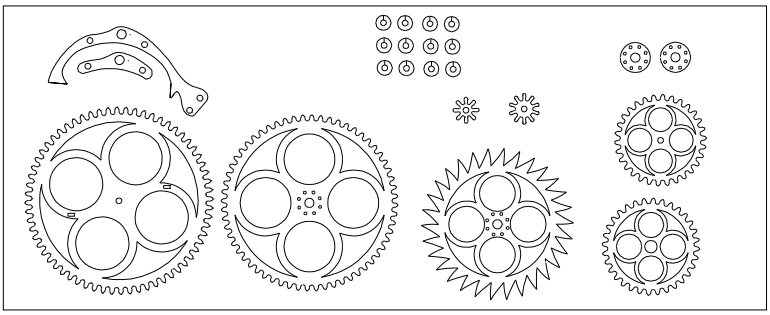


2) After the hour pipe glue is completely cured, apply glue to the inside of the central hole in the 32-tooth gear. Press or gently hammer the hour pipe into the 32-tooth gear.



Gear Staining

Any desired staining should be completed on all gears and set washers (see diagram below) before installing the gears on the arbors.



Do not use a varnish or polyurethane finish on gears, escape lever/crutch, or 1/8" diameter dowels (pinion rods). Do not attempt to sand the laser browning off the edges of the gear teeth (this could distort the shape of the gear teeth).

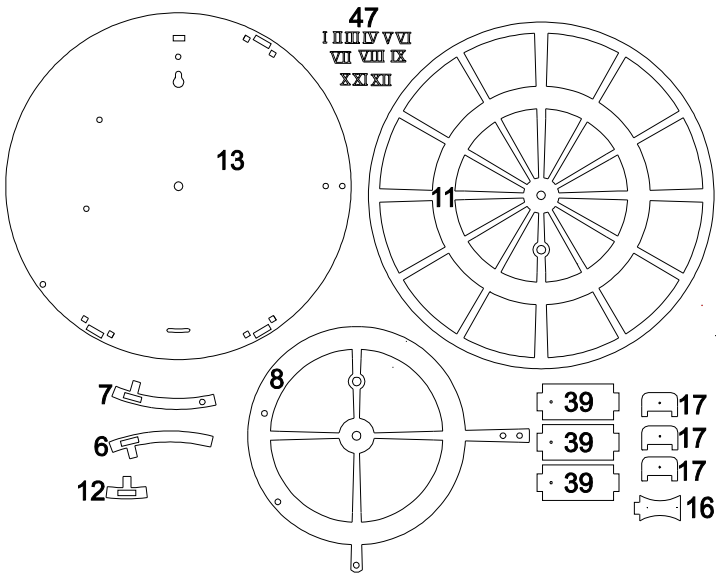
One method of staining is to dip the gears in a pan of stain and blot off the excess stain. Be sure to follow manufacturer's instructions, particularly with regard to safe disposal of oily rags.

We suggest using a contrasting colors for the gears and the frame. Also, the hands and numerals should be finished in a color that contrasts with the dial.

Frame Assembly

Parts

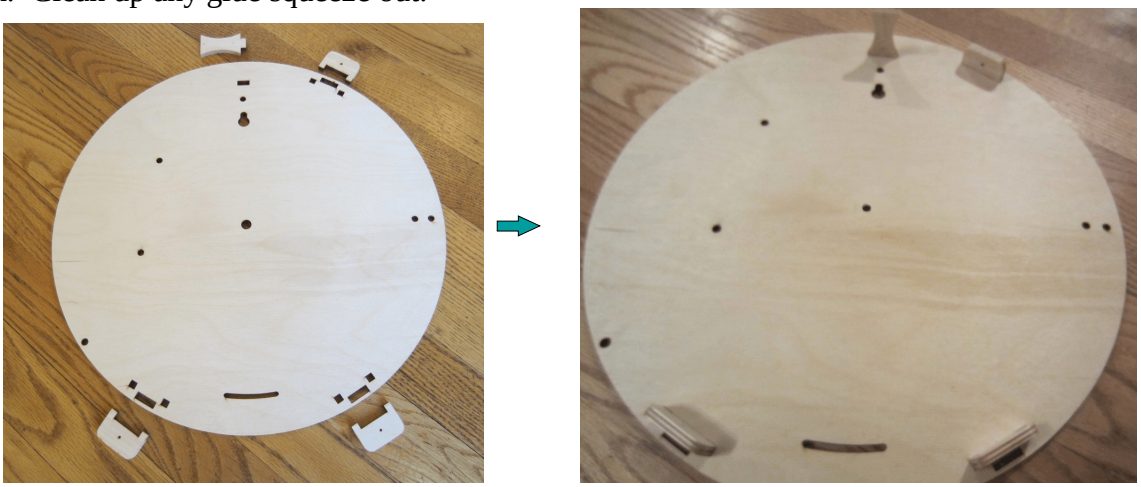
1 - Back (#13)
1 - Dial (#11)
1 - Dial backer (#8)
1 - Lower left pillar seat (#7)
1 - Lower right pillar seat (#6)
1 - Upper right pillar seat (#12)
3 - Pillars (#39)
3 - Pillar anchors (#17)
1 - Pendulum support plate (#16)
12 - Roman numerals (#47)
4 - Nylon shoulder washers



Assembly Procedure

1) If desired, sand the perimeter of the back. If desired, sand the edges of the three pillar anchors, but do not sand the edges of the rectangular tabs that protrude from the bottom of these pieces. If desired, sand the edges of the pendulum support plate, but do not sand the edges of the rectangular tab.

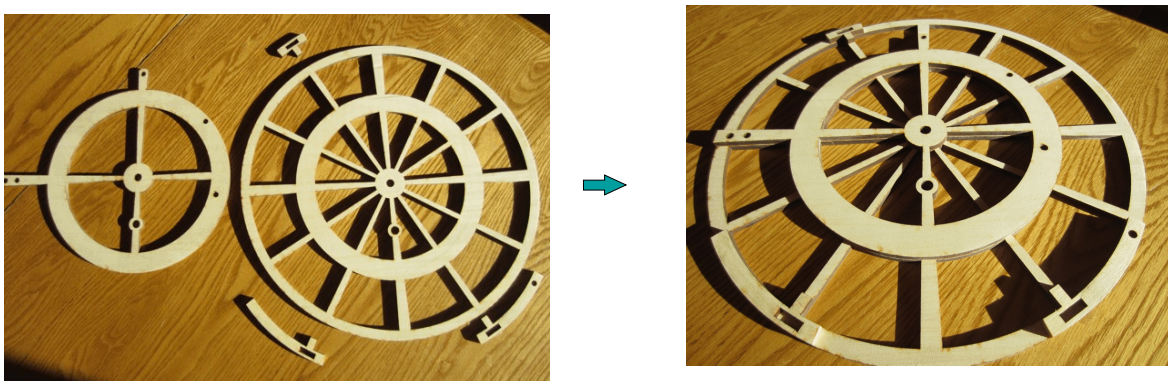
2) Lay the back on a table with the hole pattern oriented as shown below. Glue the three pillar anchors into the corresponding locations on the back. Be sure they seat down completely; tap down with a hammer if necessary. Also glue the pendulum support plate into the rectangular hole at the top of the back. Clean up any glue squeeze out.



3) Apply finish to the back unit as desired.

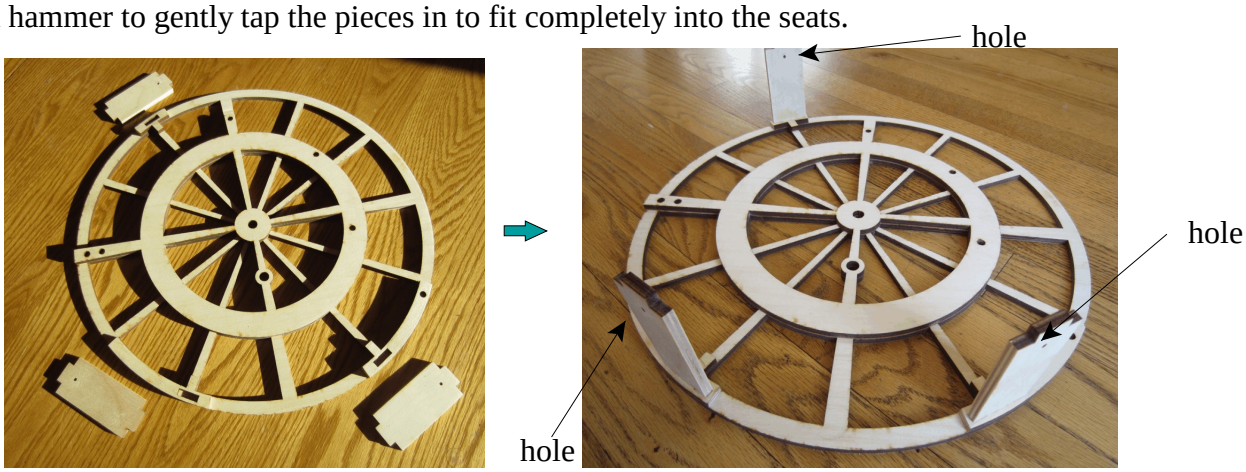
4) Do any desired sanding on the two faces of the dial.

5) Lay the dial on a table with the most attractive side down. Glue the dial backer to the dial. Make sure the dial and dial backer are oriented as shown below. Carefully line up all corresponding edges. Glue the upper right pillar seat, the lower left pillar seat, and the lower right pillar seat to the dial in the locations and orientations as shown below (note that the lower left pillar seat has a hole in it but not the right pillar seat). Make sure matching edges are lined up.



6) If desired, sand the outer edge of the dial. If desired, sand the long edges of the pillars

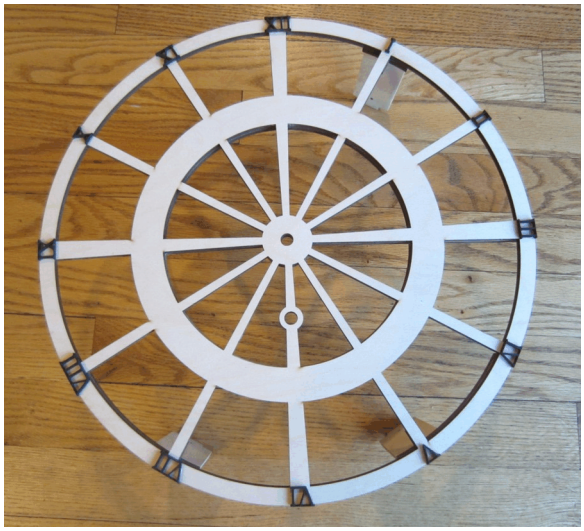
7) Glue the three pillars into the corresponding slots in the pillar seats <u>with the hole in each pillar up.</u> Use a hammer to gently tap the pieces in to fit completely into the seats.



8) If you plan to stain the dial, do so now. If you plan to apply a clear finish, then wait to apply the finish.

