Introduction

For centuries, 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 Diadem 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. It is intriguing to watch as the seconds and minutes tick away. This clock features a verge and foliot escapement. This escapement ushered in the era of mechanical timekeeping in the 13th century. It was used in clocks for several hundred years until the development of the pendulum and anchor escapement.

It is enjoyable 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 and small slot screwdriver
- pliers
- knife
- hammer
- clamps (small spring clamps work well)
- approximately 3 lbs of metal shot (available from sporting goods or firearms stores)
- wood glue
- CA glue ("Superglue")
- sandpaper (100, grit, 150 grit, 220 grit, 400 and 600 grit suggested)
- pencil
- toothpicks
- ruler or measuring tape

Safety

It is your responsibility to use the proper tools and techniques to accomplish this project. Consult the owner's manuals and label directions for any tools or products used in completing this project.

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

Copyright

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 pieces as needed rather than all at once.**

2) You can stain your clock if desired. If you are working from a kit or material set that does not have contrasting wood, we recommend one stain for all of the parts that are found on the gear panel, and a contrasting finish for the rest of the parts.

Although it is possible to do all the staining after the clock is assembled (the clock is easily disassembled), you might find it easier to stain the gears prior to assembly. Since a finish can hinder glue bonding, wait to apply finish until the components have been glued together (a suggested sequence for sanding and finishing is included in the step by step instructions). **If you choose to apply a varnish, avoid getting varnish on the contact faces of the gears**.

3) A few 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 step.

5) Some laser-cut pieces 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**. Note that the backsides of some pieces may show residue from the laser cutting operation. A light sanding will remove this residue. However, this should not be 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.

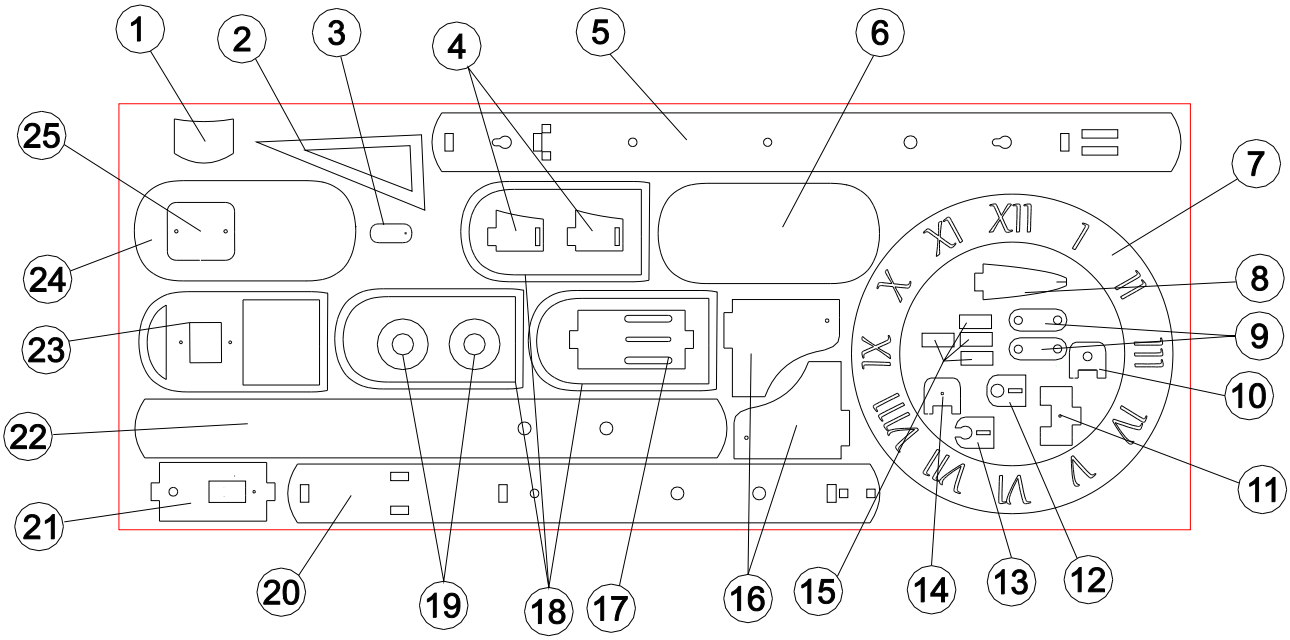
6) Some of the parts fit tightly together. It may be necessary to gently tap them together with a hammer. If the fit seems too tight, some light sanding may be necessary to insure a proper fit.

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

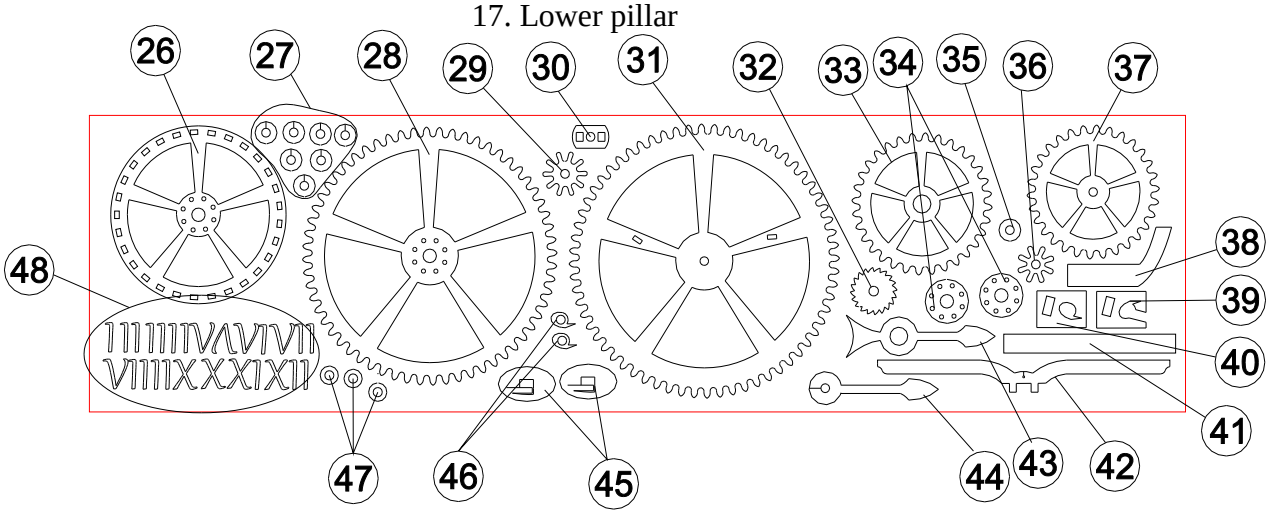
8) A duplicate copy of the part list (Part Locator) is included on the last page of this manual. Remove this page from the manual so that it can be easily referred to during assembly.

9) Take your time and enjoy the process! Please contact us if you have any questions during assembly.

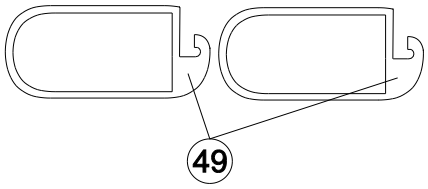
Part List



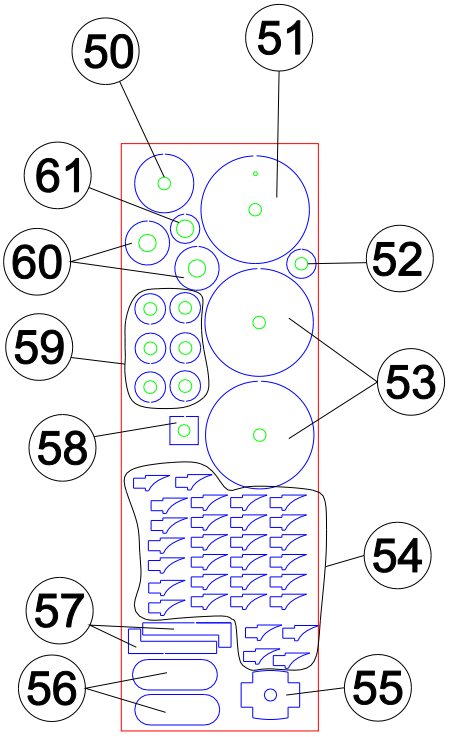
1. Dial placement jig
2. Square
3. Winding pull middle piece
4. Crown arbor support sides
5. Rear frame
6. Weight shell front
7. Dial
8. Cord support
9. Weight pulley sides
10. Upper pillar anchor
11. Lower verge bearing plate
12. Lower verge bearing
13. Upper verge bearing
14. Lower bracket anchor
15. Bearing rails
16. Lower brackets
17. Lower pillar
18. Weight shell middle pieces
19. Lantern pinion install pads
20. Front frame rear piece
21. Upper pillar
22. Front frame front piece
23. Weight shell inner back
24. Weight shell back
25. Weight shell cover plate



26. Crown wheel
27. Set washers
28. Middle wheel
29. 10-tooth gear
30. Foliot base
31. Great wheel
32. Rachet
33. 32-tooth gear
34. Pinion hubs
35. Pillar pin cap
36. 8-tooth gear
37. 30-tooth gear
38. Verge spacing guage
39. Verge jig end A
40. Verge jig end B
41. Verge jig bar
42. Foliot
43. Hour hand
44. Minute hand
45. Foliot weights
46. Pallets
47. Hour pipe sections
48. Numeral set



49. Weight shell hook pieces



50. Weight spool hub
51. Weight spool interior divider
52. Winding spool hub
53. Outer spool sides
54. Crown wheel teeth
55. Crown arbor support plate
56. Pulley covers
57. Pawls
58. Arbor sizing jig
59. Spacer washers
60. Pulley wheel sides
61. Pulley wheel hub

Hardware

19' braided cord
12 nylon shoulder washers
2 - #8 x 1 5/8" screws
5 - #4 x ½" screws

Dowels

1/4" diameter

3 - 1 1/16"
1 - 1 ½"
1 - 2 3/16"
1 - 3 7/16"
1 - 5"
1 - 6 ½"

1/8" diameter

16 - 1 1/4"

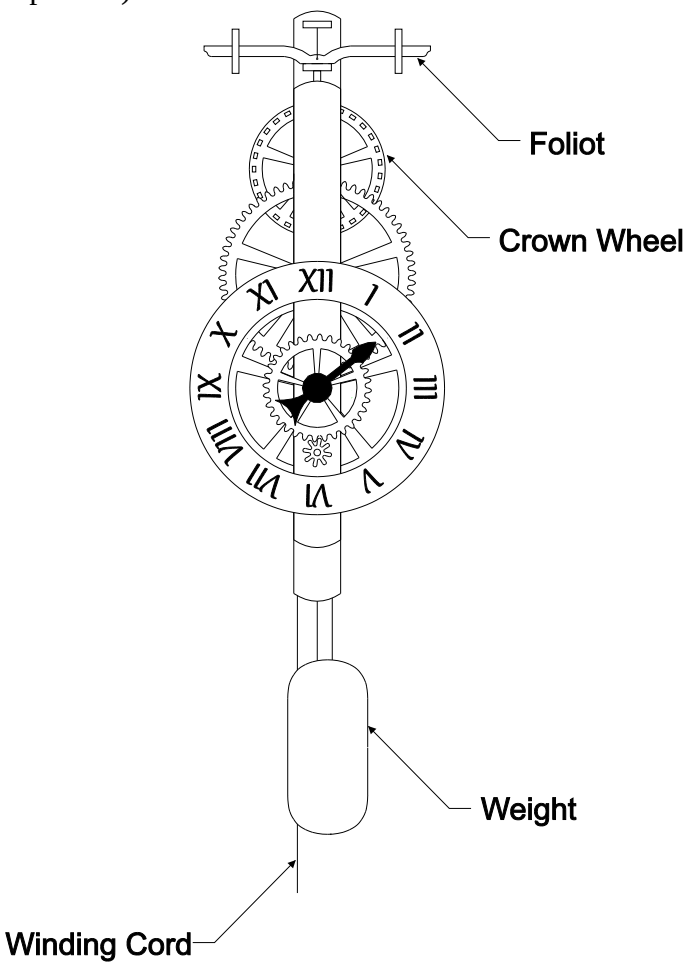
How the Diadem Clock Works

When assembling the clock, it will be beneficial to have some understanding of how the clock works.

The Diadem 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 pulls on the cord, causing the arbor to rotate. The gears that are attached to this arbor mesh with a train of other gears, causing them to rotate as well. When the cord has unwound to a point where the weight has nearly reached the floor, the clock is "wound" by winding the cord back around the arbor.

The speed at which the weight is allowed to rotate the gear train is regulated by the horizontal foliot that rotates back and forth. As the foliot rotates back and forth, it causes the verge to rotate back and forth along with the foliot. Paddles ("pallets") on the verge rod alternately stop and then release teeth on the crown wheel. In this way, the gear train is made to advance at a controlled pace.

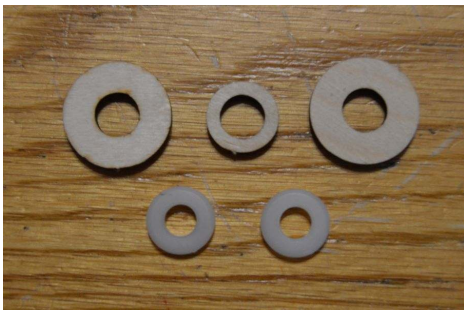
The faster the foliot moves back and forth, the faster the crown wheel (and the entire gear train) will be allowed to advance. The foliot swing period is determined by how far the foliot weights are from the center and also the amount of driving force provided by the weight. Moving the foliot weights outward on the foliot arm increases the time it takes the foliot to complete its swing. This makes the clock run slower. Moving the foliot weights inward decreases the time it takes the foliot to complete its swing, making the clock run faster. In addition, increasing the driving weight will cause the clock to run faster and vice versa. Therefore, adjusting the position of the foliot weights in combination with adjusting the driving weight controls whether the clock runs fast or slow and provides a means by which the clock can be made to run "on time." (It should be noted that the verge and foliot escapement in not as accurate as modern escapements. Error of 10 minutes per day can be expected.)



Pulley Wheel Assembly

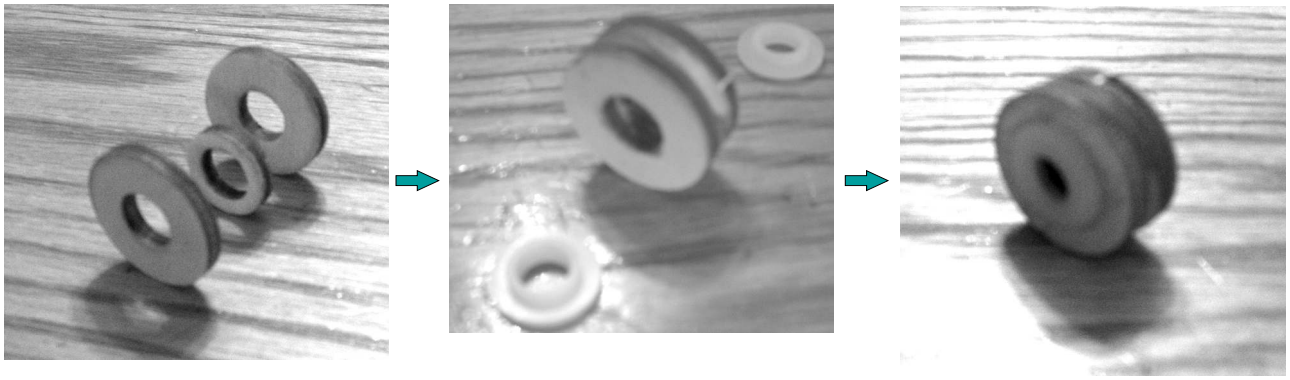
Parts

1 - Pulley hub (#61)
2 - Pulley wheel sides (#60)
2 - Nylon shoulder washers



Procedure

Glue together the three pulley pieces with the smaller diameter pulley hub sandwiched between the two larger pulley wheel sides with all three holes aligned. A piece of 3/8"dowel, a drill bit, or piece of scrap 1/4"dowel can be used to help make sure holes are aligned. After the glue has dried, the pulley edges can be sanded and finish applied, if desired. 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.



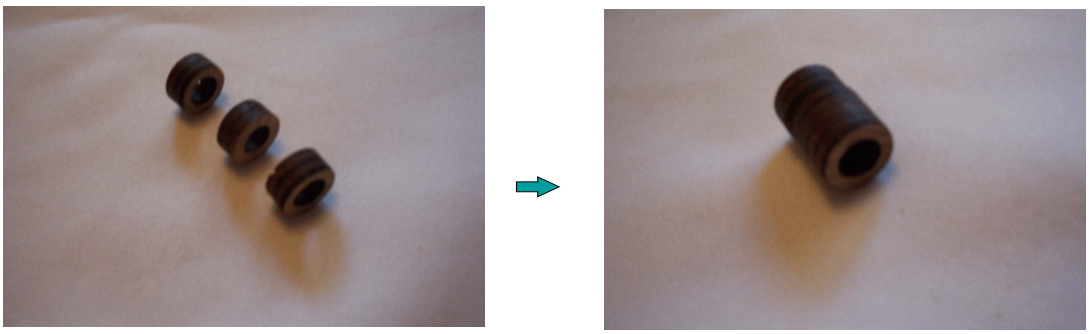
Hour Pipe

Parts

3 - Hour pipe sections (#47)

Procedure

Glue together the three hour pipe sections. Clear any glue squeeze out from the center. Clamp and allow glue to cure completely.



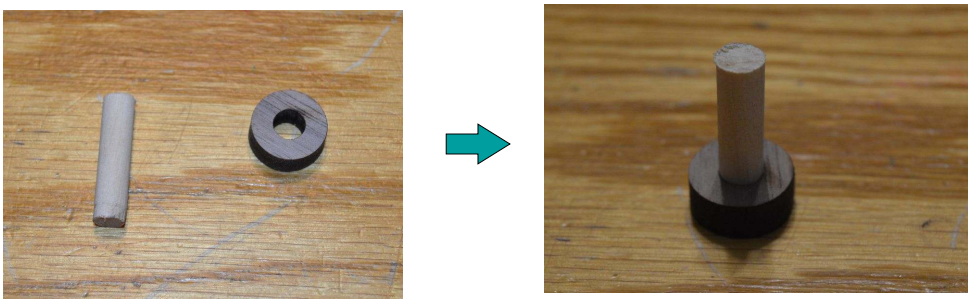
Top Pillar Pin

Parts

1 - 1 1/16" dowel
1 - Pillar pin cap (#35)

Procedure

Glue a 1 1/16" dowel into the pillar pin cap. Tap in with a hammer to drive the dowel completely into the pillar pin cap.



Verge Assembly Jig

Parts

1 - Verge jig end A (#39)
1 - Verge jig end B (#40)
1 - Verge jig bar (#41)

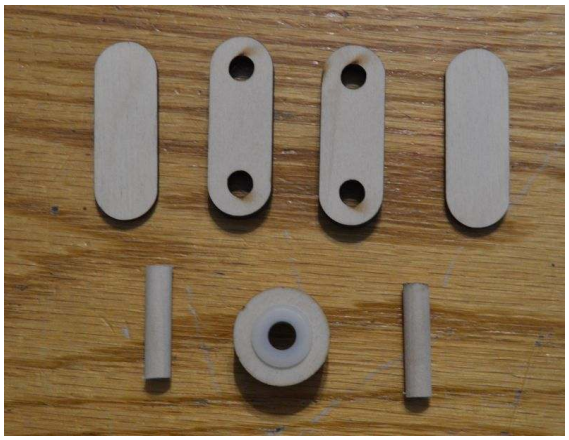
Procedure

Glue the verge jig bar into the rectangular holes in the verge jig ends with the ends of the verge jig bar flush with the outside faces of the verge jig ends. *Make sure the cutouts in the jig ends are oriented as shown in the photo below, right.*

Weight Pulley

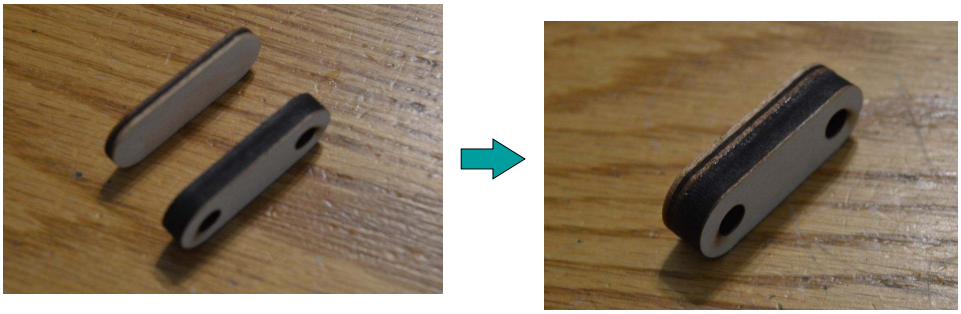
Parts

2 - Weight pulley sides (#9)
2 - Pulley covers (#56)
2 - 1 1/16" dowels
1 - Pulley wheel (assembled previously)

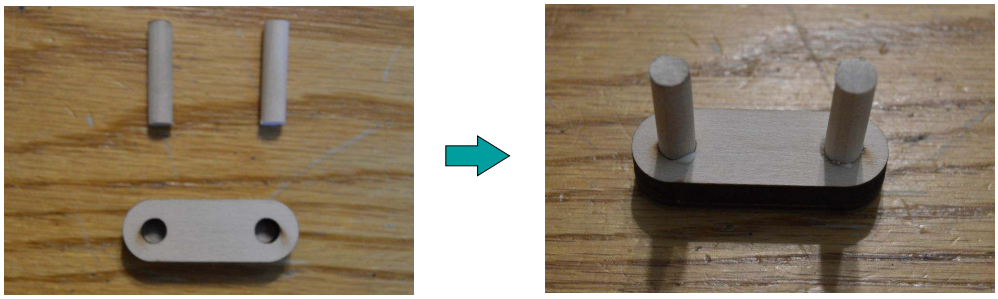


Procedure

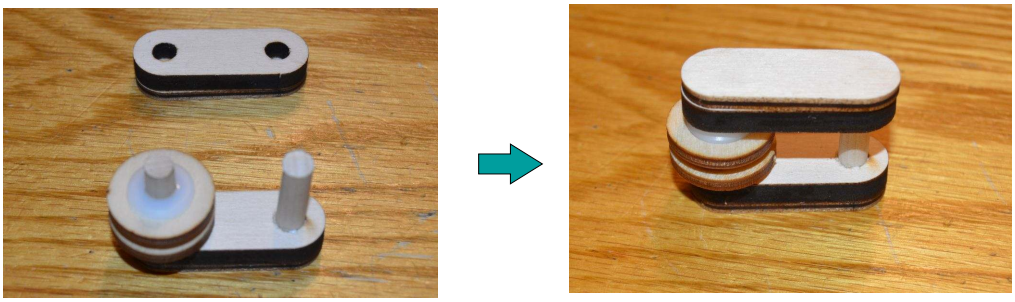
1) Glue one of the pulley covers to one of the weight pulley sides. Repeat for the other pulley cover and pulley side. Clear any glue from the interior of the holes. If desired, sand the perimeter of the pulley side units and apply finish.



2) Glue the two 1 1/16" dowels into one of the pulley side units that were assembled in the previous step, using a hammer to drive them fully into the holes



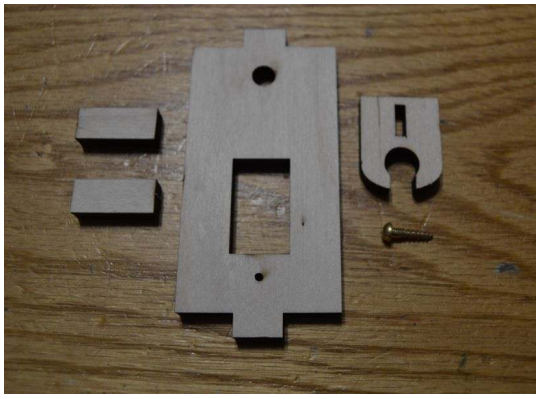
3) Slide the pulley wheel (assembled previously) onto one of the dowels in the pulley frame. Test to be sure the pulley wheel spins freely, sanding the dowel if necessary. Glue the other pulley side unit onto the dowels, using a hammer to drive the dowels fully into the holes. Immediately verify that the pulley wheel spins freely and is not pinched by the sides. If necessary, pry apart the side slightly to free the pulley wheel.



Upper Pillar

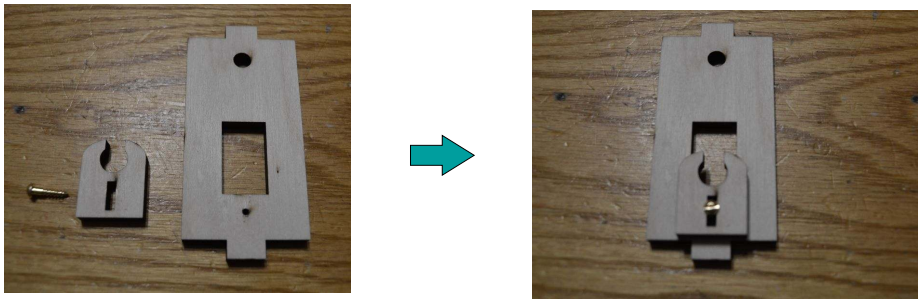
Parts

1 - Upper pillar (#21)
1 - Upper verge bearing (#13)
2 - Bearing rails (#15)
1 #4x1/2" screw

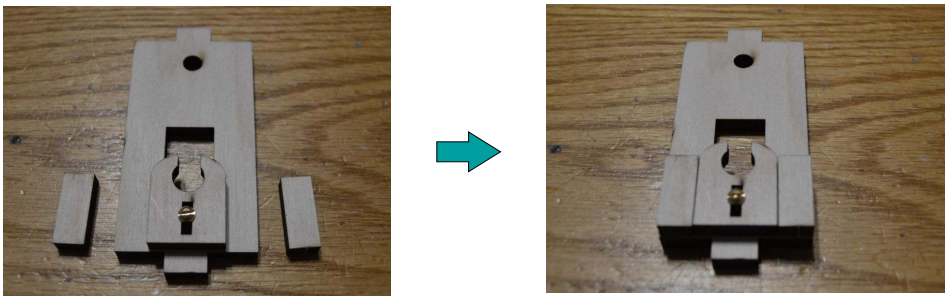


Procedure

1) Use a #4x1/2" screw to secure the upper verge bearing to the upper pillar. The screw passes through the slot in the upper verge bearing and into the pilot hole in the upper pillar. Align the upper verge bearing as shown in the photos below. Position it so the flat edge of the upper verge bearing is about 1/16" from the edge of the upper pillar edge and runs approximately parallel with the upper pillar. Tighten the screw just enough to hold the upper verge bearing in place.



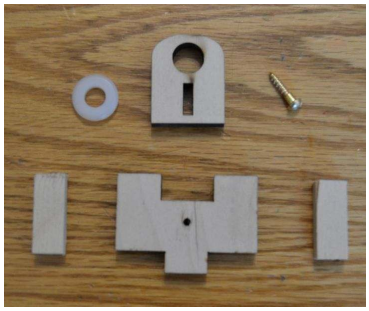
2) Glue two bearing rails to the upper pillar on either side of the upper verge bearing. Align the two outside edges of each rail with the edges of the upper pillar. Be sure no excess glue gets on the upper verge bearing since it needs to be repositionable (the upper verge bearing can be removed at this point, if needed, to prevent it from getting glued into place). If desired, sand the long edges of the pillar.



Lower Verge Bearing

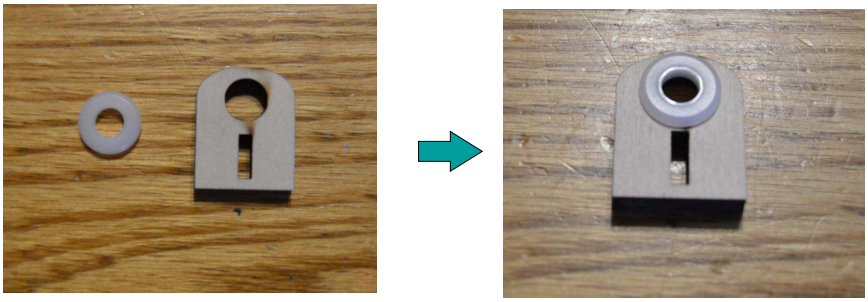
Parts

1 - Lower verge bearing (#12)
1 - Lower verge bearing plate (#11)
2 - Bearing rails (#15)
1 - Nylon shoulder washer
1 - #4x1/2" screw

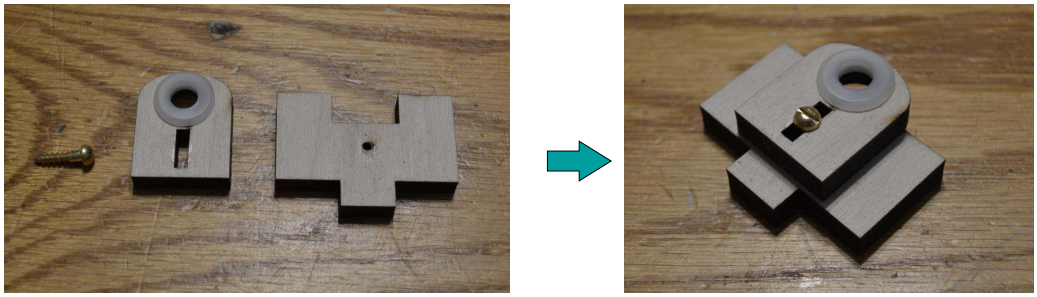


Procedure

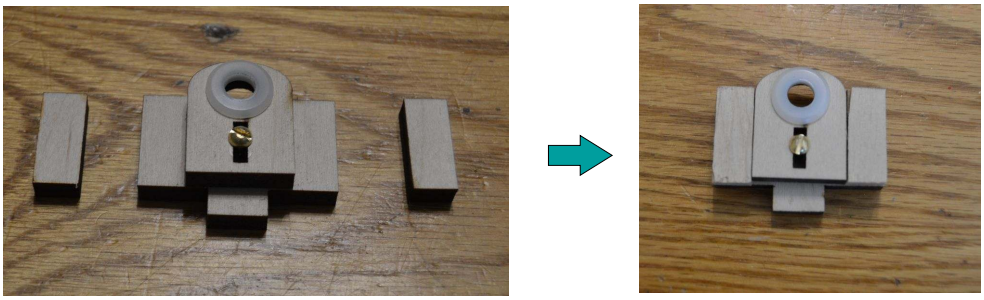
1) Apply a small amount of CA glue around the rim of the hole in the lower verge bearing. Insert the nylon shoulder washer into the lower verge bearing. It might be necessary to press or tap the washer in with a hammer to get it to seat fully into the lower verge bearing.