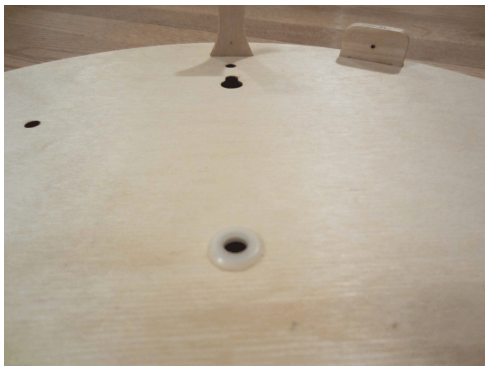
9) Stain or paint the roman numerals, leaving the backside of the numerals unfinished for better glue adhesion.

10) Glue the roman numerals onto the front of dial as shown below (note that the number VI spoke is the one with the circle in it; also note that the bottoms of the numerals face the inside of the dial). The gluing is most easily done by using a toothpick to apply a small amount of glue to the back of the numerals and then pressing them into place on the dial.



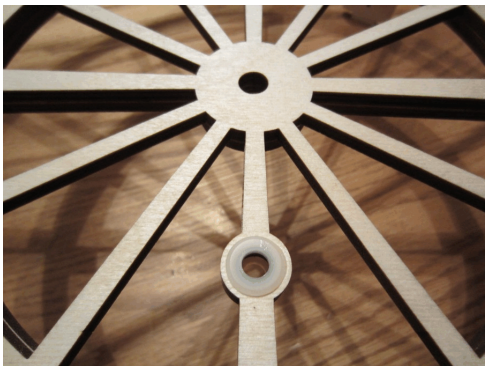
11) If desired, apply a clear finish to the dial unit and back unit. This is most easily done with a spray finish.

12) Apply a small amount of CA glue around the rim of the 3/8" diameter hole in the center of the back. Insert a nylon shoulder washer into that hole. Press it into place so that it seats completely into the hole. If necessary, tap in gently with a hammer.

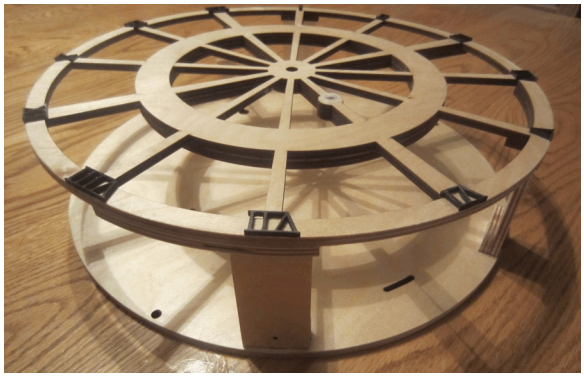


13) Apply a small amount of CA glue around the rims of the two 3/8" diameter holes in the dial backer. Insert a shoulder washer into each of those two holes. Press into place so that they seat completely into the holes. If necessary, tap in gently with a hammer.

14) Flip the dial over. Apply a small amount of CA glue around the rim of the 3/8" diameter hole in the spoke. Insert a shoulder washer into that hole. Press it into place so that it seats completely into the hole. If necessary, tap in gently with a hammer. Do not insert a shoulder washer into the hole in the front, center of the dial.



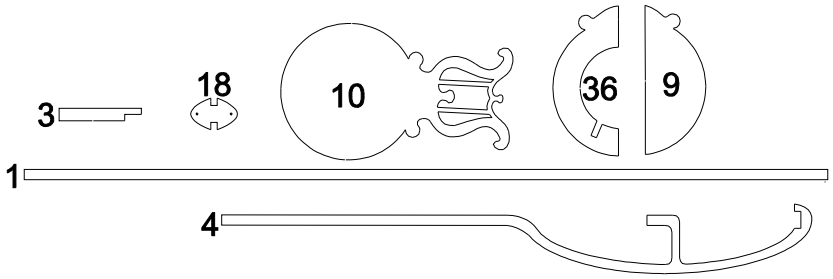
15) Test fit the frame together by lining up and inserting the pillar tabs into the corresponding holes in the back. The fit should allow the pieces to fit together easily. If the fit is too tight, sand the pillar tab to allow the parts to slip together.



Pendulum Assembly

Parts

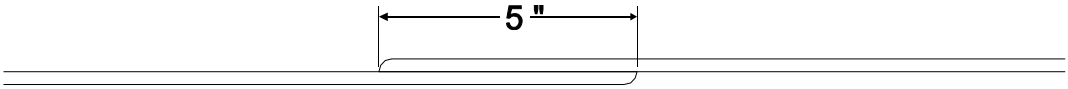
1 - Pendulum shaft top (#4)
1 - Pendulum shaft bottom (#1)
1 - Pendulum bracket (#18)
1 - Pendulum bob front (#10)
1 - Pendulum bob rear A (#36)
1 - Pendulum bob rear B (#9)
1 - Pendulum clamp (#3)
2 - ½" x #4 screws



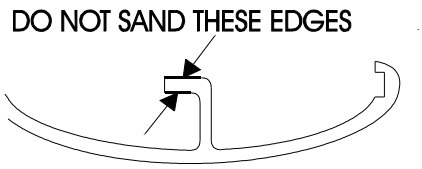
Assembly Procedure

1) If desired, sand a radius on one end (this will be the top end) of the pendulum shaft bottom and the front edge of the lower end of the pendulum shaft top.

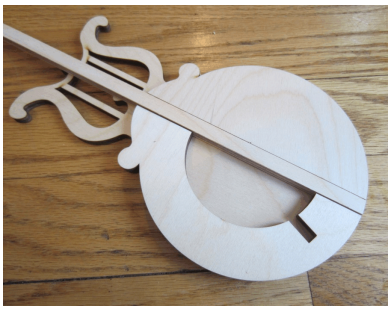
2) Glue the two pendulum shaft pieces together with the radiused end of the pendulum shaft bottom overlapping the bottom end of the pendulum shaft top by 5". Be sure that the pendulum shaft top is on top of the pendulum shaft bottom and that the pendulum shaft top is oriented as shown below.



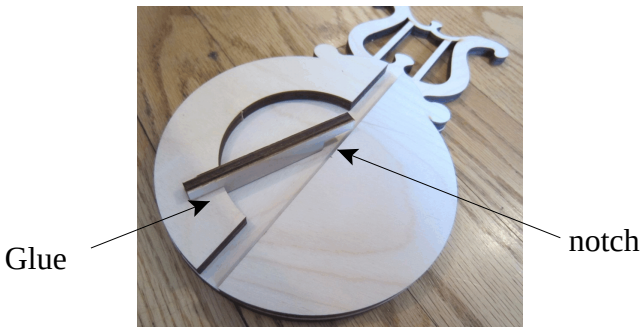
3) After the glue has dried, sand the edges of the pendulum shaft if desired. However, do not sand the portion of the pendulum shown in the diagram below:



4) Lay the pendulum bob front on a table with the most attractive face down. Position the two pendulum bob rear pieces on the pendulum bob front with the pendulum shaft between the rear pieces. Glue the two rear bob pieces to the front bob piece, adjusting their position so that the shaft fits snugly yet is able to slide between the two pieces. *Do not glue the shaft to the bob.*



5) Remove the shaft from the bob. Glue the pendulum clamp into the slot in the back of the pendulum bob with the cutout notch over the channel that runs down the middle of the bob. Glue the clamp only where it fits into the slot in pendulum rear piece A.

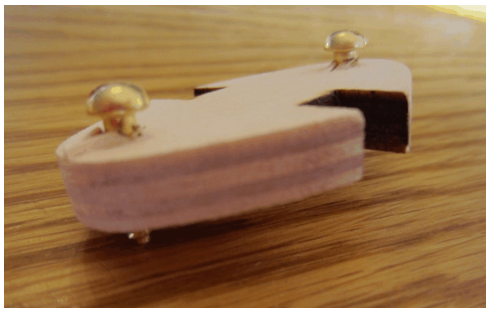


6) Sand the perimeter of the pendulum bob and apply finish as desired.

7) Slide the bottom portion of the pendulum shaft into the slot on the rear of the bob with the crook at the top of the pendulum oriented as shown below. The clamp should hold the shaft in place, yet allow the bob to be repositioned on the shaft as the clamp is flexed away from the shaft.

8) If desired, sand the perimeter of the pendulum bracket.

9) Drive two ½" x #4 screws into the holes in the pendulum bracket. Leave approximately 1/8" between the screw heads and the wood.



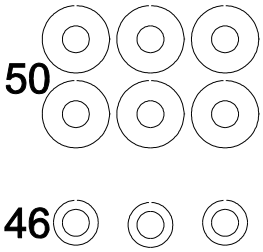
10) Glue the pendulum bracket into the crook at the top of the pendulum shaft top with the tips of the screws pointing toward the long end of the pendulum shaft.

11) Finish the pendulum shaft as desired.

Pulley Wheel Assembly

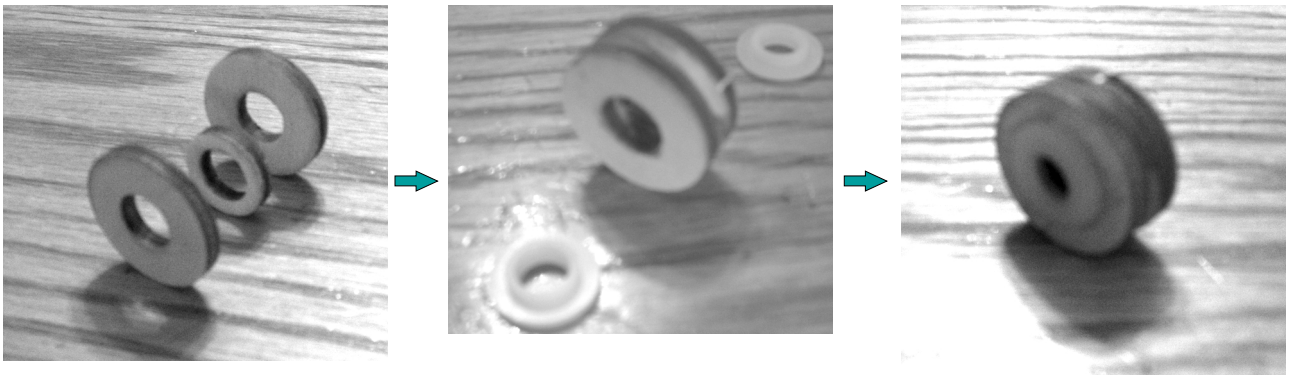
Parts

3 - Pulley wheel hub (#46)
6 - Pulley wheel sides (#50)
6 - Nylon shoulder washers



Assembly Procedure

Glue together the three pulley pieces with the smaller diameter hub sandwiched between the two larger side pieces with all three holes aligned. After the glue has dried, the pulley edges can be sanded and finish applied. Next, apply a small amount of CA glue around the rim of the hole in both pulley faces and insert a nylon shoulder washer. It might be necessary to either press the washer firmly into place or to tap it into place with a hammer. Be sure the washers seat completely into the holes.

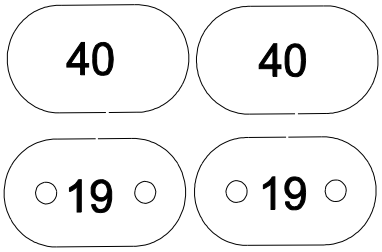


Repeat this procedure to make two more pulley wheels.

Weight Pulley

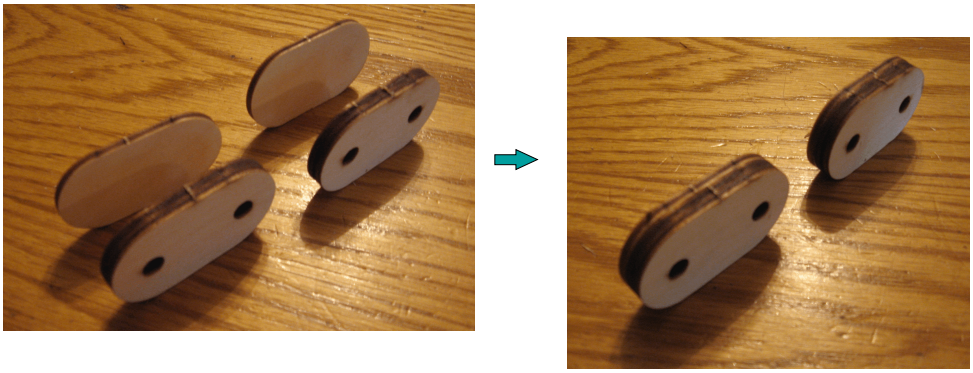
Parts

2 - Weight pulley side covers (#40)
2 - Weight pulley sides (#19)
2 - 1" dowels
1 - Pulley wheel (assembled previously)



Assembly Procedure

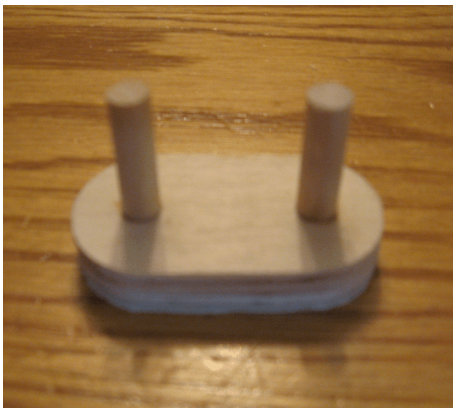
1) Glue the weight pulley sides to the weight pulley side covers, making sure all edges are aligned.



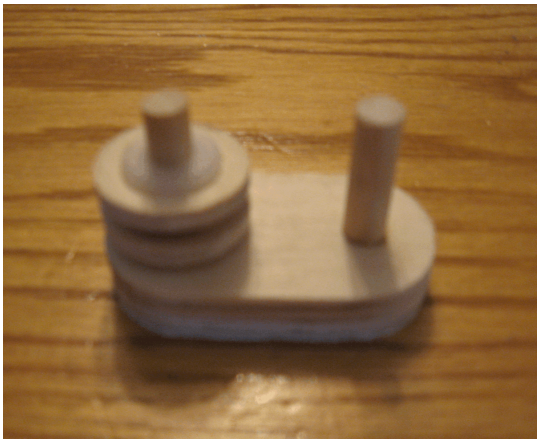
2) Sand the edges of the two weight pulley side units and apply finish as desired.

3) Verify that the pulley wheel freely spins on the center of one of the 1" dowels. Sand the dowel as necessary to allow the pulley wheel to spin.

4) Glue the two 1" dowels into one of the weight pulley sides.



5) Place the weight pulley on the dowel that allows it to spin freely.

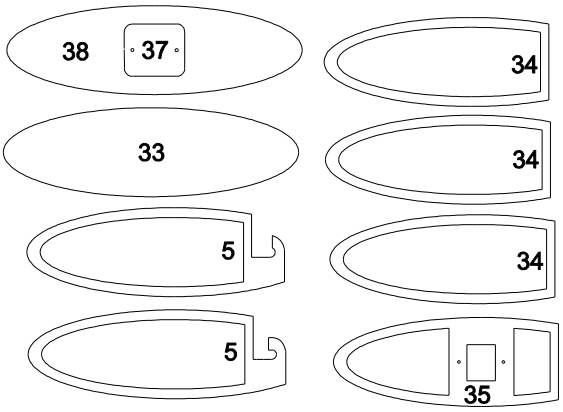


6) Complete the weight pulley unit by gluing dowels into the remaining weight pulley side piece. Do not pinch the pulley wheel between the sides. Verify that the pulley wheel spins freely and adjust as necessary before the glue cures.

Weight Shell Assembly

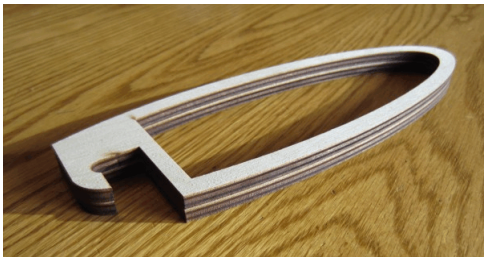
Parts

1 - Weight shell front face (#33)
3 - Weight shell inner pieces (#34)
2 - Weight shell hook pieces (#5)
1 - Weight shell rear piece (#35)
1 - Weight shell rear face (#38)
1 - Weight shell cover plate (#37)
2 - #4 x 1/2" screws
metal shot (approximately 3 lbs)

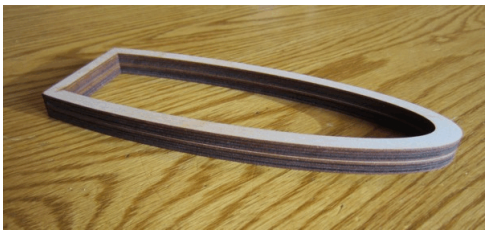


Assembly Procedure

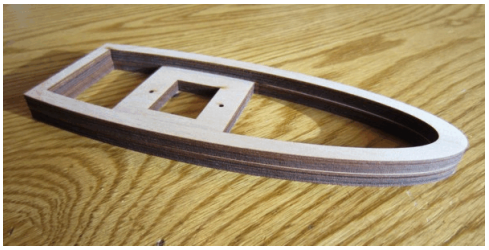
1) Glue together the two weight shell hook pieces, making sure all edges are aligned.



2) Glue together two of the weight shell inner pieces, making sure all edges are aligned.

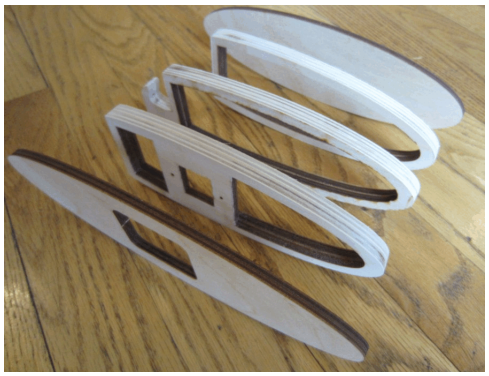


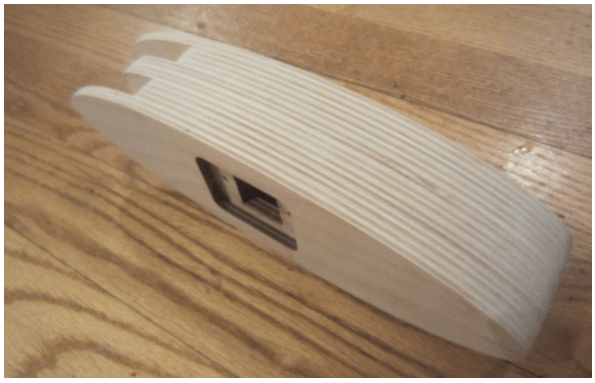
3) Glue together the weight shell rear piece and the remaining weight shell inner piece, making sure the outer edges are aligned.



4) If you plan to sand the outer edges of the weight shell, sand the outer edges of the three weight shell subassemblies completed in the three previous steps.

5) Break the weight shell cover plate away from the weight shell rear face. Glue together the weight shell front face, the weight shell inner piece assembly, the weight shell hook assembly, the weight shell rear assembly and the weight shell rear face in the order shown in the photos below. Note that the weight shell rear piece (#35) glues to the rear face (#38). Make sure that all edges are aligned.

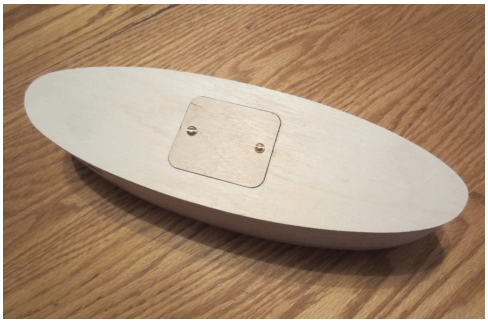




6) If desired, sand the perimeter of the weight shell.

7) Carefully fill the weight shell with metal shot. If using lead, please follow all precautions specified by the product manufacturer, MSDS, or other qualified source. The filled weight shell should weigh between 3 and 4 lbs.

8) Secure the weight shell cover plate to the weight shell with two #4 x 1/2" screws.

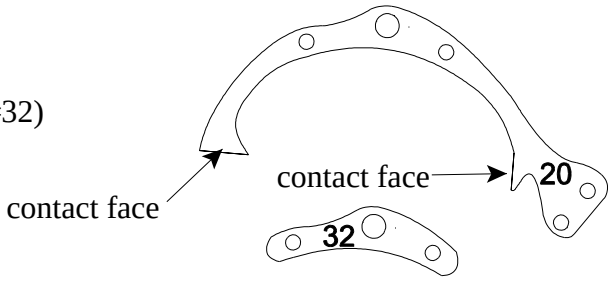


9) Apply finish to the weight shell as desired.

Escape Lever/Crutch Assembly

Parts

1 - Escape lever/crutch (#20)
1 - Escape lever extension bar (#32)
4 - 1" x 1/4" dowels
2 - Nylon shoulder washers

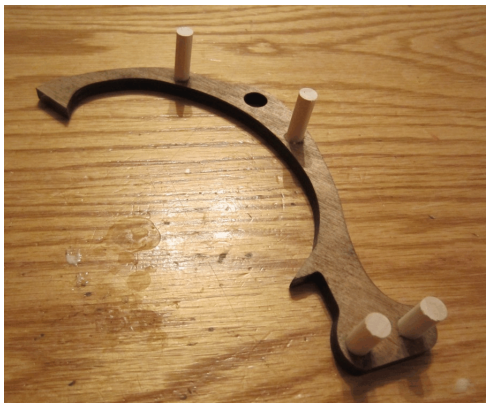


Assembly Procedure

1) The two, flat contact faces (“pallets”) of the escape lever must be smooth. Lay a piece of 220 grit sandpaper on a smooth, hard surface and lightly sand these two faces, making sure not to alter the angle or flatness of the faces. Repeat with 400 and then 600 grit sandpaper. The two contact faces must be flat and slick. Color the contact faces with pencil lead for lubrications

2) Use a toothpick to apply glue to the insides of the two 1/4" diameter holes in the end of the escape lever/crutch. With the escape lever/crutch lying on a table, oriented as shown below, use a hammer to gently tap a 1" dowel into each of the two holes.

3) Use a toothpick to apply glue to the insides of the two remaining 1/4" diameter holes in the escape lever/crutch. Use a hammer to gently tap two 1" dowels into the escape lever/crutch holes.