2) Use a #4x1/2" screw to secure the lower verge bearing to the lower verge bearing plate. The screw passes through the slot in the lower verge bearing and into the pilot hole in the lower verge bearing plate. Align the lower verge bearing as shown in the photos below. Position it so the flat edge of the lower verge bearing is about 1/16" from the edge of the lower verge bearing plate and runs approximately parallel with the lower verge bearing plate. Tighten the screw just enough to hold the lower verge bearing in place.



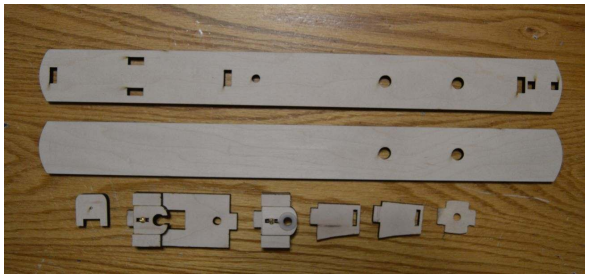
3) Glue two bearing rails to the lower verge bearing plate on either side of the lower verge bearing. Align the two outside edges of each rail with the edges of the lower verge bearing plate. Be sure not to let excess glue get on the lower verge bearing since it needs to be repositionable (the lower verge bearing can be removed at this point, if needed, to prevent it from getting glued into place). If desired, sand the long edges of the lower verge bearing unit.



Front Frame

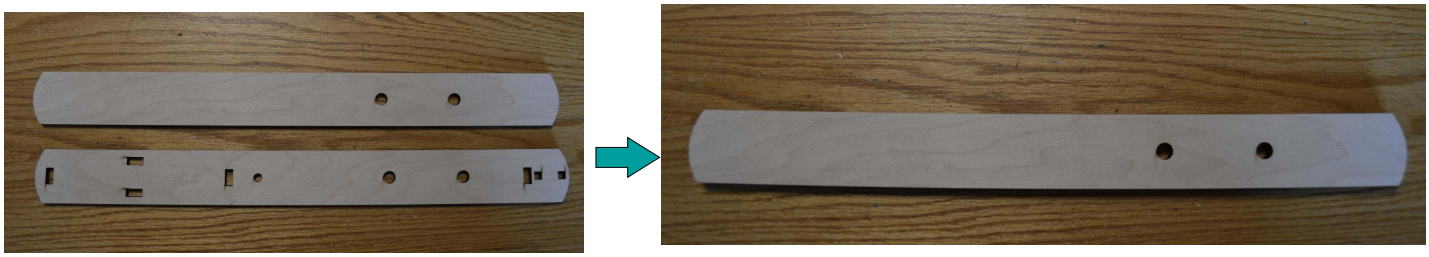
Parts

1 - Front frame front piece (#22)
1 - Front frame rear piece (#20)
2 - Crown arbor support sides (#4)
1 - Crown arbor support plate (#55)
1 - Lower bracket anchor (#14)
1 - Lower verge bearing unit (assembled previously)
1 - Upper pillar unit (assembled previously)

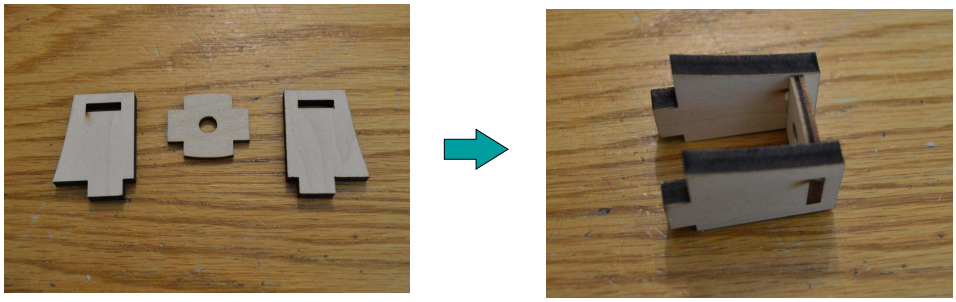


Procedure

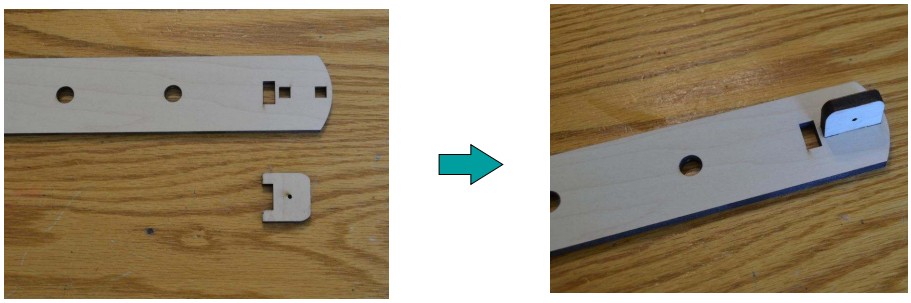
1) Glue the front frame front piece to the front frame rear piece with the two holes lined up. Verify that all of the edges line up flush. If desired, sand the edges of the front frame unit.



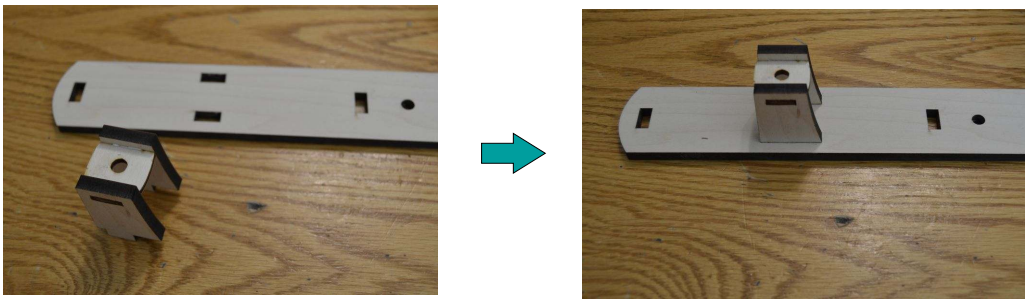
2) If desired, sand the two straight and one curved edges of the crown arbor support sides. Glue the crown arbor support plate into the crown arbor support sides. Be sure the curved edges of both support sides are facing up as shown below.



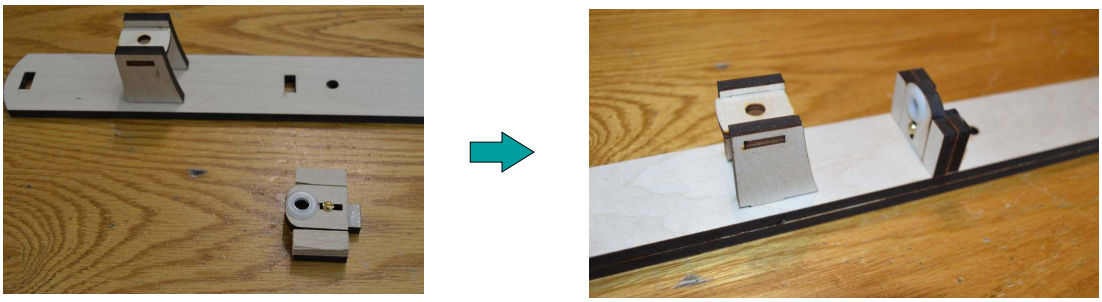
3) Glue the lower bracket anchor (note: do not to confuse with the upper pillar anchor which has a large hole!) into the front frame. If necessary, carefully tap it in with a hammer. Wipe away any glue squeeze out.



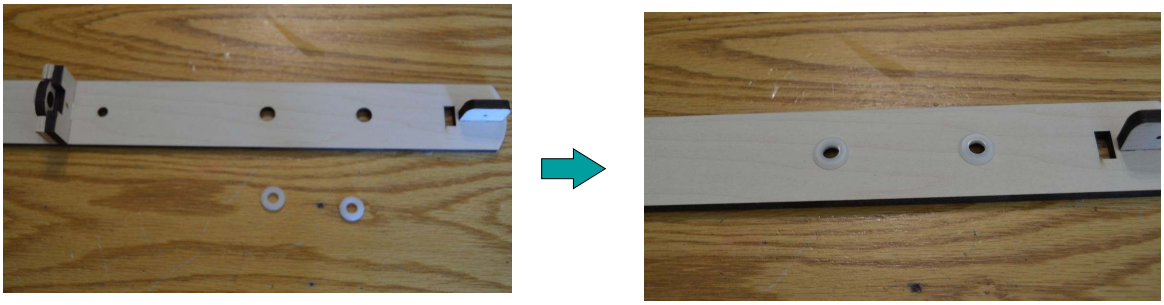
4) Glue the crown anchor support unit into the front frame. The curved edges of the sides must face towards far end of the front frame as shown in the photo below.



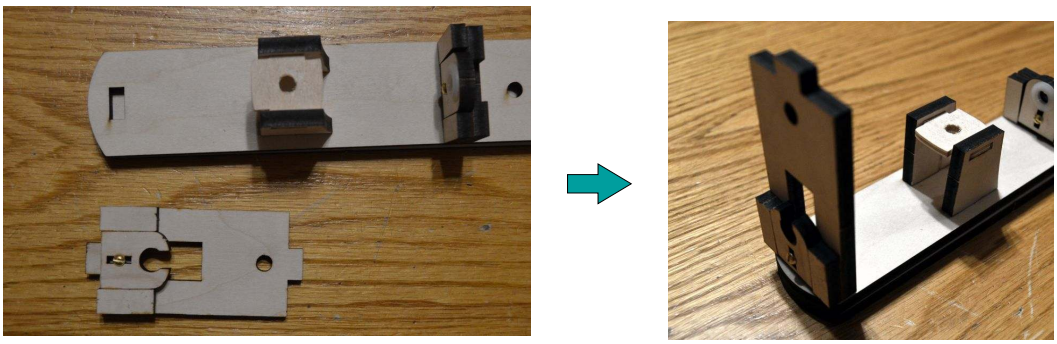
5) Glue the lower verge bearing assembly into the slot in the front frame. Be sure the nylon washer is facing the crown anchor support as shown in the photo below. Press or tap down to seat fully.



6) With the lower bracket anchor and lower bearing unit up, apply a small amount of CA glue to the rims of the two large holes in the front frame. Insert a nylon shoulder washer into each hole. It might be necessary to press or tap with a hammer to fully seat the washers in the front frame.



7) Glue the upper pillar unit into the slot at the end of the front frame. Be sure the upper verge bearing faces toward the end of the front frame as shown below.



Arbor Preparation

Parts

1 - 3 7/16" dowel
1 - 2 3/16" dowel
1 - 1 1/2" dowel
1 - Arbor sizing jig (#58)
1 - Set washer (#27)

Procedure

1) Mark a ‘1' on one end of the 3 7/16" dowel. With the marked end of the dowel to the left, lay the dowel on the diagram below and mark the location of the set washer. Twist a set washer onto the dowel until it reaches the marked location.

2) Mark a ‘2' on one end of the 2 3/16" dowel.

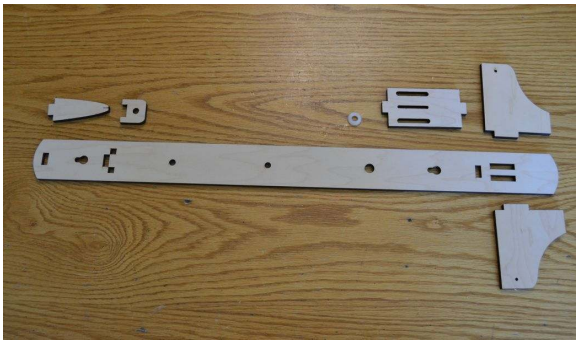
3) Verify that the arbor sizing jig is able to slip easily over the shaded portions of the each arbor in the diagram below, sanding if necessary with 150 grit paper to reduce the size of the dowel.

4) Use a series of 220, 400, and 600 grit sandpaper to polish the shaded regions of the dowels. Apply graphite to the shaded portions of the dowels by coloring them with a pencil.

Rear Frame

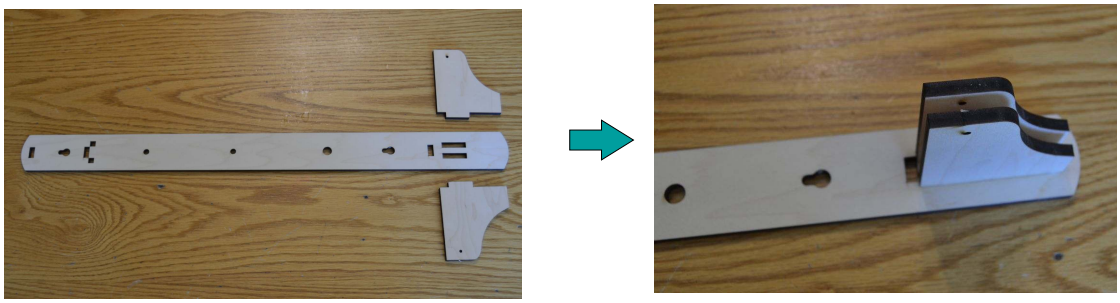
Parts

1 - Rear frame (#5)
1 - Cord support (#8)
1 - Upper pillar anchor (#10)
2 - Lower brackets (#16)
1 - Lower pillar (#17)
1 -Square (#2)
1 - Nylon shoulder washer
1 - Set washer (#27)
1 - 2 3/16" dowel
1 - 3 7/16" dowel

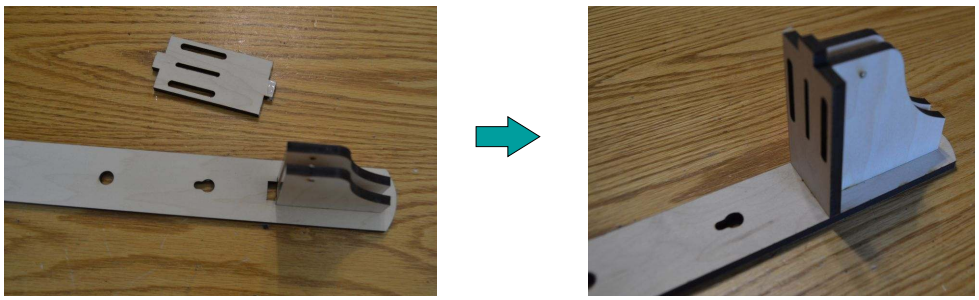


Procedure

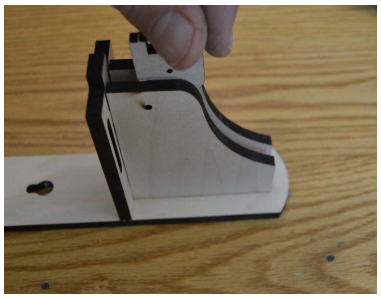
1) If desired, sand the edges of the rear frame, the curvy edges of the lower brackets, and the long edges of the lower pillar. Glue the two lower brackets into the slots in the rear frame. Apply glue on the tab and along the end of the bracket pieces. Carefully tap in with a hammer so brackets seat fully against the rear frame.



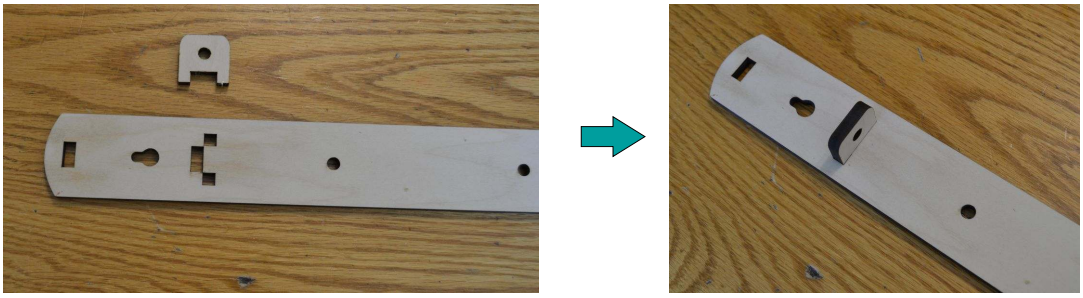
2) Apply glue to the tab and end of lower pillar opposite the slots. Also apply glue to the vertical edges of the lower brackets. With the slots up, insert the lower pillar into the slot in the lower frame adjacent to the brackets. If necessary, carefully tap in with a hammer to fully seat the lower pillar into the rear frame.



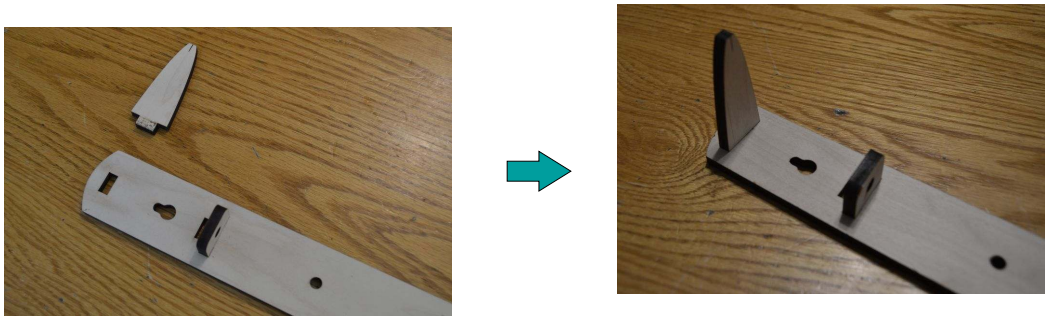
3) Immediately verify that a piece of the 1/4" frame wood can slip between the brackets. Clamp or tape lower pillar to brackets to ensure a good bond between the pillar and brackets.



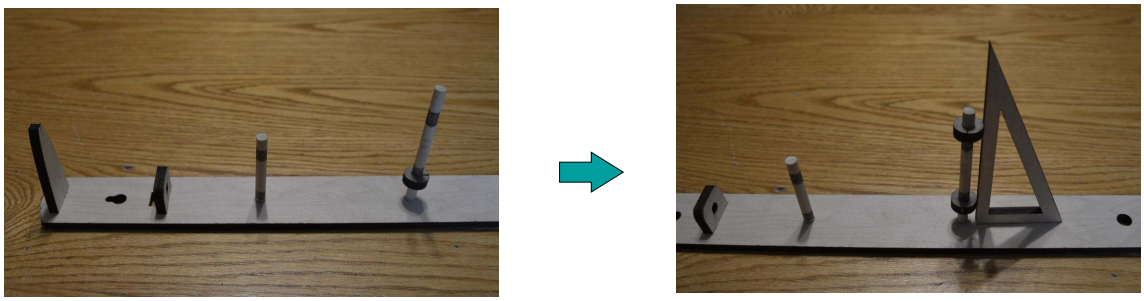
4) If desired, sand the outer three edges of the upper pillar anchor. With the lower pillar up, glue the upper pillar anchor (not to be confused with the lower pillar anchor which has a small hole) into the rear frame. If necessary, tap with a hammer to fully seat the pillar anchor into the frame.



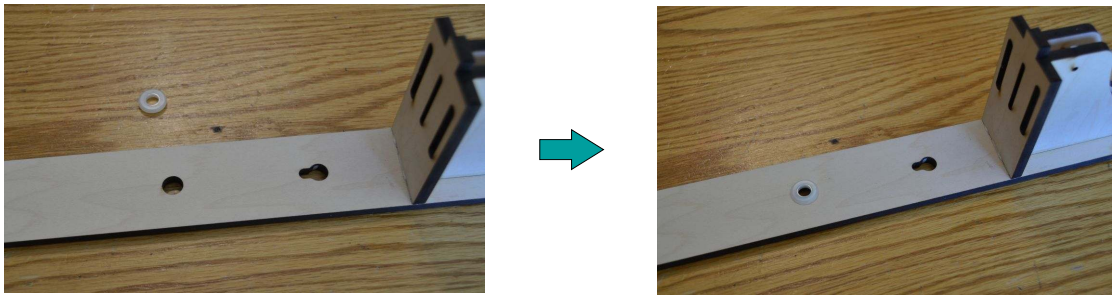
5) If desired, sand the edges of the cord support. With the upper pillar anchor up, glue the cord support into the top of the rear frame.



6) Glue the 2 3/16" and the 3 7/16" dowel into the rear frame in the locations shown below. The end of the dowel marked with a number is inserted into the hole in the rear frame. Tap with a hammer to be sure dowel is fully inserted. Immediately verify that the dowels are perpendicular to the rear frame in all directions and adjust as necessary (for the 3 7/16" dowel, twist a set washer onto the top of the arbor to provide a temporary vertical surface for the square.) Wait for the glue to fully cure and remove the top set washer.



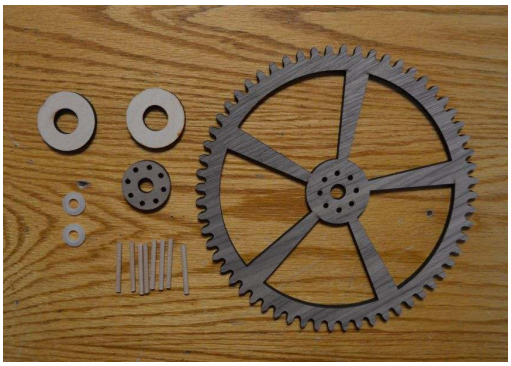
7) Apply a small amount of CA glue to the large hole in the rear frame. Insert a nylon shoulder washer into the hole. It might be necessary to press or to tap with a hammer to fully seat the washer.



Middle Wheel Unit

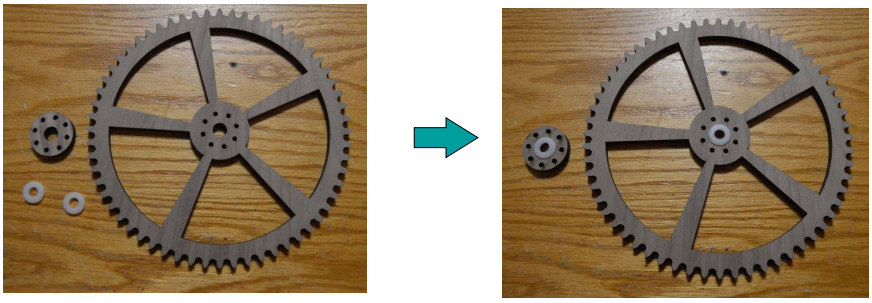
Parts

1 - Middle wheel (#28)
1 - Pinion hub (#34)
8 - 1/8"x1 1/4" dowels
2 - Nylon shoulder washers
2 - Lantern pinion install pads (#19)

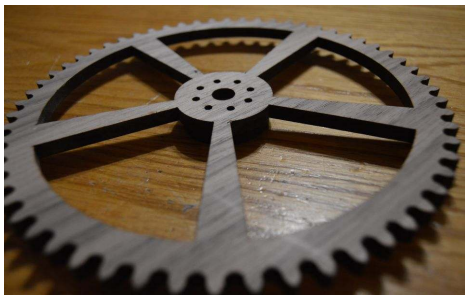


Procedure

1) Apply a small amount of CA glue to rim of the central hole in the middle wheel. Insert a nylon shoulder washer into this hole, tapping in with a hammer if necessary. Repeat this process for the pinion hub.

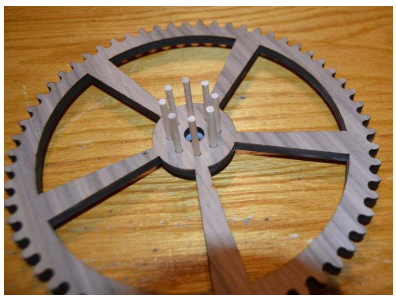


2) Place a lantern pinion install pad on a rigid surface and place the middle wheel on top with the nylon washer down (the nylon washer will fit in the hole of the lantern pinion install pad).

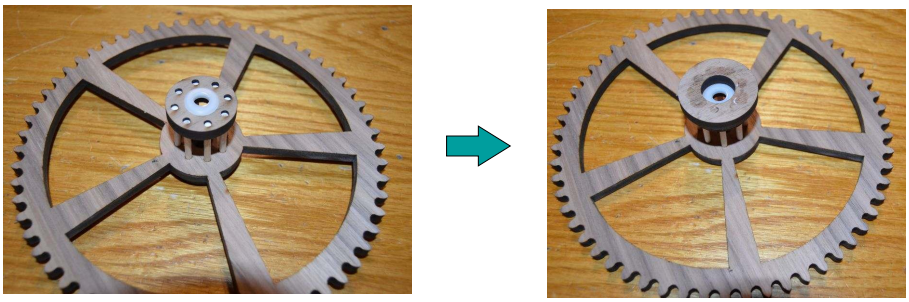


3) Use 400 grit or higher sandpaper to lightly polish eight of the 1/8"x1 1/4" dowels.

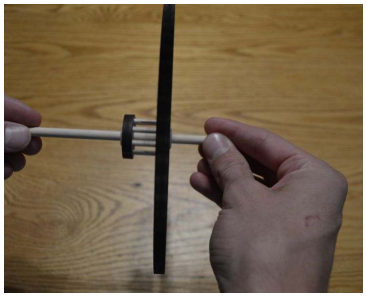
4) Use a toothpick to apply glue to the inside of the eight small holes in the middle wheel. Insert an 1/8" dowel into each of these holes. Tap lightly with a hammer to be sure they are fully inserted. Proceed immediately to the next step.



5) Use a toothpick to apply glue to the inside of the eight small holes in the pinion hub. With the nylon washer up, place the pinion hub on top of the dowels protruding from the crown wheel. Align one or two dowels with their holes and lightly tap to engage with the holes. Work gradually around the wheel, adjusting the dowels slightly to match up with the holes. Once all dowels are engaged, place the remaining lantern pinion install pad on top of the pinion hub and tap with a hammer to bring the hub flush with the ends of the dowels. Proceed immediately to the next step.



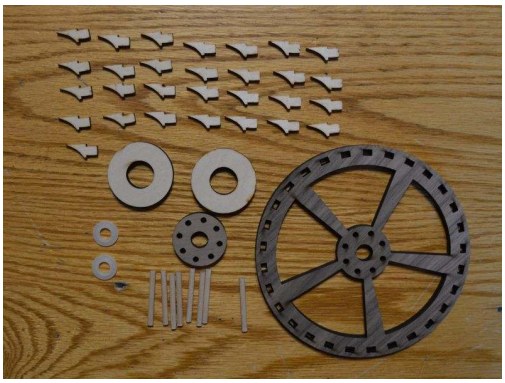
6) Place the middle wheel unit on a 1/4" dowel and spin it. View it from the side to see if there is excessive wobble in the wheel. If there is more than a slightl wobble (1/16"), slowly rotate the wheel to find the region of maximum deflection. Apply pressure at this location to correct the trueness of the wheel. This is done immediately after gluing the middle wheel unit together so that corrections can be made before the glue sets.



Crown Wheel

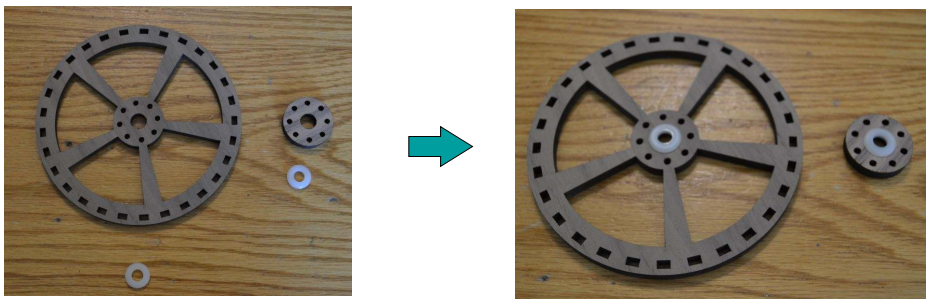
Parts

1 - Crown wheel (#26)
1 - Pinion hub (#34)
2 - Lantern pinion install pads (#19)
8 - 1/8"x1 1/4" dowels
29 - Crown wheel teeth (#54)
2 - Nylon shoulder washers

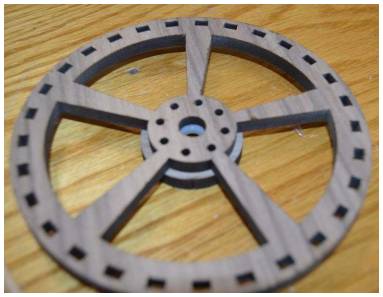


Procedure

1) If desired, sand the perimeter of the crown wheel. If desired, apply finish to the crown wheel. Apply a small amount of CA glue to rim of the central hole in the crown wheel. Insert a nylon shoulder washer into this hole, tapping in with a hammer if necessary. Repeat this process for the pinion hub.

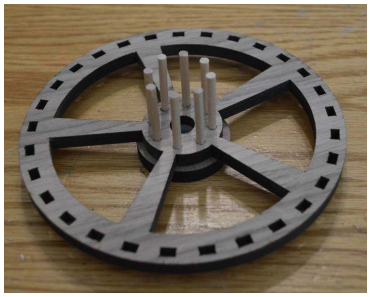


2) Place a lantern pinion install pad on a rigid surface and place the crown wheel on top with the nylon washer down (the nylon washer will fit in the hole of the lantern pinion install pad.