4) Use a toothpick to apply glue to the insides of the two 1/4" diameter holes in the escape lever extension bar. Use a hammer to gently tap the escape lever extension bar onto the two 1" dowels protruding from the escape lever/crutch, making sure the curves of the extension bar match the curves of the escape lever. While the glue is still soft, insert a dowel through the pair of 3/8" holes. Hold the dowel horizontally so the escapement unit hangs from it. Check that the escape lever/crutch hangs perpendicular to the dowel; adjust the fit as necessary before the glue cures.

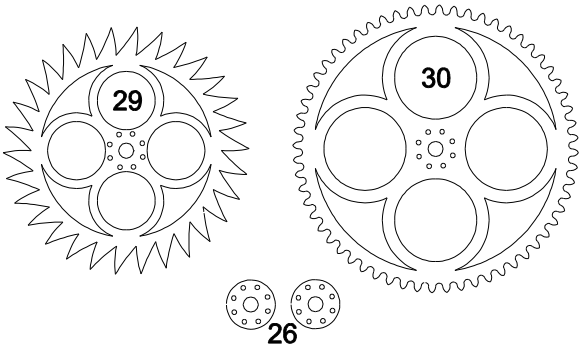
5) Apply a small amount of CA glue around the rim of the 3/8" diameter hole in the escape lever extension bar. Insert a shoulder washer into that hole. Press it into place so that it seats completely into the hole. If necessary, tap in gently with a hammer, but do so only if the dowel glue is completely cured.

6) Flip the escapement unit over and apply a small amount of CA glue around the rim of the 3/8" diameter hole in the escape lever. Insert a shoulder washer into that hole. Press it into place so that it seats completely into the hole. If necessary, tap in gently with a hammer, but do so only if the dowel glue is completely cured.

Gear and Lantern Pinion Assembly

Parts

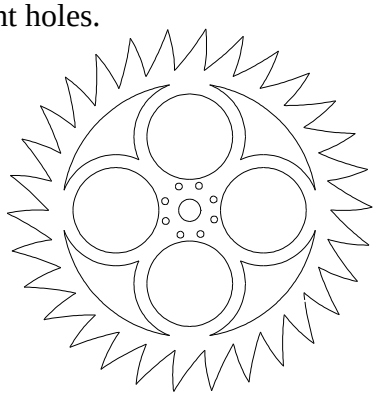
1 -Escape wheel (#29)
2 - Pinion hubs (#26)
1 - 60 tooth mid wheel (#30)
16 - 1 1/2" x 1/8" dowels
4 - Nylon shoulder washers

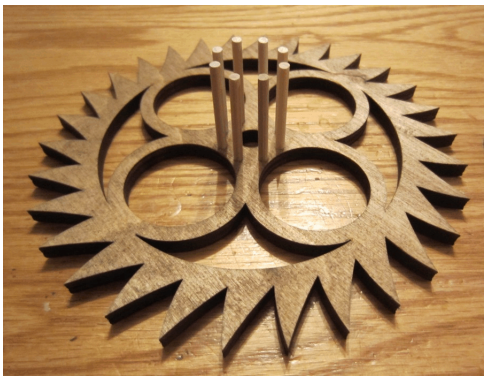


Assembly Procedure

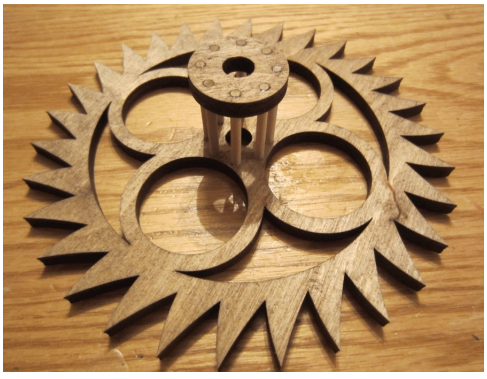
1) Polish the sixteen 1/8" dowels with 400 grit sandpaper so that the sides are smooth and round.

2) Use a toothpick to apply glue to the insides of the eight 1/8" diameter holes in the escape wheel. With the escape wheel teeth oriented as shown below, use a hammer to gently drive eight 1 ½" dowels into these eight holes.

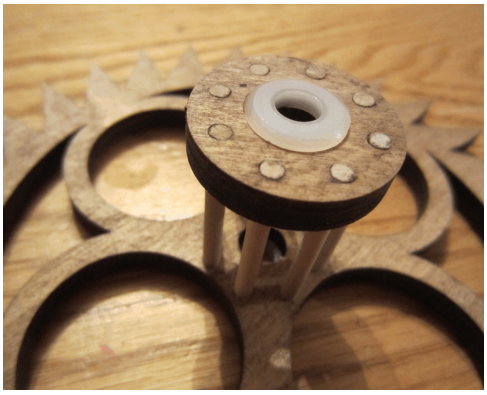




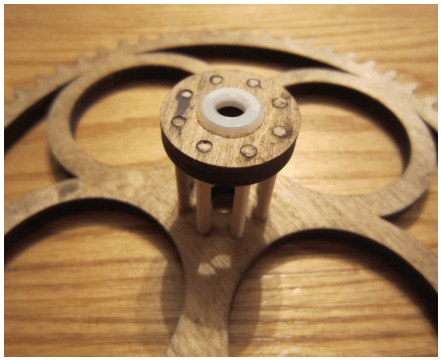
3) Use a toothpick to apply glue to the insides of the eight 1/8" diameter holes in a pinion hub. Use a hammer to gently drive the pinion hub into the 1/8" dowels protruding from the escape wheel. This is most easily accomplished by tipping the pinion hub so that it partially engages with a single dowel and then gradually work around the circle, engaging only a couple of dowels at a time. Drive the dowels in until they are flush with the outer faces of both the escape wheel and pinion hub.



4) Apply a small amount of CA glue around the rim of the 3/8" diameter hole in the center of the pinion hub. Insert a shoulder washer into that hole. Press it into place so that it seats completely into the hole. If necessary, tap in gently with a hammer, but do so only after the pinion glue is completely cured. Flip the unit over and repeat this procedure to mount a nylon shoulder washer into the escape wheel.



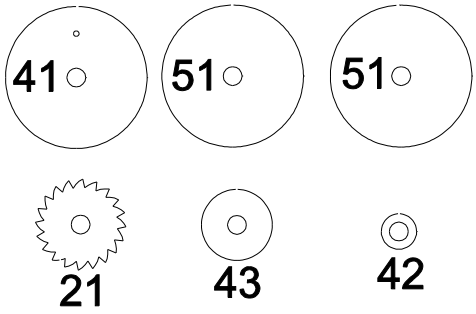
5) Repeat the previous three steps to assemble the pinion rods to the mid wheel and the other pinion hub. Install a nylon shoulder washer in both the mid wheel and the pinion hub.



Weight Spool Assembly

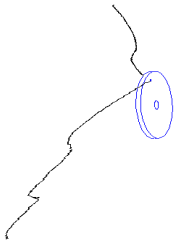
Parts

1 - Rachet (#21)
2 - Outer spool sides (#51)
1 - Weight spool divider (#41)
1 - Weight spool hub (#43)
1 - Winding spool hub (#42)
cord

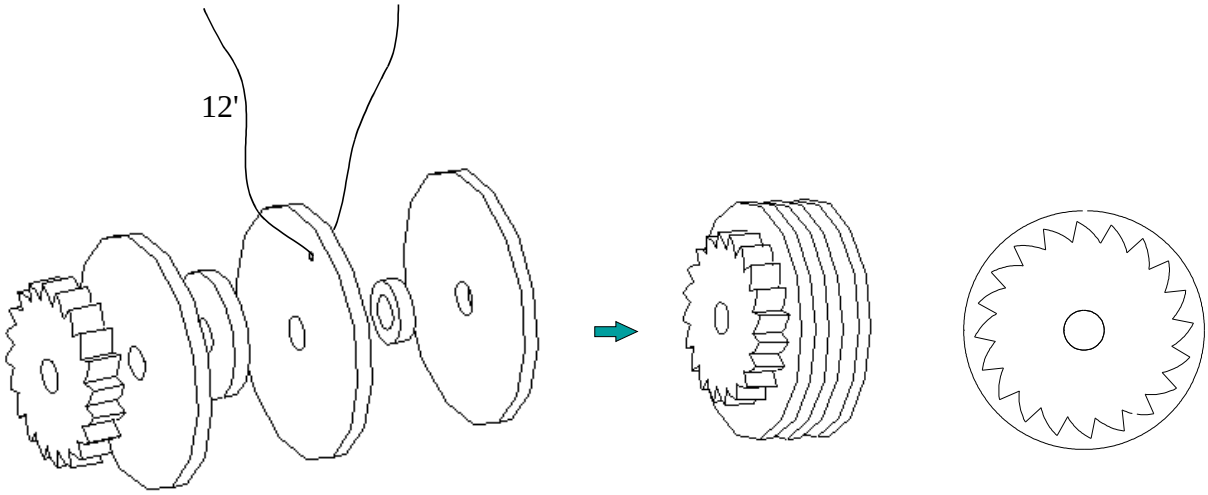


Assembly Procedure

1) Thread the winding cord through the small hole in weight spool divider. Pull a few feet of cord through the hole so that it does not slip back through during spool assembly.



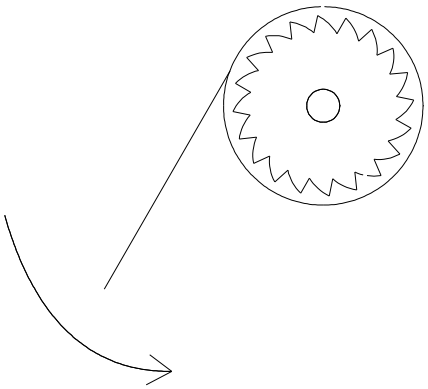
2) Glue the rachet, outer spool sides, spool divider, weight hub, and winding hub together in the order shown below. **Be careful to orient the rachet teeth as shown**. Use a piece of 1/4" dowel or a drill bit to help align the pieces and to clear the center hole of excess glue (remove dowel before glue sets). **It is critical that the glue bond between all of the spool pieces are solid–ensure adequate glue coverage and clamp time**.



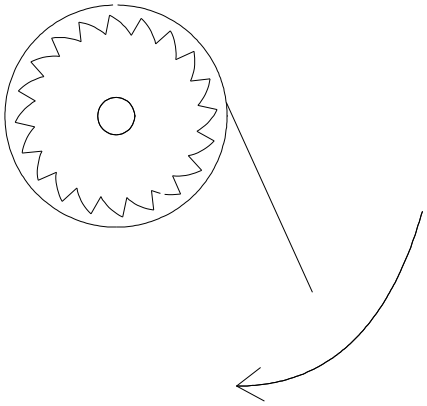
3) Pull the cord through the weight spool divider until there is approximately 12 feet of cord on the rachet side of the weight spool divider.

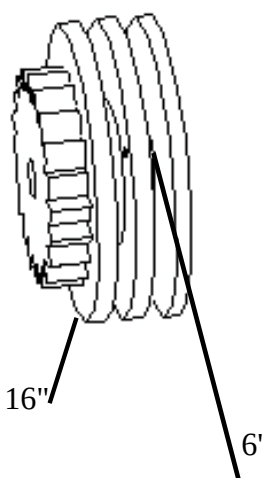
4) If desired, apply finish to the weight spool (the cord can be removed to stain and then reinserted with tweezers or similar tool).