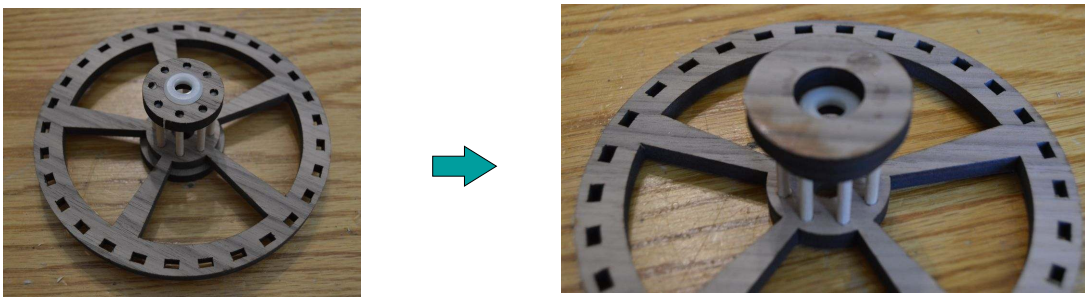


3) Use 400 grit or higher sandpaper to lightly polish eight of the 1 1/4"x1/8" dowels

4) Use a toothpick to apply glue to the inside of the eight small holes in the crown wheel. Insert an 1/8" dowel into each of these holes. Tap lightly with a hammer to be sure they are fully inserted. Proceed immediately to the next step.

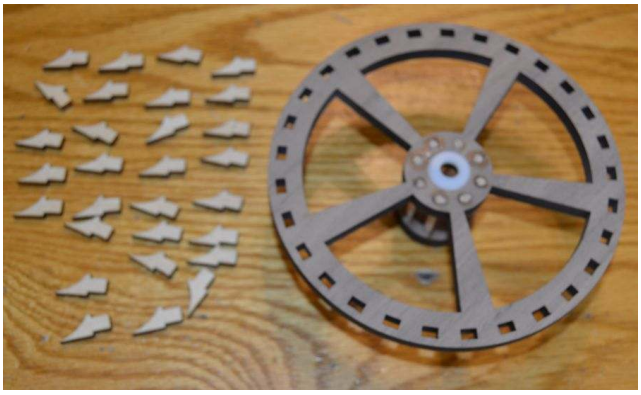


5) Use a toothpick to apply glue to the inside of the eight small holes in the pinion hub. Place the pinion hub on top of the dowels protruding from the crown wheel. Align one or two dowels with their holes and lightly tap to engage with the holes. Work gradually around the wheel, adjusting the dowels slightly to match up with the holes. Once all dowels are engaged, place a lantern pinion install pad on top of the pinion hub and tap with a hammer to bring the hub flush with the ends of the dowels. Proceed immediately to the next step.

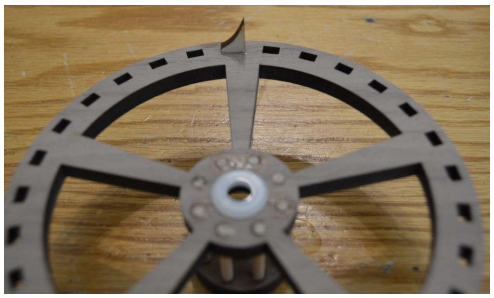


6) **It is very important that the crown wheel runs straight and true.** As was done with the middle wheel, place the crown wheel unit on a 1/4" dowel and spin it. View it from the side to see if there is excessive wobble in the wheel. If there is more than a slightly wobble (1/16"), slowly rotate the wheel to find the region of maximum deflection. Apply pressure at this location to correct the trueness of the wheel. This is done immediately after gluing the crown wheel together so that corrections can be made before the glue sets.

7) Locate the 29 crown wheel teeth along with the crown wheel unit.

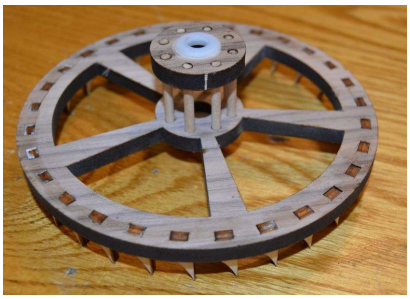


8) With the crown wheel up, glue a crown wheel tooth into one of the slots in the rim of the crown wheel. Be sure the flat side of the tooth is oriented as shown in the photo below.



9) In the same way, glue the remaining teeth into the crown wheel, with all teeth oriented the same way. Proceed immediately to the next step.

10) Place the crown wheel teeth-down on a flat surface. Apply light pressure to ensure that all teeth are fully inserted into the wheel.



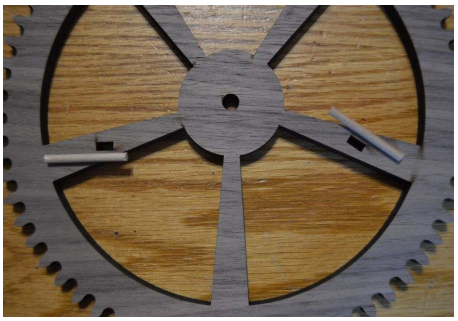
Great Wheel Pawls

Parts

1 - Great wheel (#31)
2 - Pawls (#57)

Procedure

1) Lay the great wheel on a flat surface **with the spokes oriented as shown below** (in the photo, dowels are placed next to the rectangular holes to emphasize the orientation of the holes).



2) Use a toothpick to apply glue to the insides of the two rectangular holes in the great wheel spokes. Insert the short tabs of the pawls into these holes. It might be necessary to tap them with a hammer to fully seat the pawls. Verify that the orientation of the pawls matches the photos below.

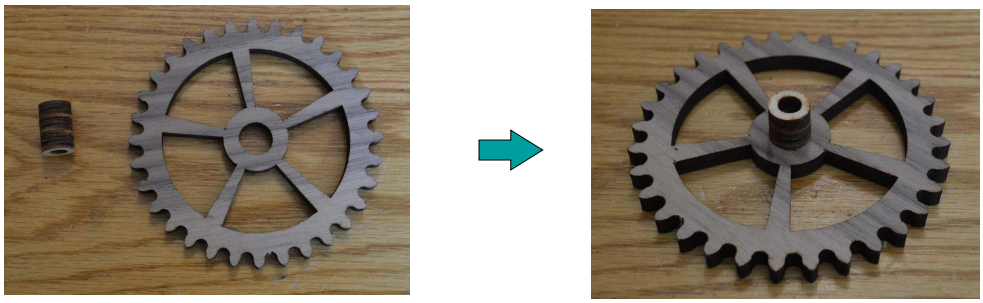
Hour Hand / Gear

Parts

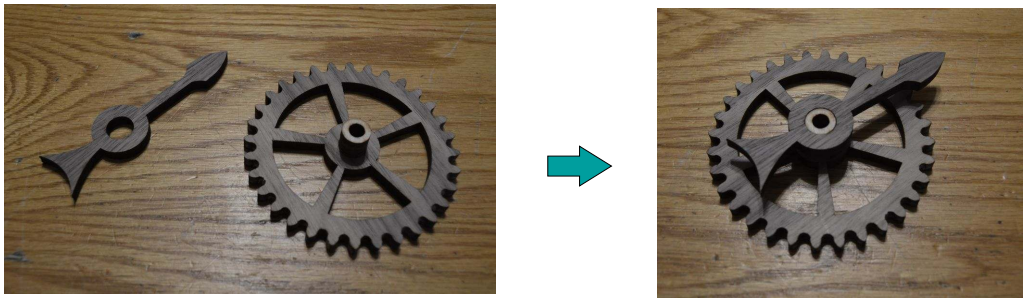
1 - 32-tooth gear (#33)
1 - Hour pipe (assembled previously)
1 - Hour hand (#43)

Procedure

1) Apply some glue to the hole in the center of the 32-tooth gear. Use a hammer to carefully tap the hour pipe (assembled previously) into that hole until the hour pipe is flush with the back of the gear.



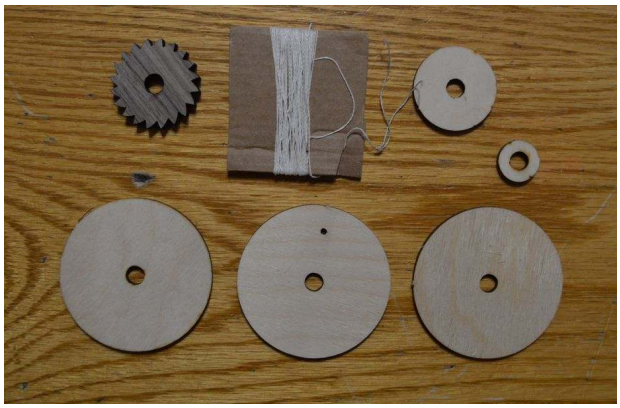
2) If desired, sand the outer perimeter of the hour hand. Press/twist the hour hand onto the hour pipe **but do not glue the hand to the pipe**. The hand must be friction fit so that it is loose enough to be able to be repositioned. If the hand fits too tightly, lightly sand the hour pipe.



Weight Spool Assembly

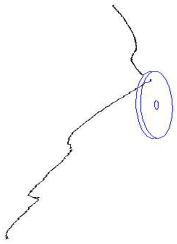
Parts

1 - Rachet (#32)
2 - Outer spool sides (#53)
1 - Weight spool interior divider (#51)
1 - Weight spool hub (#50)
1 - Winding spool hub (#52)
cord

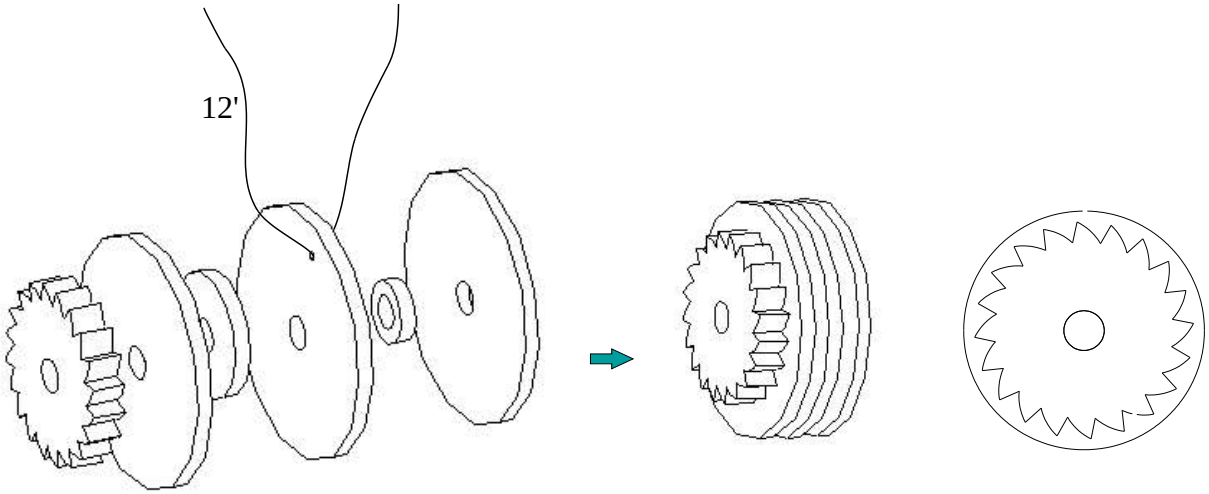


Procedure

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



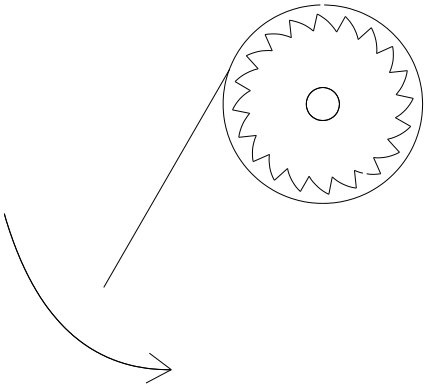
2) Glue the rachet, outer spool sides, winding spool interior divider, weight spool hub, and winding spool hub together in the order shown. **Be careful to orient the rachet teeth as shown**. Use a piece of 1/4" dowel or a drill bit to help align the pieces and to clear the center hole of excess glue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



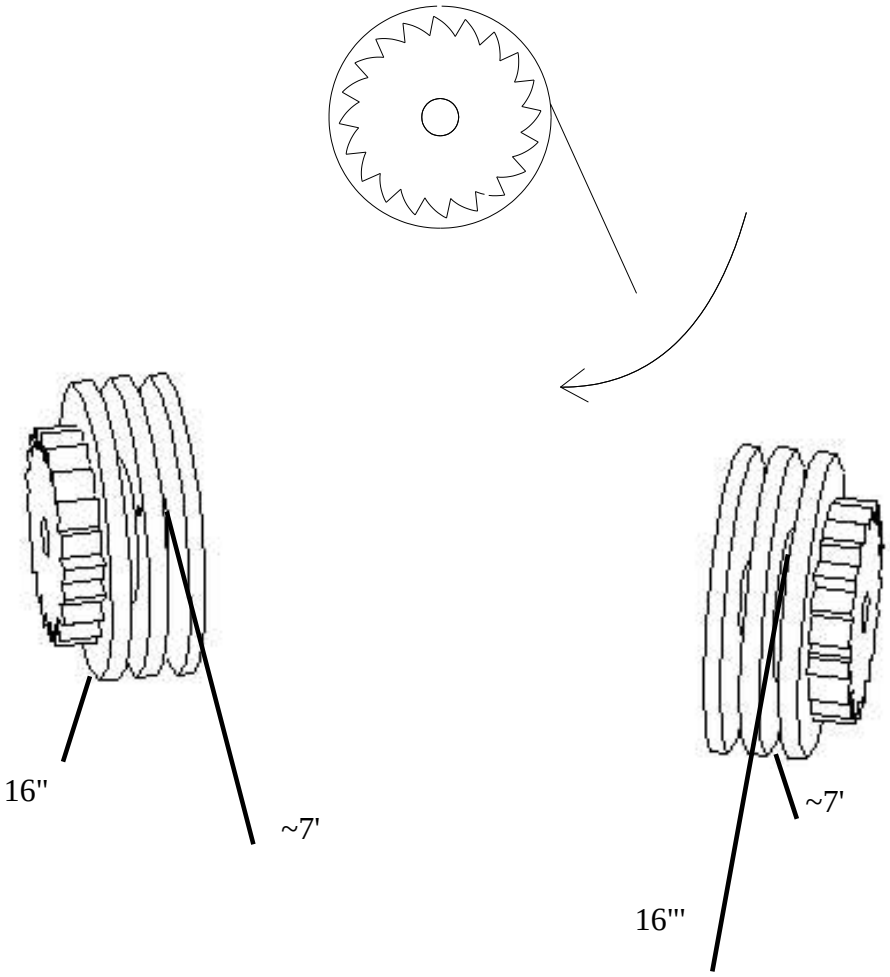
3) If desired, apply finish to the weight spool (if desired, cord can be removed to stain and then reinserted with tweezers or similar tool).

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

5) Hold the spool so the rachet is facing you (as pictured below). Wrap the 12' of 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 3 times around the smaller hub in a clockwise direction (nearly 7 feet of cord will remain).



7) Cut off 6" from the longer, 7' cord coming off of the small hub. Put this 6" piece of cord in a safe place; it will be used later.

8) Wind the longer cord around a small piece of cardboard. Secure the two strings in a slit in the cardboard square (or with a piece of tape) so they do not unwind during the upcoming assembly sequence.

Great Wheel Assembly

Parts

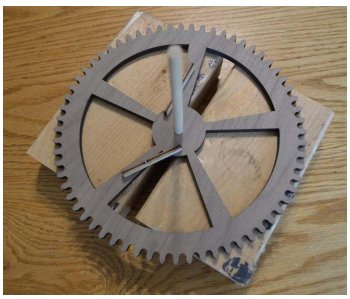
1 - Great wheel (#31)
1 - 5" dowel
1 - square (#2)
2 - set washers (#27)
1 - 10-tooth gear (#29)

Procedure

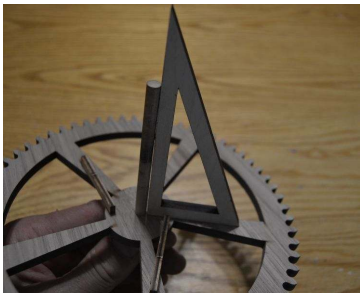
1) Label one end of the 5" dowel with a G. Place the 5" dowel on the diagram below with the G end on the left. Make marks on the dowel at the locations shown in the diagram (these marks indicate gear locations).

2) Place the great wheel on the sturdy, flat surface with the pawls up. Place the G end of the 5" dowel into the hole in the center of the great wheel. Use a hammer to drive the dowel into the hole until the dowel hits the table. Try to keep the dowel perpendicular to the gear as you tap it in.

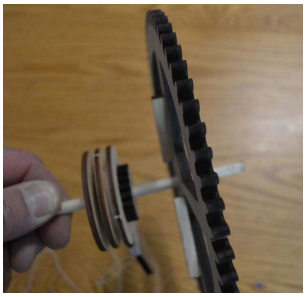
3) Place two blocks of wood (at least 1 1/2" thick) on the tabletop. Separate the blocks of wood by about ½". Apply a small amount of glue to the dowel between the lines marked to show the location of the great wheel. Place the great wheel unit on top of the blocks with the dowel centered over the gap between the blocks. Continue to drive the dowel through the great wheel until the great wheel reaches the mark on the dowel that indicates its location. Proceed immediately to the next step.



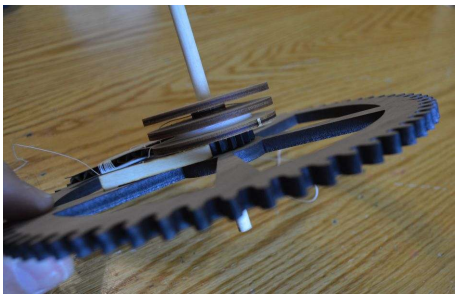
4) Verify that the arbor is perpendicular to the gear and adjust as necessary before the glue sets.



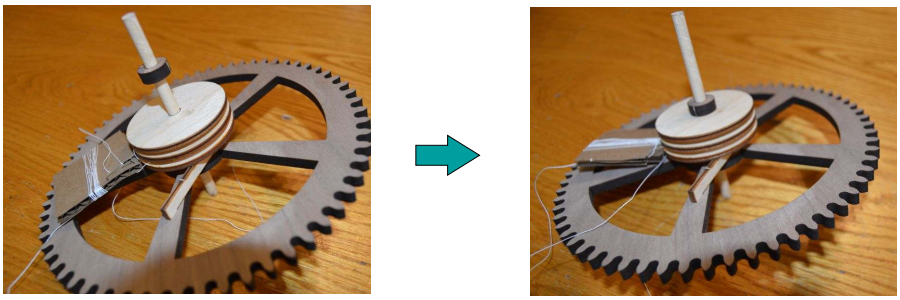
5) Slide the weight spool onto the longer end of the great wheel arbor, rachet side first. The spool should rotate freely on the arbor. If it does not, either sand the great wheel arbor or use a drill bit to clean out the spool hole.



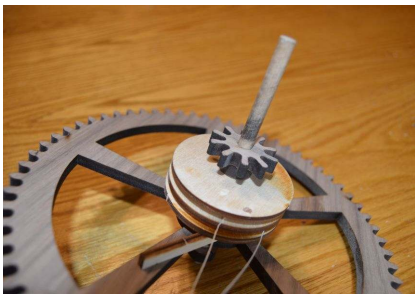
6) Push the spool toward the great wheel. Twist the spool and/or flex the pawls apart to allow the rachet to snap in between the pawls. Check the operation of the spool. Rotating the spool in one direction will force the wheel to turn. Rotating in the opposite direction will allow the spool to turn independent of the great wheel and make a click-click-click sound as the rachet teeth slip past the pawls.



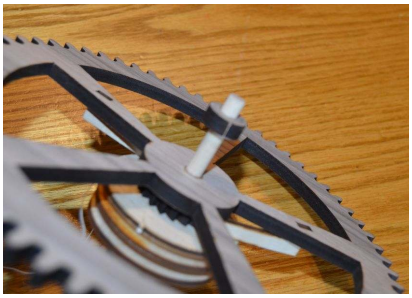
7) Twist a set washer onto the longer end of the great wheel arbor. Move it down the arbor until it is nearly in contact with the spool (the spool needs to be able to rotate, so the set washer cannot be pinching the spool tightly to the arbor).



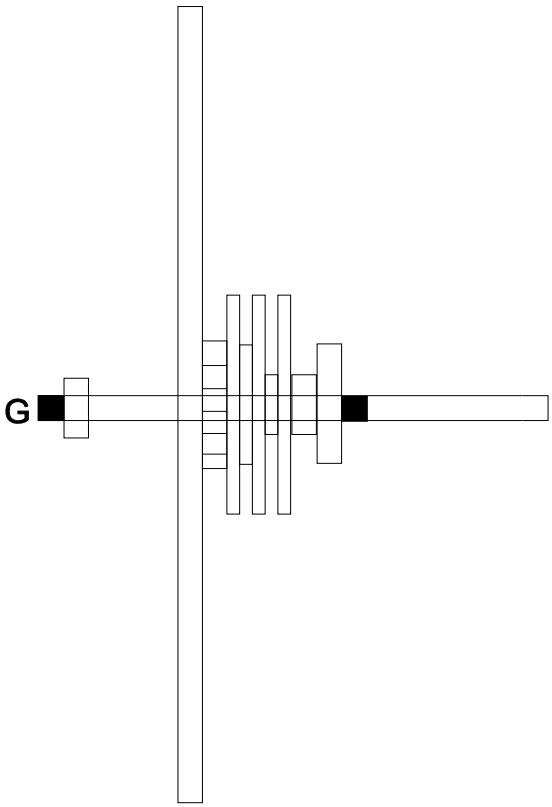
8) Twist the 10-tooth gear onto the longer end of the great wheel dowel until it reaches the set washer. If the gear is too tight to press on, lightly sand the dowel to permit the gear to be twisted on.



9) Twist a set washer onto the shorter end of the great wheel arbor so that 1/4" of dowel protrudes beyond the set washer. Do not glue the set washer yet.



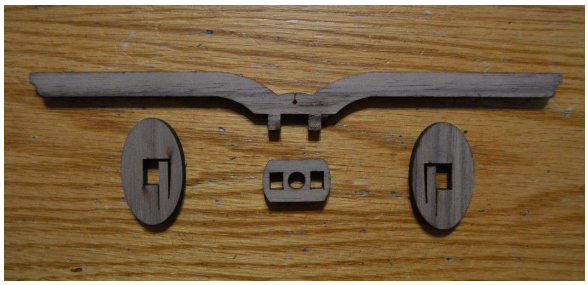
10) Use 100 grit sandpaper to sand the two ends of the arbor until the arbor sizing jig can slide completely onto both ends of the dowel. After this is achieved, use a succession of 220, 400, and 600 grit sandings to smooth and polish the sections of the dowel that are shaded in the diagram below. Apply graphite to the shaded regions of the dowel by coloring those sections of the dowel with a pencil.



Foliot

Parts

1 - Foliot arm (#42)
1 - Foliot base (#30)
2 - Foliot weights (#45)
6" cord (cut previously)



Procedure

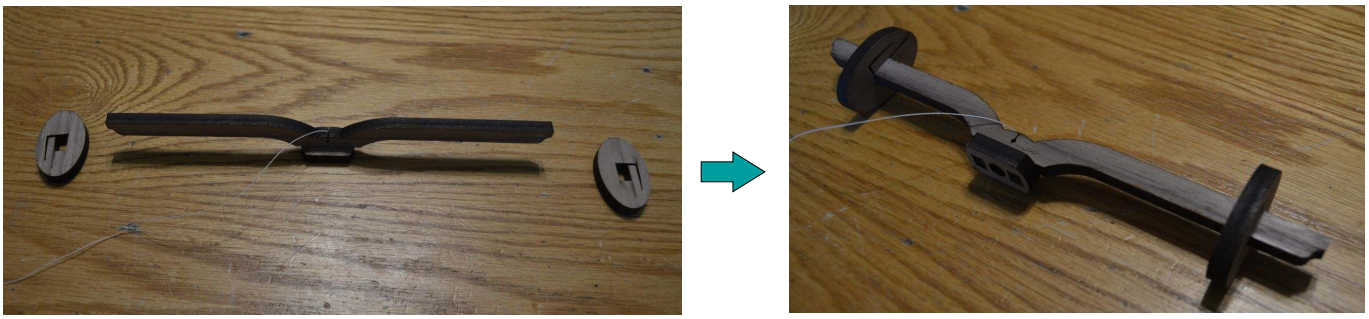
1) Glue the foliot arm into the foliot base.

2) Retrieve the 6" of cord that was previously cut from the supplied cord. Tie a triple knot near one end of that cord.

3) Pass the end of the cord nearest the knot through the hole in the foliot arm.

4) Continue to pull the cord through the hole so the knot ends up inside the hole in the verge arm. If it is a tight fit, use a pliers to pull the knot in or use a nail to push the knot into the hole. Once the knot is within the hole, pull the longer end of the cord up so that it passes through the slit in the foliot arm. Center the cord within the slit. Insert a drop of glue into the hole to secure the knot within the hole.

5) If desired, sand the perimeter of the foliot weights. Slide a foliot weight onto each end of the foliot arm. Press the foliot arm against the tab in the foliot weight to allow the foliot arm to engage into the hole. The foliot weights should be tight but repositionable on the foliot arm. Position the foloit weights about 1" from the ends of the foliot arm.



Verge

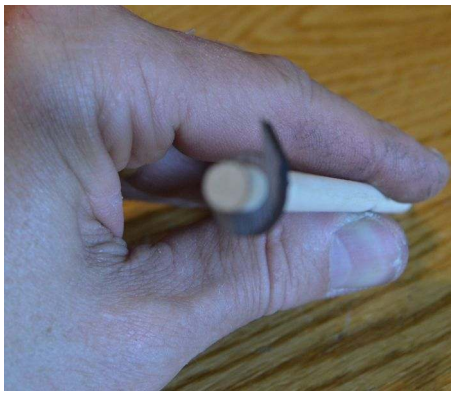
Parts

2 - Pallets (#46)
1 - 6 ½" dowel
1 - Verge jig (assembled previously)
1 - Foliot (assembled previously)
1 - Nylon shoulder washer

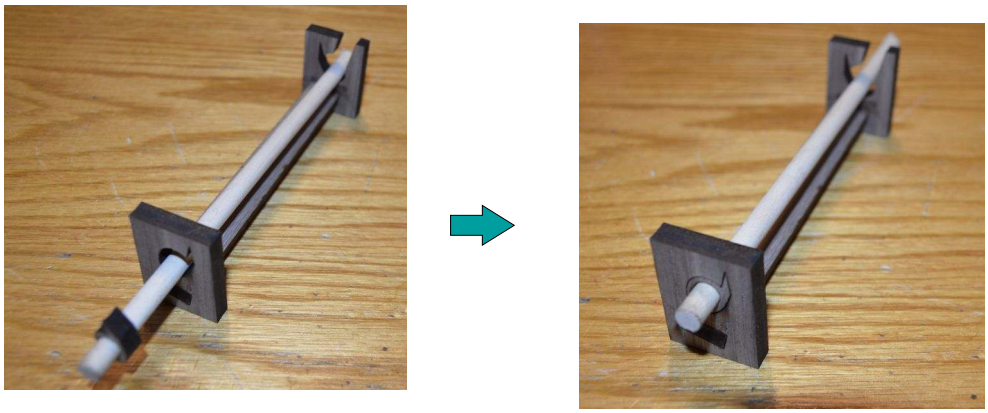
Procedure

1) The pallets must be able to slide easily onto the 6 1/2" dowel. If the pallets require much force to move or rotate on the arbor, sand down the arbor with 220 or 400 grit sandpaper.

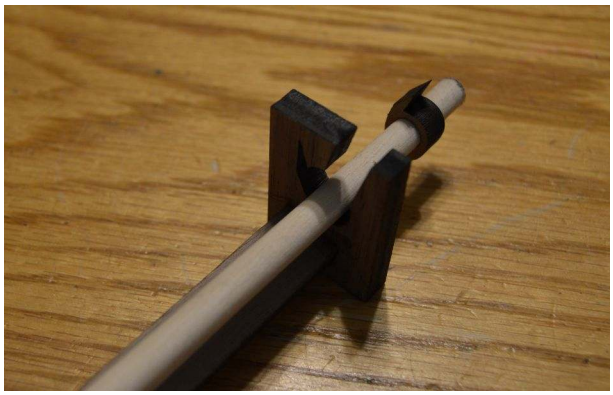
2) Slide one of the pallets onto the verge rod with the flat edge of the pallet oriented as shown in the photo below. Glue the pallet to the dowel so there is 3/8" of dowel protruding past the pallet.

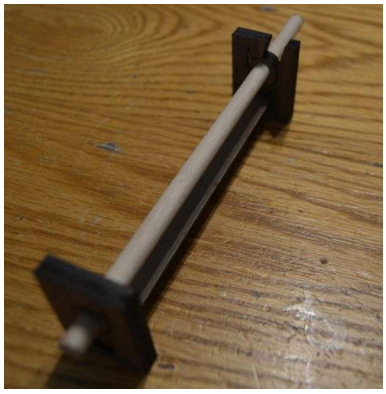


3) Slide the verge rod into the hole in the verge jig end. Push the verge rod through until the verge pallet fits into the cutout in the verge jig end.

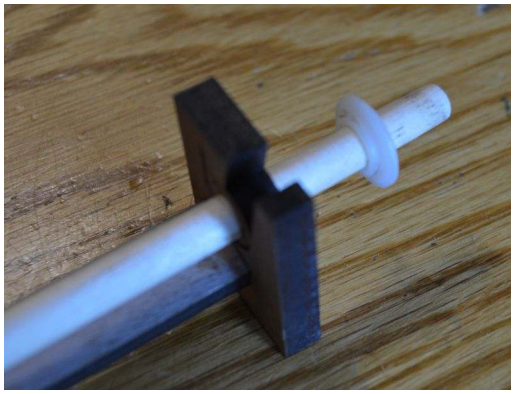


4) Slip the remaining pallet onto the other end of the arbor, with the pallet oriented so that it will fit into the verge jig end. Place a small dot of glue to the portion of the dowel that is within the opening of the verge end. Slide the pallet along the arbor until it fits in cutout in the verge end. At this point, both pallets should be within the verge jig ends.