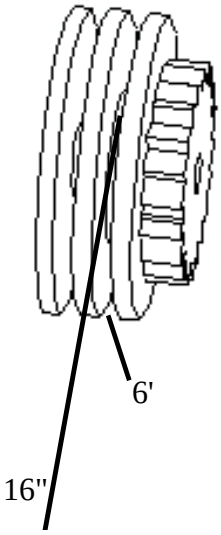
5) Hold the spool so the rachet is facing you (as pictured below) with approximately 12' of cord coming off the rachet side of the weight spool divider. Wrap the cord protruding from the rachet side of the spool around the larger hub in a counter-clockwise direction. Continue winding until about 16" of cord remains.



6) With the rachet in the same position, wind the other length of cord 6 times around the smaller hub in a clockwise direction (about 6 feet of cord will remain).





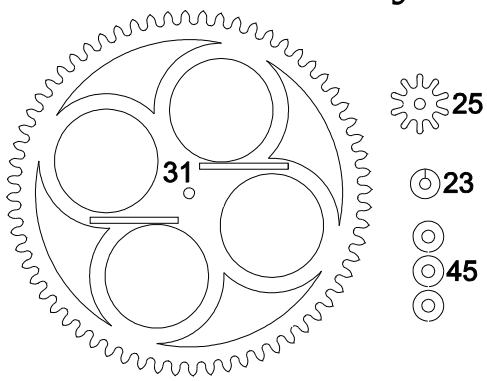


7) Secure the two strings with a piece of tape so they do not come unwound during the upcoming assembly sequence.

Great Wheel Arbor Assembly

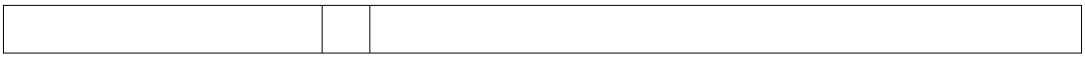
Parts

1 - 64 tooth great wheel (#31)
3 - Spacer washers (#45)
1 - Set washer (#23)
1 - 10 tooth gear (#25
1 - 5 5/8" dowel
1 - Weight spool (assembled previously)

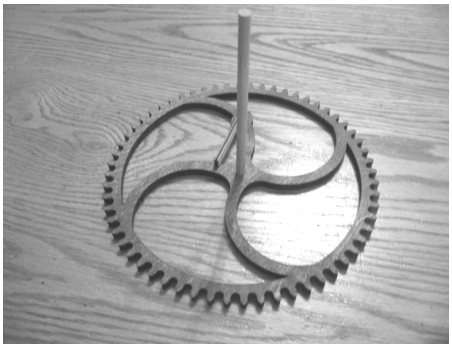


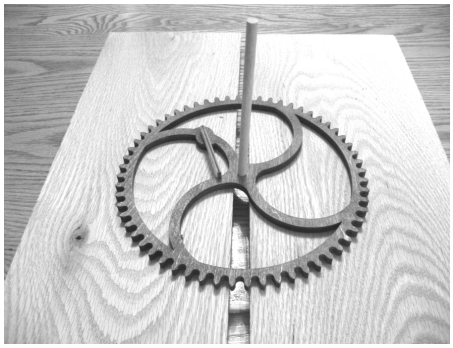
Assembly Procedure

1) Lay the 5 5/8" dowel on the diagram below. Make a mark on the dowel at each of the two locations indicated below.

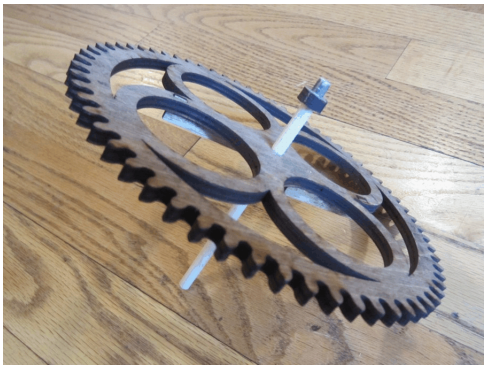


2) Lay the great wheel on a table or solid surface with the pawls on the top side of the gear. Use a hammer to gently drive the arbor into the gear. Be sure to drive the arbor in perpendicular to the gear. Once the arbor is fully engaged in the gear, place the gear on two blocks of wood spaced apart slightly more than the width of a dowel. Continue to drive the arbor through the gear until it arrives between the two marks on the arbor. Use a square or other right angle object to verify that the gear is perpendicular to the arbor and adjust as necessary. **Do not glue the gears in place yet; their positions may need to be adjusted after the clock is assembled!**



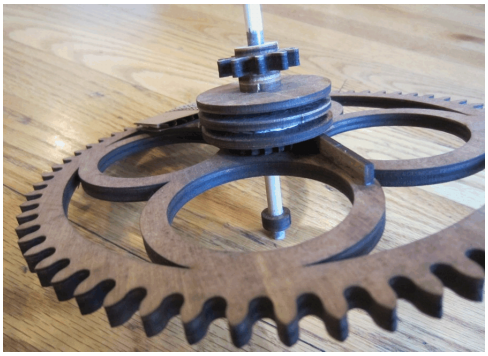


3) On the end of the arbor opposite the pawls, glue a set washer onto the arbor so that 1/4" of the dowel protrudes beyond the set washer.

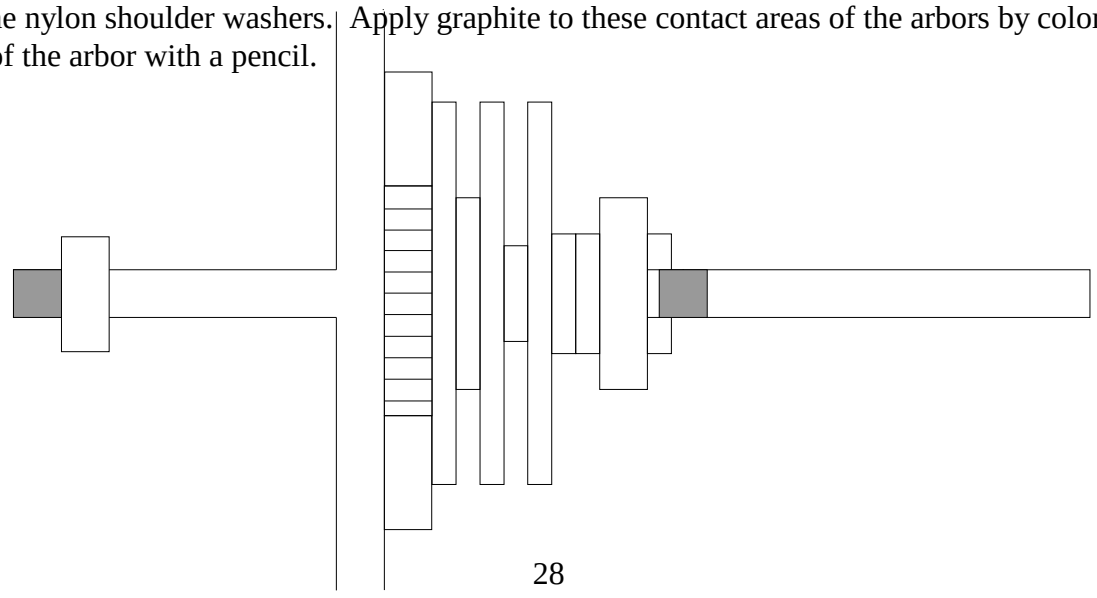


3) Slide the weight spool onto the arbor, rachet side first. Twist the hub so the rachet snaps in between the two pawls.

4) Place two 1/8" thick spacer washers on the arbor adjacent to the weight spool. Place the 10-tooth gear on a solid surface. Use a hammer to gently drive the arbor into the gear. Be sure to drive the arbor in perpendicular to the gear. Once the arbor is fully engaged in the gear, place the gear on two blocks of wood spaced apart slightly more than the width of a dowel. Continue to drive the arbor through the gear until the spacer washers are nearly in contact with the weight spool. Check that the weight spool rotates properly by holding the great wheel firmly and rotating the weight hub counterclockwise, allowing the rachet to slip past the pawls as it rotates (you will hear a click-click-click). Adjust the position of the 10-tooth gear so it is as far on the arbor as possible while still allow the weight spool to rotate counter-clockwise. Add an 1/8" thick spacer washer on the arbor adjacent to the 10-tooth gear.



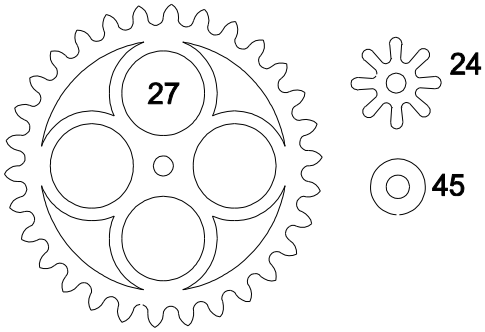
5) Use fine sandpaper to smooth the portions of the arbor that will rest in the frame. These portions of the arbor are indicated with gray shading on the diagram below. This sanding is most easily done by wrapping a small strip of sandpaper around the arbor and twisting the arbor back and forth. Use a sanding sequence of 220, 400, and 600 grit. Check that these portions of the arbor will fit loosely into one of the nylon shoulder washers. Apply graphite to these contact areas of the arbors by coloring that section of the arbor with a pencil.



Minute Arbor Assembly

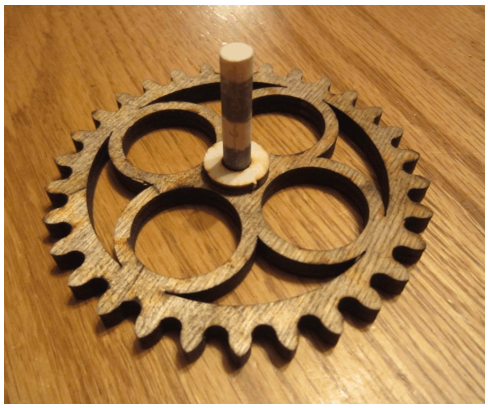
Parts

1 - 30 tooth gear (#27)
1 - Spacer washer (#45)
1 - 8 tooth gear (#24)
1 - 1 1/2" dowel

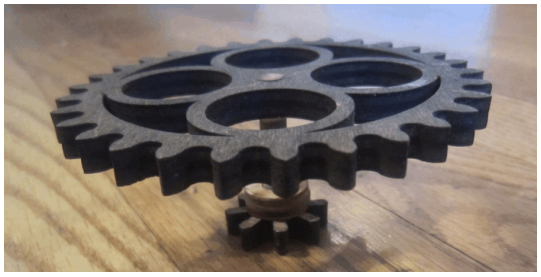


Assembly Procedure

1) Use a toothpick to apply glue to the inside of the small hole in the 30-tooth gear. Lay the 30-tooth gear on a table or solid surface. Use a hammer to gently drive the 1 ½" arbor into the gear. Check that the arbor is perpendicular to the gear and adjust as necessary before the glue cures. Place an 1/8" thick spacer washer on the arbor.