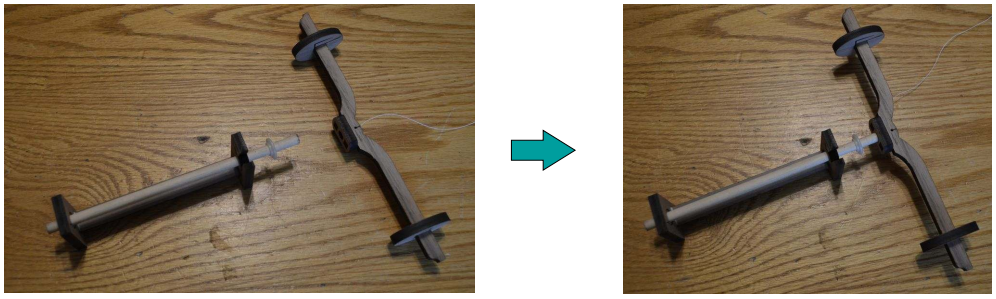


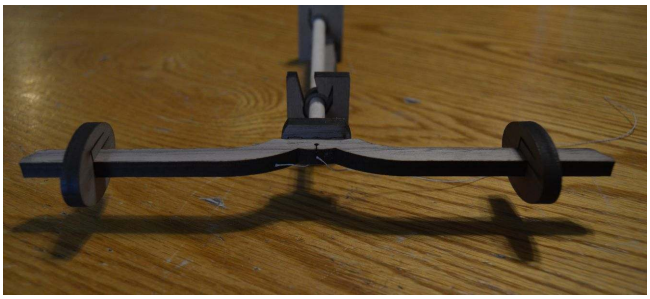


5) Place a nylon shoulder washer on the end of the verge rod protruding from the jig. Be sure that the flat face of the washer faces away from the jig (the ridged face adjacent to the jig).

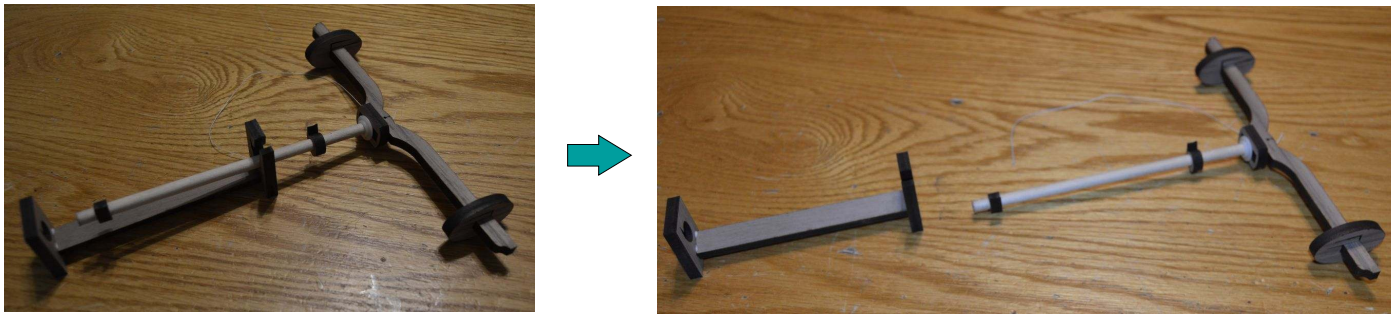


6) Press the foliot onto the end of the verge rod (do not glue yet). With the verge jig resting on the table as in the previous steps, the foliot should be parallel with the tabletop.





7) Remove the verge unit from the jig by sliding the unit to the side and lifting it out of the jig.



Finish Application

If you are going to apply finish to the frame, mask off the two dowels protruding from the rear frame. Also, mask off the nylon shoulder washers to prevent finish from getting inside the washers. Apply finish if desired.

If you are going to apply finish to the gears, mask off arbors and nylon shoulder washers. Do not apply a built-up finish (such as varnish or polyurethane) to the contact surfaces of the gears or the crown wheel teeth.

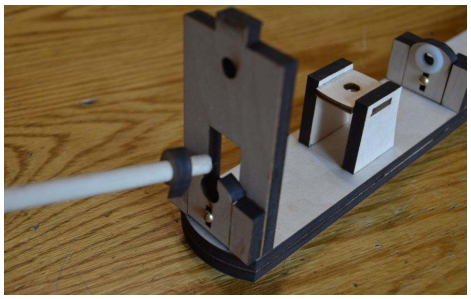
Verge Installation

Parts

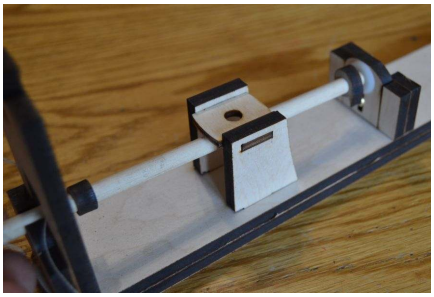
1 - Verge (assembled previously)
1 - Front frame (assembled previously)

Procedure

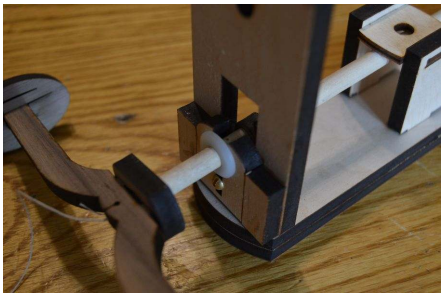
1) Insert the verge rod through the opening in the upper pillar.



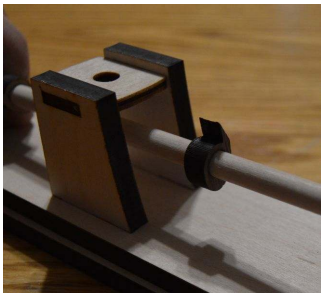
2) Pass the verge rod into the nylon washer in the lower verge bearing.



3) Snap the nylon washer on the verge rod into the circular opening in the upper verge bearing.



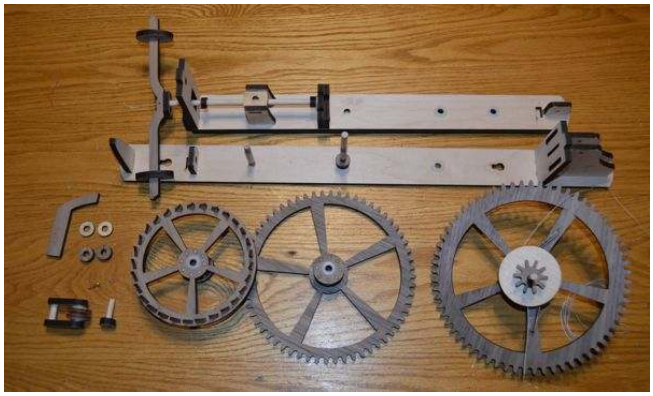
4) Rotate the verge rod so the pointed ends of the pallets are pointed away from the front frame (upwards in the photo below).



Final Assembly

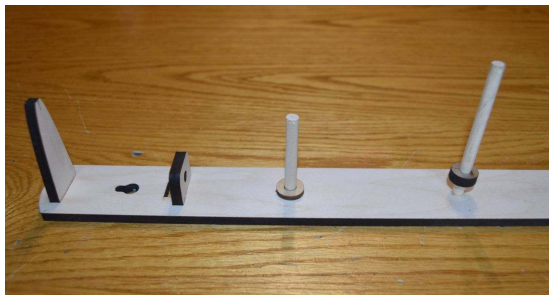
Parts

1 - Front frame unit (assembled previously)
1 - Rear frame unit (assembled previously)
1 - Crown wheel unit (assembled previously)
1 - Middle wheel unit (assembled previously)
1 - Great wheel unit (assembled previously)
2 - Spacer washers (#59)
2 - Set washers (#27)
1 - Verge spacing gauge (#38)
1 - top pillar pin (assembled previously)
1 - pulley unit (assembled previously)
1 - #4x1/2" screw
1 - nylon shoulder washer

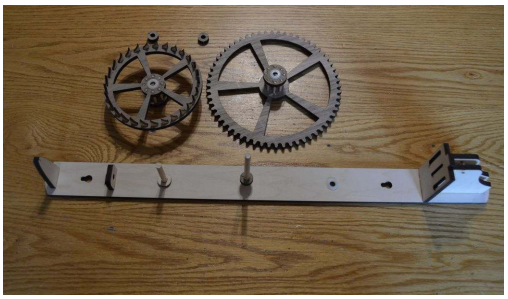


Procedure

1) Drop a spacer washer (1/8" thick) onto the shorter arbor in the rear frame.

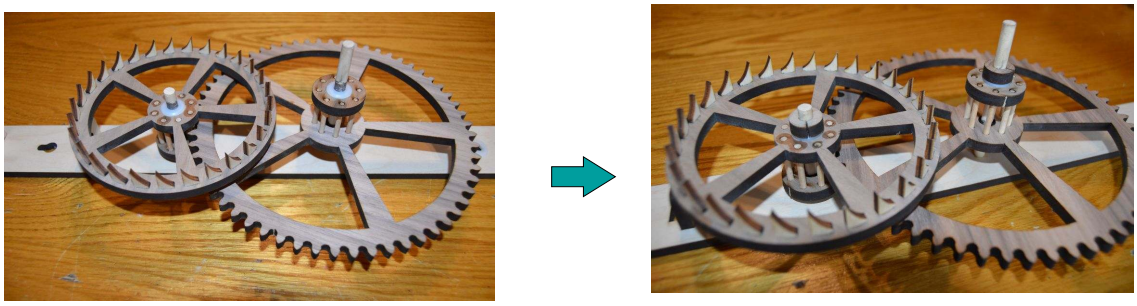


2) Locate the crown wheel unit, middle wheel unit, and two set washers.

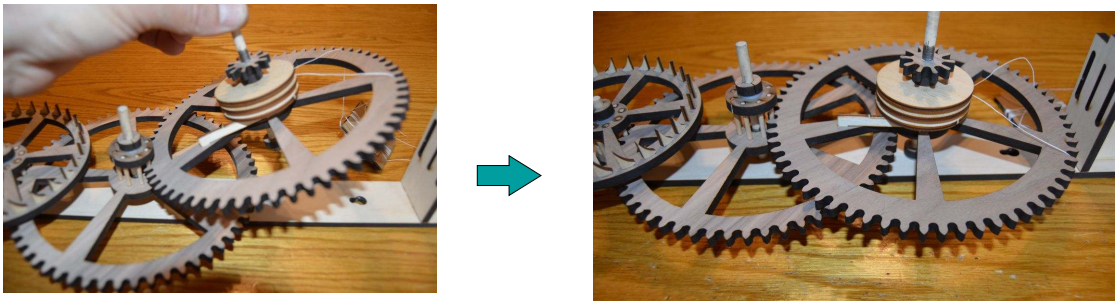


3) Hold the crown wheel and middle wheel unit together with the crown teeth of the crown wheel and the pinions of the middle wheel both facing up. The teeth of the 60-tooth gear fit into the pinions of the crown wheel. Drop the two wheel units onto the arbors in the rear frame with the crown wheel unit on the shorter of the two arbors (nearest the cord support). Rotate the gears to verify that they mesh smoothly

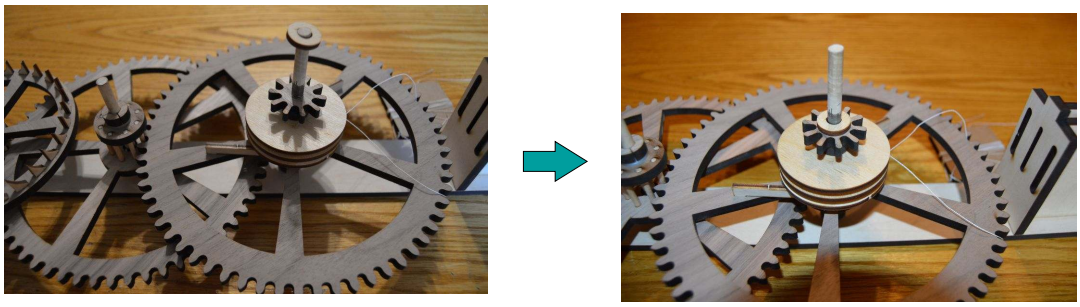
4) Twist a set washer onto both of the rear frame arbors. Locate each set washer so that it is nearly in contact with the nylon washer in the gear unit. The gears require some clearance to spin freely, so there should be a small amount of space between the set washer and the nylon washer.



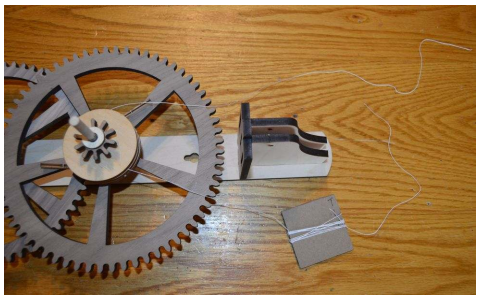
5) With the spool up, tip the great wheel unit so its teeth engage with the pinions of the middle wheel. Then drop the end of the great wheel arbor into the nylon washer in the rear frame.



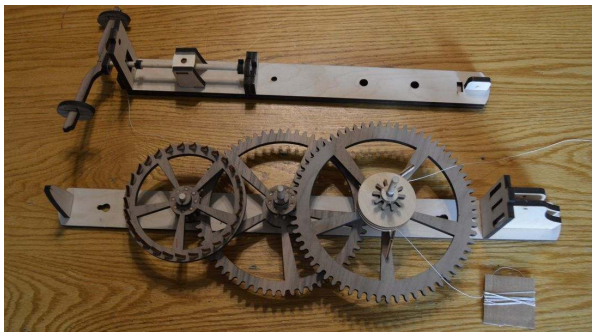
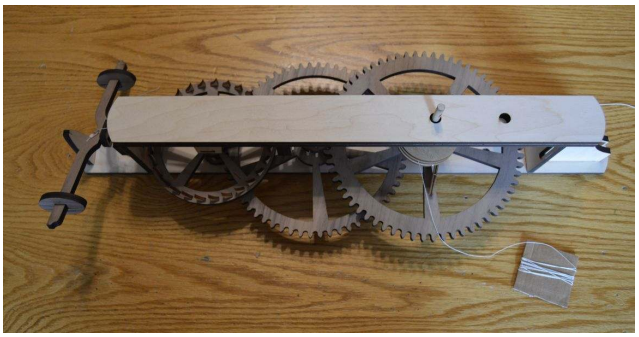
6) Drop a spacer washer on the great wheel arbor.



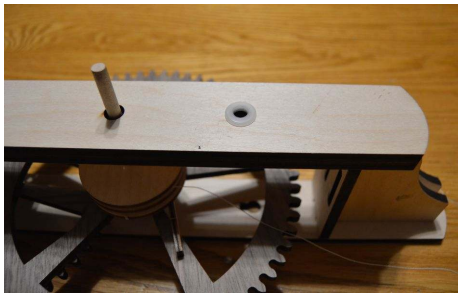
7) Separate the two cords coming off the spool so that each passes on one side of the lower bracket without crossing over each other (in the photo below, the longer cord is wrapped around the cardboard square. The shorter cord lies on the opposite side of the lower support bracket).