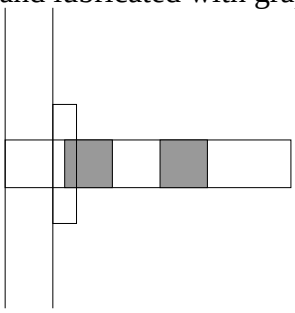


2) Do not apply glue to the 8-tooth gear, but drive the other end of the 1 ½" arbor into the hole in the gear.



Carefully twist and pull on the gear to remove it from the arbor. (This will make it easier to fit the 8-tooth gear on the arbor later in the assembly process.)

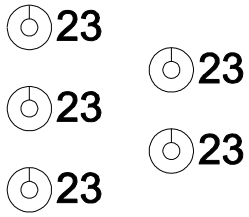
3) As was done with the great wheel arbor, use fine sandpaper (through 600 grit) to smooth the portions of the arbor that will rest in the frame. Color those portions with pencil lead. The portions of the arbor that needs to be polished and lubricated with graphite are indicated by gray shading on the gear location diagram below.



Arbor Preparation

Parts

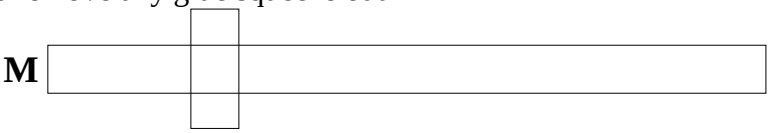
5 - Set washers (#23)
6 - 3 3/4" dowels
2 - Pulley wheels (assembled previously)



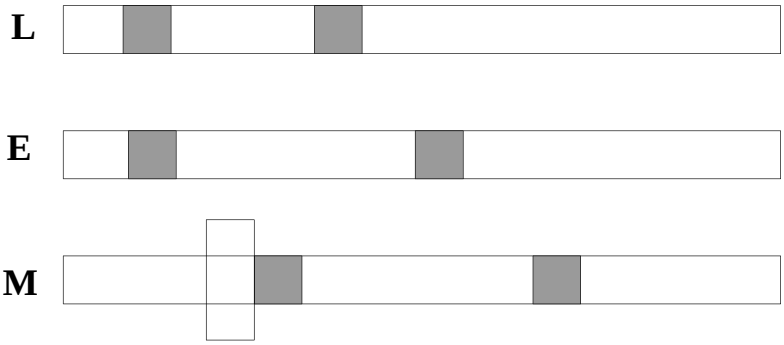
Assembly Procedure

1) Use a pencil to write one a letter (L, E, M, R, T, X) on one end of each of the six 3 3/4" dowels.

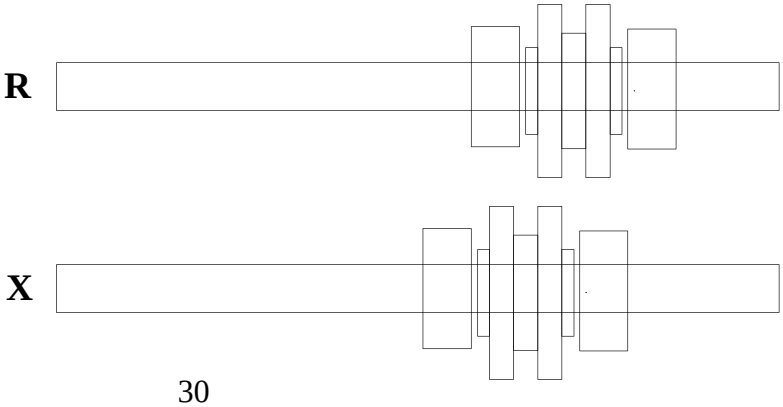
2) On arbor M, mark the location of the set washer as indicated in the diagram below; make sure that the end marked with the letter corresponds with the lettered end in the diagram. Apply a small amount of glue at the this position. Push the set washer onto the arbor and twist it to the marked location. If the washer fit too tightly, repeat the hammering technique that was used to mount the gears on the great wheel. Be sure to remove any glue squeeze out



3) Referring to the arbor diagrams below, use fine sandpaper to smooth the portions of the arbors that are shaded gray. Be sure the marked ends of the dowels correspond with the letters in the diagram. This sanding is most easily done by wrapping a small strip of sandpaper around the arbor and twisting the arbor. Use a sanding sequence of 220, 400, and 600 grit. Check that these portions of the arbor will fit loosely into one of the nylon shoulder washers. Apply graphite to these contact areas of the arbors by coloring those sections of the arbor with a pencil.



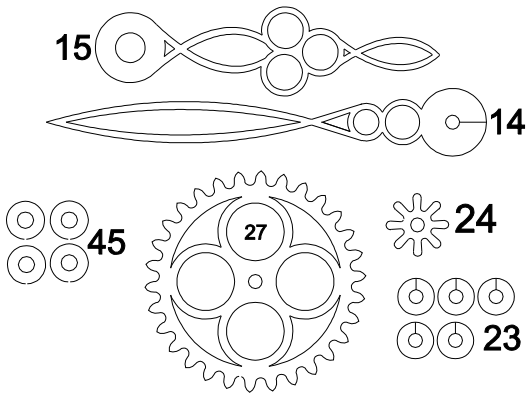
4) On arbor R and arbor X, push one of the set washers onto the arbor until its location matches the diagrams below (do not glue it in place). Slip a pulley wheel onto each of these arbors, in the locations shown in the diagrams, followed by another set washer. Leave a small amount of clearance between the set washers and pulley wheel so that the pulleys are able to spin freely on the arbors.



Final Clock Assembly

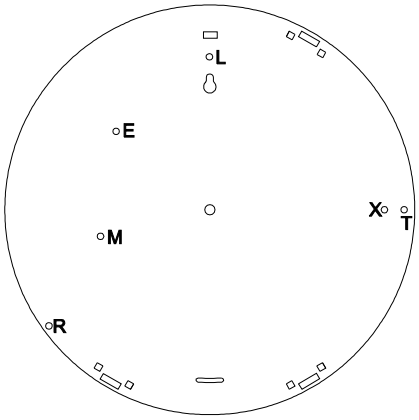
Parts

Rear frame (assembled previously)
Dial (assembled previously)
Escapement unit (assembled previously)
Escape wheel unit (assembled previously)
Mid wheel unit (assembled previously)
Great wheel unit (assembled previously)
30-tooth gear (with dowel installed previously)
32-tooth gear (with hour pipe installed)
8-tooth gear
5 - set washers (#23)
4 - spacer washers (#45)
hour hand (#15)
minute hand (#14)
6 - 3 ½" dowels (some with set washers and pulleys installed)
3 - #4 x ½" screws



Assembly Procedure

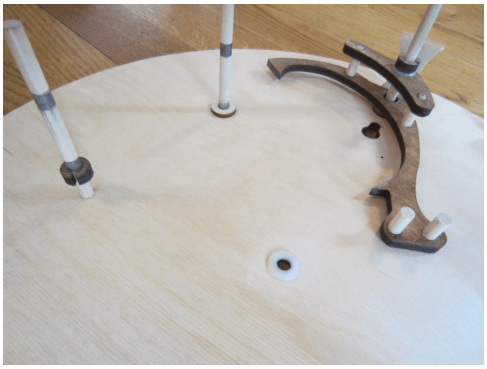
1) Place the rear frame on a table with the pillars sticking up. Use a toothpick to apply glue to the inside wall of hole L, as indicated in the diagram below.



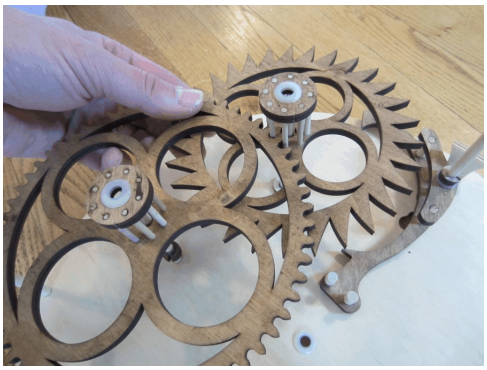
Insert the end of arbor L that is marked with an L into hole L in the back. Use a hammer to gently tap in the arbor until it bottoms out flush with the back of the rear frame. Use a small square or other right angle object to verify that the arbor is perpendicular to the frame in all directions; adjust as necessary before the glue sets.

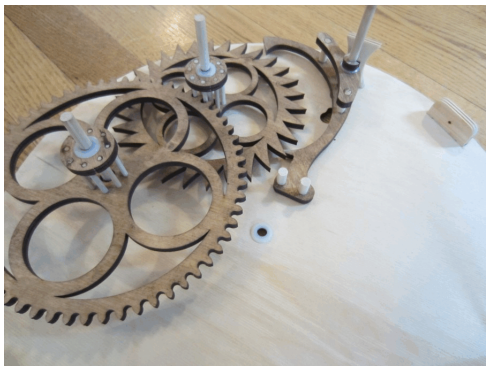
Repeat this procedure for arbors E, M, X, and T (do not insert arbor R yet).

2) Place an 1/8" thick spacer washer on arbor L and arbor E. Place the escape lever unit onto arbor L with the crutch forks sticking up. Push a set washer onto arbor L so it is nearly in contact with the shoulder washer on the escape lever unit. There should be small amount of clearance so the escape lever is free to rotate on the arbor.

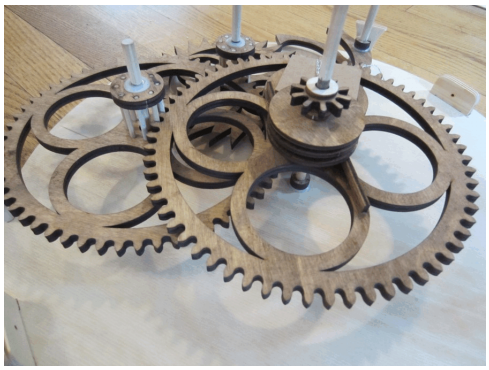


3) Place the 60-tooth mid wheel on top of the escape wheel with the pinions of both wheels facing up. Simultaneously lower the escape wheel unit and the mid wheel unit onto arbors E and M as shown below. The teeth of the escape wheel should slip between the tips of the escape lever.





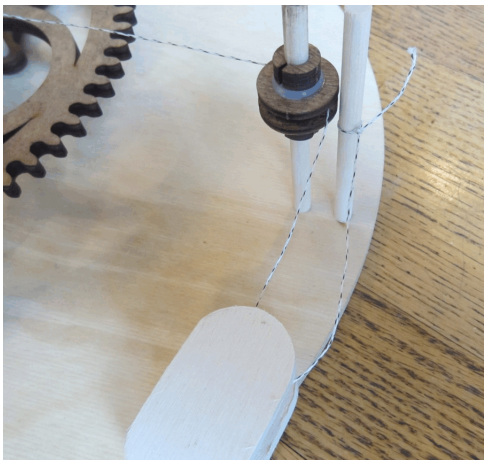
4) Insert the rear end of the great wheel arbor (the end with the set washer) into the nylon shoulder washer in the center of the rear frame. While inserting the arbor into the nylon shoulder washer, tip the arbor to the right and then stand it up straight so that the great wheel teeth are allowed to engage with the pinions of the mid wheel.



5) Glue arbor R into hole R in the back as was done with the other five 3 3/4" arbors.

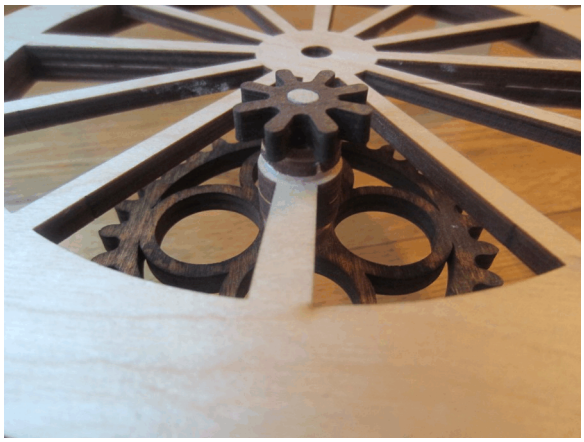
6) Lay the long cord that comes off the smaller hub of the weight spool between the winding guide pulley wheel and the mid wheel arbor.

7) Thread the short cord that comes off the larger hub of the weight spool over the top of the weight guide pulley wheel, around the weight pulley wheel, and tie it off rod T. The weight will be hanging from this cord, so ensure that the knot is secure. (Once the clock is mounted, the cord can be moved forward or backward on the arbor to allow the weight to hang straight.)

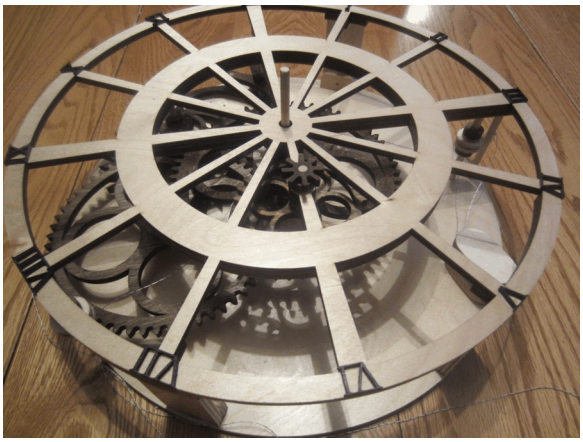


8) Push a set washer onto arbor E and arbor M, positioning each set washer so there is about 1/16" of clearance between the pinion hub shoulder washer and the set washer.

9) Verify that a spacer washer is still on the arbor with the 30-tooth gear installed. From the back side of the dial, insert the arbor of the 30-tooth gear through the nylon shoulder washers in the spoke of the dial. Next, place two 1/8" thick spacer washers on the arbor protruding through the front of the dial. Press the 8-tooth gear onto the arbor. Check that gears are not pinching together on the dial and restricting the arbor from being able to spin freely.



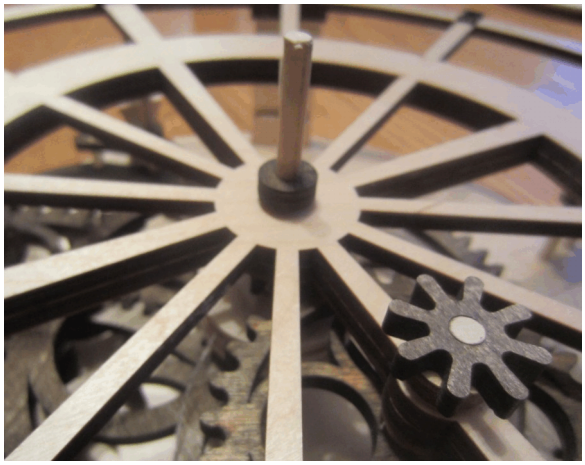
10) This step will likely be the most tedious of the clock assembly: set the dial into place so that the great wheel arbor goes through the hole in the center of the dial. Line up the arbors and the pillars with their corresponding holes or slots. Work gradually around the dial, guiding the arbors and pillars, one at a time, so they begin to enter their holes. Once all are partially engaged, press the dial into place so that all pillars and arbors seat completely into their holes. Also, make sure that the 30-tooth meshes with the 10-tooth gear on the great wheel arbor.



11) From the outside of each pillar, screw in a #4x1/2" screw through the predrilled hole in each of the three pillars.

12) There should be about 1/16" of clearance between the spacer washer on the great wheel arbor and the nylon washer on the back of the dial. If necessary, adjust the position of the great wheel and/or the 10-tooth gear on the arbor (it will be necessary to remove the dial).

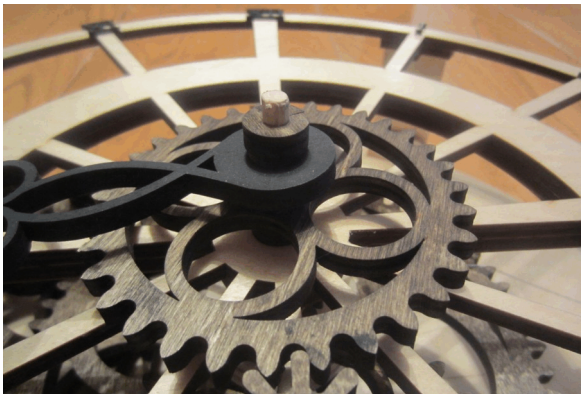
13) Press a set washer onto the front of the great wheel arbor, and locate so there is about an 1/8" gap between the gear and the dial.



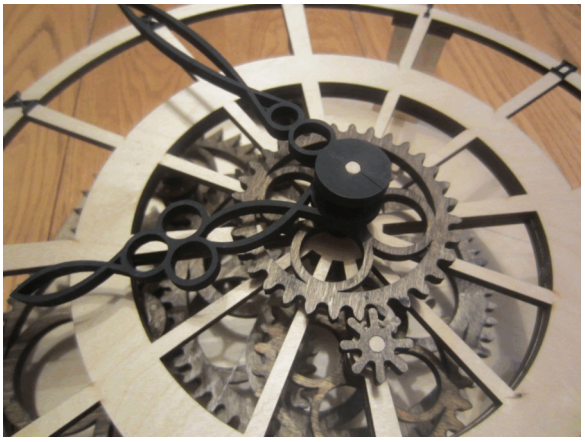
14) Press and/or twist the hour hand onto the hour pipe. The hour hand should be loose enough so that it can be rotated on the hour pipe, yet tight enough so that it will not slip on its own.

15) Slip the 32-tooth hour gear onto the great wheel arbor so that it rests against the set washer and engages with the 8-tooth gear.

16) Press a set washer onto the front of the great wheel arbor. Locate it so it is nearly in contact with the hour pipe (the hour pipe must not be pinched tightly between the two set washers).



17) Press and/or twist the minute hand onto the great wheel arbor. The minute hand should be loose enough so that it can be rotated on the arbor, yet tight enough so it will not slip on its own. If it is too tight, sand the arbor. If it is too loose, add a thin layer of glue to the arbor and allow it to dry completely before mounting the minute hand.



Mounting Instructions

1) Determine the location to hang your clock. Be sure to consider the following:

a) The clock must be mounted securely to the wall. Locate a stud within the wall for solid mounting.

b) Choose a location which is free from obstructions to the swinging pendulum or the descending weight.

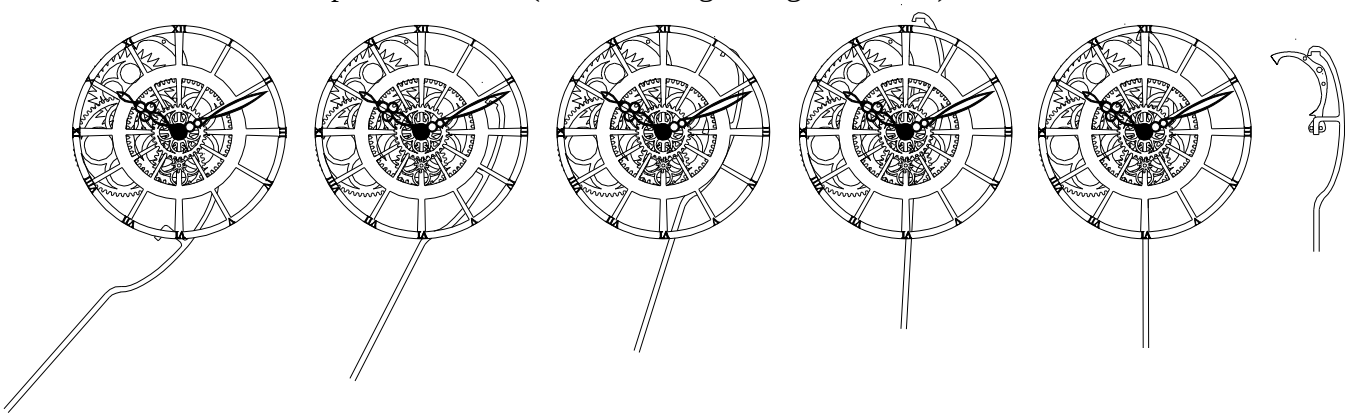
c) For best operation, select a location that will be free from vibration and drafts (adjacent to a door may be problematic due to vibrations or air currents from slamming doors)

d) The clock has a hanging weight and cords, which pose a potential hazard to children. Keep young children away from the weight and cords.

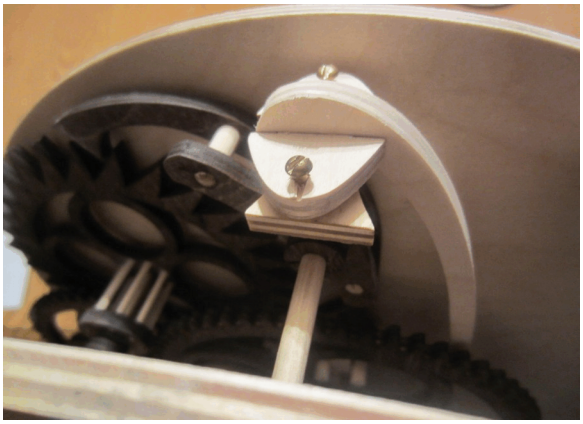
2) Drive a 1 5/8" screw into the wall at a height of approximately 76" above the floor. Leave approximately 1/4" of the screw protruding from the wall. The screw should fit snugly into the keyhole slot in the back of the dial. Adjust the screw depth until the screw seats firmly into the narrow portion of the keyhole slot. Hang the clock on the wall.

3) With the clock dial vertical, place the mounting washer (#44) on a 1 5/8" screw and drive it through the center of the slot toward the bottom of the back into the wall. Tighten so that the clock is held snugly to the wall.

4) Put the pendulum in place by tipping it to the side and threading it up past the right side of the gears. Rotate it back into place above the gears so that the pendulum bracket is above the pendulum support plate. Bring the pendulum downward so that the hook on the pendulum shaft slides between the crutch forks on the escape lever/crutch (see the far right diagram below).



Position the pendulum bracket screw tips so that they rest in the small holes in the top of the pendulum support plate. Note that the screw tips simply rest on the support plate holes; they do not get driven into the support plate. If the pendulum is not hanging straight down, or if either screw is not able to rest on its support plate hole, turn one of the pendulum screws in or out of the bracket to lower or raise that screw.



5) The weight pulley is suspended by the weight cord. Make sure the string passes under the pulley wheel rather then beside it. Also make sure that the weight cord passes over the pulley wheel on the weight guide arbor on the right side of the clock.

6) Hang the weight shell hook on the lower dowel of the weight pulley.

7) Gently push the pendulum to one side and release to start the clock's motion.

8) The vertical orientation of any pendulum clock is critical. As the escape lever rocks back and forth, it must deliver an even, balanced "tick-tock". The clock should be balanced if the dial is vertical (i.e., VI and XII lie on a vertical line), but some slight adjustment might be necessary: if the escape lever stalls on its lower (right) side, the bottom of the clock needs to be shifted slightly to the left. If the escape lever stalls on the top (left) side, the bottom of the clocks needs to be shifted slightly to the right. Once the clock is "in beat", secure the lower screw to the wall to hold the clock's position on the wall.

9) Verify that the winding cord passes over the pulley wheel on the winding guide arbor on the left side of the clock.

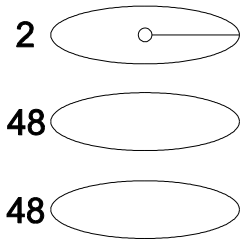
10) Look at the clock from the side. Adjust the positions of the set washers on the winding guide arbor (R) and weight guide arbor (X) so that the pulley wheels on these arbors are parallel with the corresponding hub on the weight spool. That is, make sure each cord is able to come straight off the spool and pass over the pulley wheel.

If you have difficulty getting the clock to run, refer to the Troubleshooting section later in this manual.

Winding Pull

Parts

1 - Winding pull middle (#2)
2 - Winding pull sides (#48)



Assembly Procedure

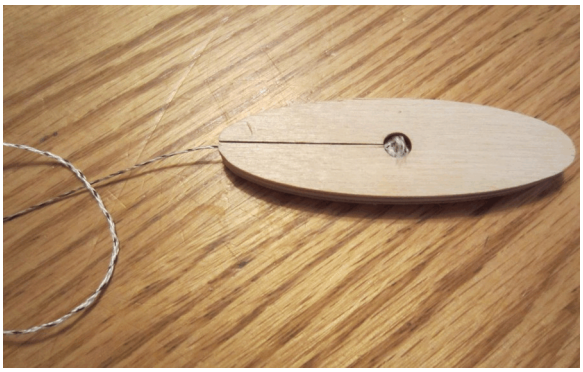
1) Sandwich the winding pull middle between the two winding pull sides. With the pieces held together, sand the perimeter if desired and then apply finish as desired.

2) Verify that the winding cord passes over the winding guide pulley wheel.

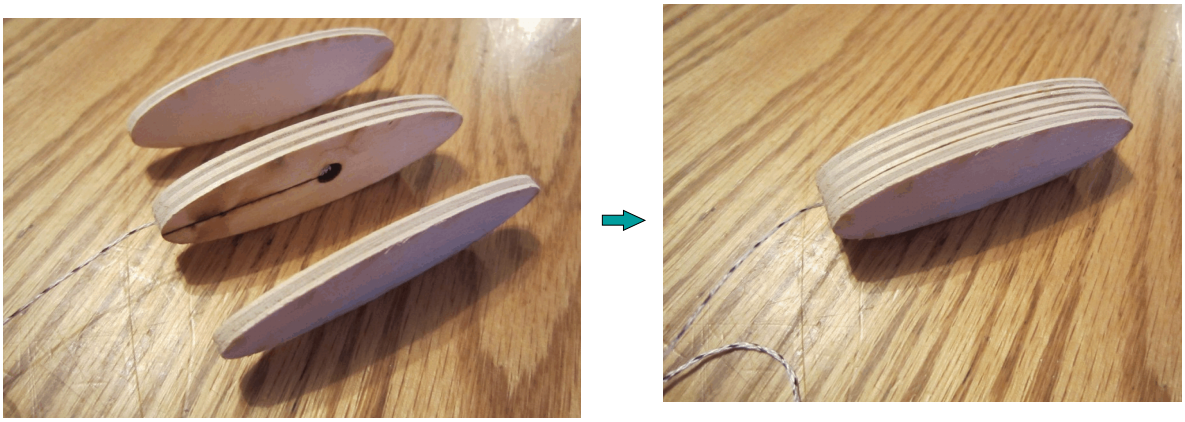
3) With the clock mounted on the wall, wind the clock fully by pulling down on the rewind cord with your left hand while simultaneously raising the weight with your right hand until the top of the weight is just below the pulley wheel on the right side of the clock. You might wish to wrap the cord a few times around a small piece of scrap wood to make it easier than simply pulling on the bare cord.

4) If necessary, cut off the winding cord so it hangs just to the floor.

5) Tie a large knot near the end of the winding cord. Insert the cord into the slot on the winding pull middle, with the knot located in the hole in the center piece. Make sure the knot cannot pull through the slot.



6) Glue the two winding pull sides to either side of the winding pull middle.



Adjusting and Regulating

1) Setting the time

The hour and minute hands need to be set independently. Both hands should be friction fit on their shafts so that they can be rotated. If the hands fit tightly, it may be necessary to grasp the great wheel when setting the hands to prevent the entire motion train from moving. After positioning the hands, verify that neither hand was inadvertently angled inward or outward so that it rubs on or interferes with the other hand or with the gear on the front of the clock.

2) Regulating the clock

The pendulum keeps the clock running at a constant pace. The position of the bob on the shaft determines how fast the clock runs. If the clock runs slow, move the pendulum bob higher on the shaft. If the clock runs fast, move the pendulum bob lower on the shaft. Patiently adjusting the bob over the course of several days should result in the clock keeping reasonably accurate time. Expect your clock to gain and lose time with changes in temperature and humidity. Also, expect your clock to require a "break-in" period of a week or so during which it may not be as consistent as it will be in the future.

TIP: use a stopwatch to time a series of 60 tick-tocks and see how close to one minute it is. Make adjustments to the bob until it is close to one minute. Now, set the time and let the clock run for a day to make finer adjustments to the bob.

3) Winding the clock

Wind the clock by pulling downward on the winding pull with your left hand while simultaneously lifting the weight with your right hand. It takes a little practice to lift enough on the weight shell so that some tension is removed from the cord, yet not so much tension is removed that the cord jumps off of the pulleys or weight spool. Before letting go of the weight shell, make sure that the shell's hook is still catching completely on the weight pulley dowel. It may be necessary to restart the pendulum after winding. Also, it might be necessary to lift the pulley wheel back onto the weight cord if it "jumped" off during winding. The clock should run for about 30 hours on one winding. Your clock will wind easier after it has been wound a few times.

4) Final Gluing

The great wheel and the 10-tooth gear were not glued to the arbor yet. This was to allow for any adjustment needed to the position of the gears on the arbor. Since the fit of these gears is tight, it will probably not be necessary to glue them in place. However, these gears can be glued in their final locations at any point in the future. The same is true for the set washers holding the cord routing pulleys in place. The two set washers on either side of the hour pipe should remain unglued in case the clock needs to be disassembled in the future.

Troubleshooting

If the clock fails to operate properly, refer to the suggestions below.

Gear Train Will Not Advance

If the gear train will not advance when weight is applied to the weight cord, check the following possible problem sources. If you are having difficulty with the gear train, it might be easier to troubleshoot if the escape lever is moved out of the way to allow free movement of the gears.

Friction between arbors and bearings

The arbors must spin freely in the nylon bearings. Check to see that the arbors have been sanded smooth where they contact the bearings. Additional sanding may be necessary if the arbors are too tight in the bearings.

Play in gear arbors

There must be a small amount of play in each of the arbors. There should be about 1/16" of free play so that the gear unit can be jiggled back and forth. If the set washers are pushed too tightly against the nylon bearings so that no back and forth movement is allowed, move one of the set washers inward on the arbor to allow a small space between the set washers and the nylon bearings.

Gear binding

Check to see that each gear is aligned with its mating gear or pinions. Check to see that no gears or the escape lever is rubbing on anything. Reposition gears on the shaft as necessary so that mating gears fall in line with each other.

Hands rubbing

Check that neither the hour nor minute hand is toed inward or outward, causing either one to rub on the other or on the gears on the front of the clock. Adjust hand positions as necessary so that the hands are able to rotate completely without interference.

Pendulum pivot seating

Check to make sure that both of the pendulum pivot screws are resting in the holes in the pendulum support plate.

Gear tooth obstruction

Inspect the gear teeth to be sure that each tooth is clean and free of burrs, shards, or stain/varnish build up.

Clock Runs For A While Before Stopping

If the clock runs for awhile but then stops, there are a number of factors that could be involved. Check each of the following:

Gear train

The problem may be with the gear train itself. Slide the escape lever out of the way of the escape wheel and troubleshoot the gear train (see above section for possible causes of gear train problems). With the escapement out of the way, try to turn the great wheel by hand. It should take very little force to advance the entire gear train.

Escapement out of beat

If the escape lever has stopped the clock by not releasing a tooth of the escape wheel, try to restart the clock by restarting the pendulum in motion. If it continues to run for a while and eventually stops on the same side of the escape lever as before, then the clock is likely out of beat. The clock is brought in beat as described in the Mounting section of these instructions.

Weight

As the escape lever releases a tooth of the escape wheel, the escape wheel should advance immediately and freely until its motion is stopped by the escape lever. If the wheel seems to lag, follow the suggestions in troubleshooting the gear train to minimize sources of friction. If this does not help, it might be necessary to add more weight to overcome the friction that is present. Try increasing the weight to see if this solves the problem. (You should not use more weight than is necessary to drive the clock, as this will place undue strain on the parts and may increase wear and tear on the components.) You might find that more weight is required during the "break-in" period, so that the amount of weight can be reduced after the clock runs for a week or two.

Crutch fork clearance

It is important to have the proper fit between the pendulum shaft and the crutch forks. Friction between the crutch forks and the pendulum shaft can rob energy from the clock and return the pendulum to a stop. If it is too tight, sand the section of the pendulum shaft that passes between the forks. This section of the pendulum must be smooth, as must the interior portions of the crutch forks. On the other hand, the gap between the shaft and the forks should not be larger than 1/16". If the gap is too large, add a piece of tape to the shaft to build up its thickness.

Lower support tightness

If the lower mounting screw is not tight enough, the clock's vertical orientation can change. This is especially likely to happen when winding the clock. Make sure that the screw is tight enough to prevent the bottom of the clock from moving left or right.

Pendulum plumb

The pendulum bob must not rub against the wall or on the weight casing. If the pendulum shaft does not hang straight down, adjust the pendulum support bracket screws in or out to alter the alignment of the pendulum shaft.

Miscellaneous

Variations in humidity and temperature can affect the accuracy of your clock.

Technical Support

If you have any problems with this clock, please contact Jeff Schierenbeck for assistance:

E-mail: jeff@wooden-gear-clocks.com
Telephone: 715-955-4104

Comments?

We'd love to hear from you about your experience with the Legacy clock. Please let us know if you want to share any thoughts about the Legacy clock or if you have any suggestions for improvements that can be made to the clock or to the instruction manual.