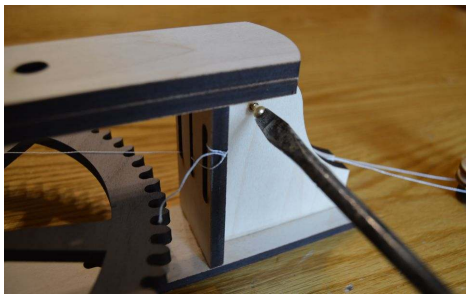
8) This step will require some patience. Place the front frame unit over the rear frame unit, starting with engaging the great wheel dowel into the second hole in the front frame. Continue to work along the front frame, gradually engaging the dowels and tabs into their front frame holes. It helps to maintain slight downward pressure on the front frame as you work the dowels into position. When complete, the following parts should be engaged into a front frame hole: lower pillar tab, great wheel arbor, middle wheel arbor, and crown wheel arbor. Also, the tab on the top pillar should engage with the hole in the rear frame.

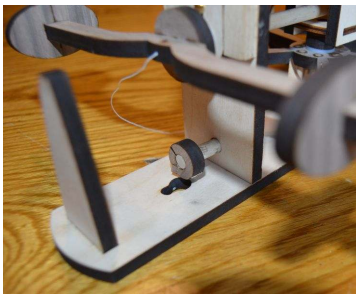
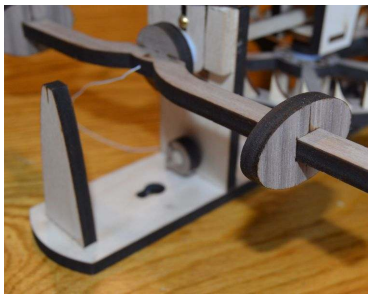
9) Apply a small amount of CA glue around the rim of the open hole in the front frame. Press a nylon shoulder washer into this hole.



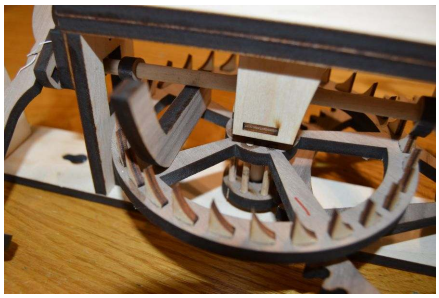
10) Drive a #4x1/2" screw through the hole in the lower bracket and into the predrilled hole in the lower bracket anchor.



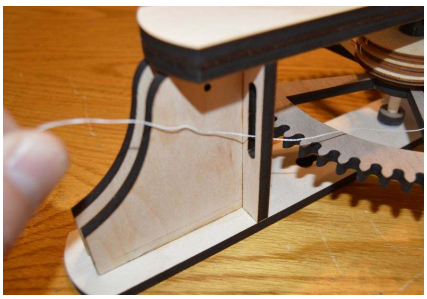
11) Insert the top pillar pin through the hole in the top pillar and through the hole in the top pillar anchor.

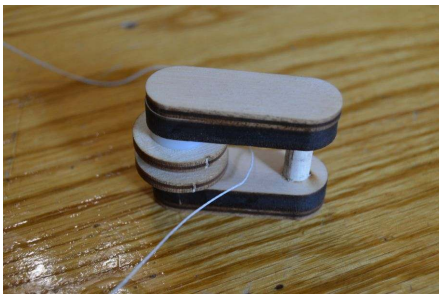
12) Slide the verge spacing gauge between the crown wheel and the verge near both the top and the bottom of the crown wheel. Adjust the position of the upper and/or lower verge bearings (by loosening the screws holding the bearings in place) until the verge spacing gauge just fits between the verge rod and the crown wheel. When testing and adjusting for spacing, be sure that both ends of the spacing gauge are resting on the crown wheel so the gauge is unable to rock.



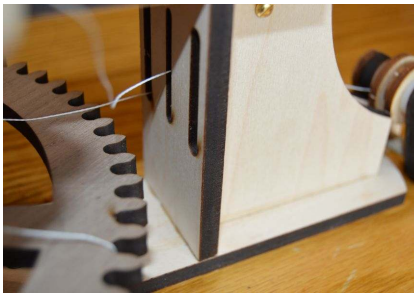
13) Pass the cord that comes off the larger hub of the spool (the shorter cord) through the slot on the right side of the lower pillar.



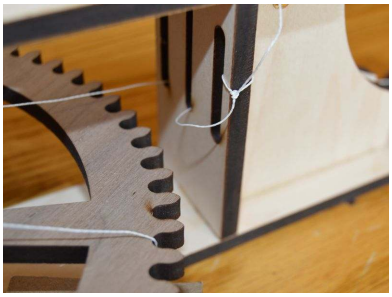
14) Pass the same (short) cord through the pulley unit.



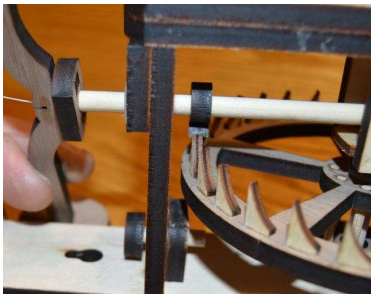
15) Pass the same (short) cord between the lower brackets and through the slot in the middle of the lower pillar.



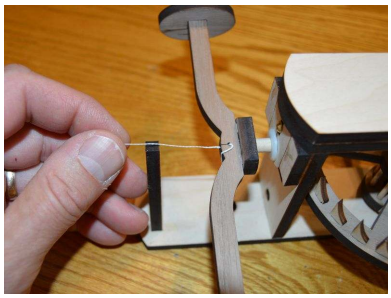
16) Pass the end of this cord through the remaining empty slot in the lower pillar and tie a knot to secure the cord to the lower pillar.

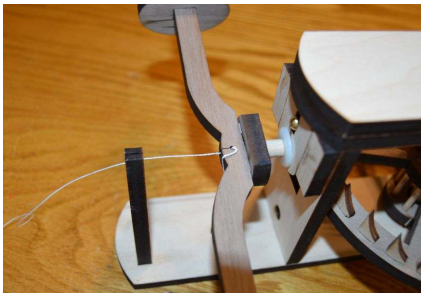


17) Position the verge rod within its bearings, centering the pallets on the crown wheel teeth.

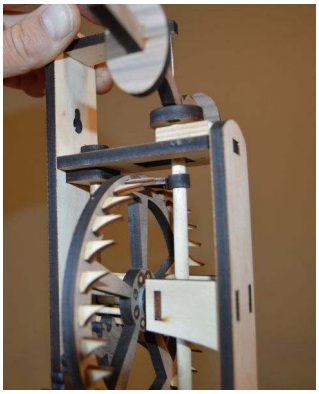


18) Hold the verge unit in this position (pallets centered on crown wheel teeth) and pull the foliot string over the slot in the cord suspension. Pass the cord into the slot in the cord suspension (a pliers will be helpful to pull the string into the slot)

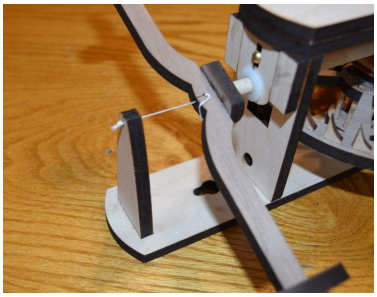




19) Turn the clock to a vertical position and allow the verge unit to hang from the suspension cord. Verify that the verge pallets are centered on the crown wheel teeth. Adjust by pulling the string one way or the other in the slot. Also, move the cord forward or backward in the slot so the string is vertical.



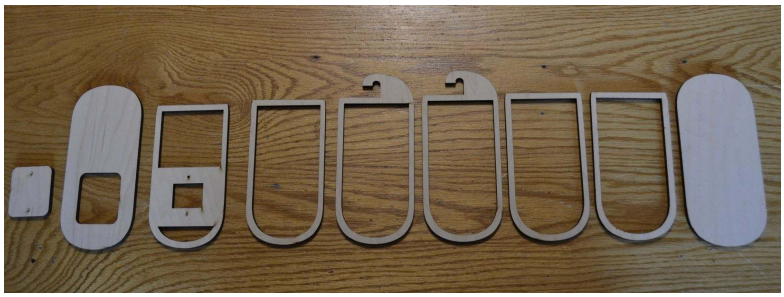
20) Tie a knot in the free end of the cord, getting the knot as close to the cord suspension as possible. Cut off the excess cord beyond the knot.



Weight Shell

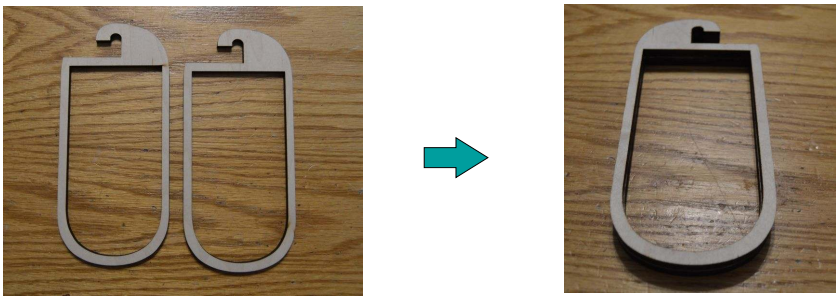
Parts

1 - Weight shell cover plate (#25)
1 - Weight shell back (#24)
1 – Weight shell inner back (#23)
3 - Weight shell middle pieces (#18)
2 - Weight shell hook pieces (#49)
1 - Weight shell front (#6)

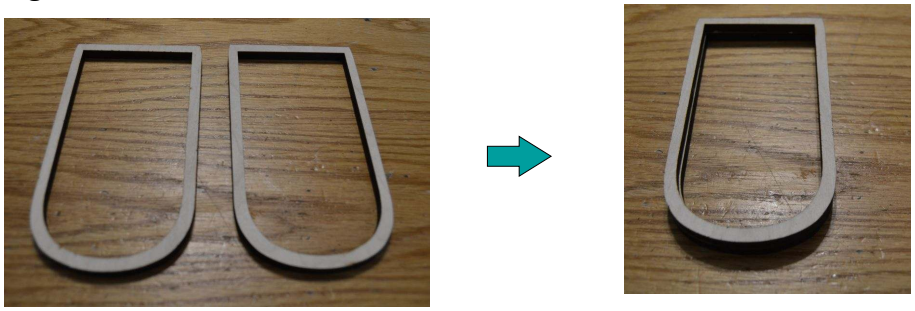


Procedure

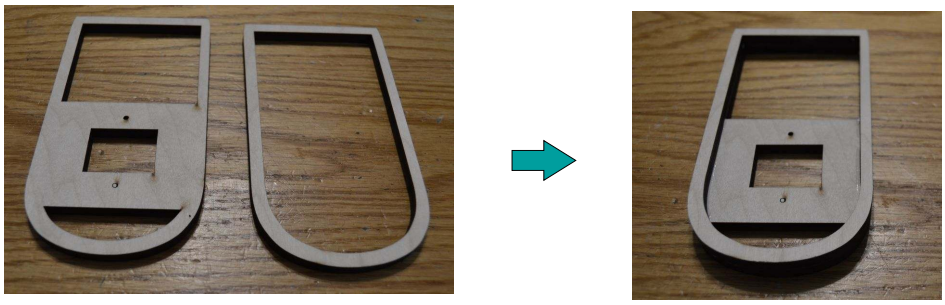
1) Glue together the two weight shell hook pieces, aligning all the outer edges. If desired, sand the perimeter edges.



2) Glue together two of the weight shell middle pieces, aligning all the outer edges. If desired, sand the perimeter edges.

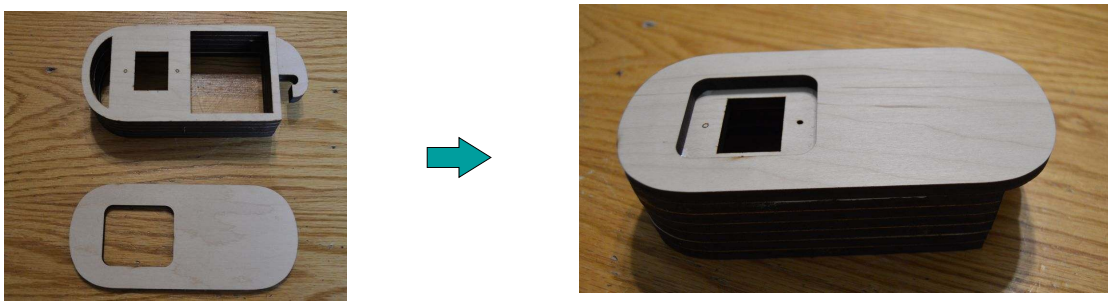


3) Glue together a weight shell middle piece and the weight shell inner back, aligning the outside edges. If desired, sand the perimeter edges.

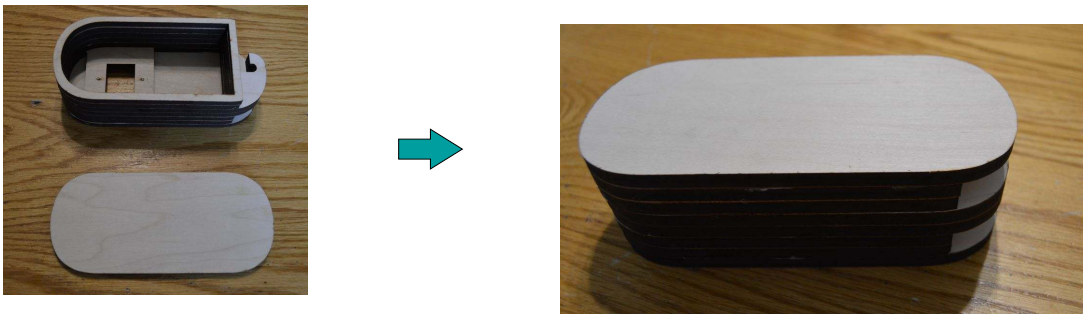


4) Glue the three previously assembled units together with the hook piece between the other two and with the inner back facing away from the hook. Complete any needed sanding on the outer edges.

5) Glue the weight shell back to the previously assembled unit so the cutout in the weight shell back is over the cutout in the weight shell inner back.

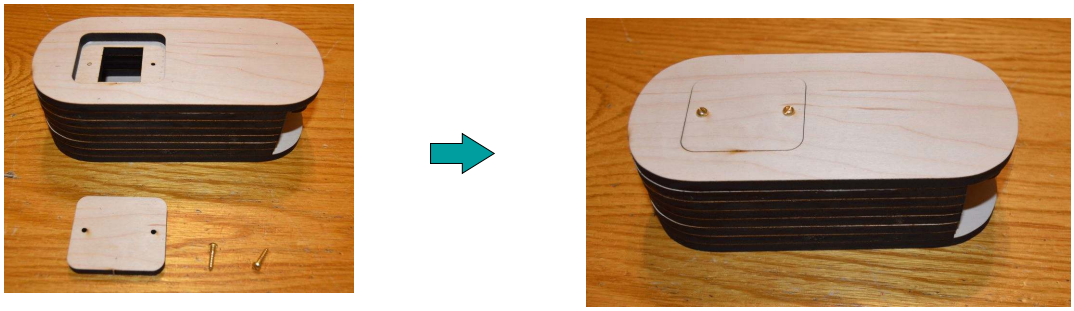


6) Glue the weight shell front onto the other (open) end of the weight shell unit. If desired, sand the outer edges.



7) Fill the weight shell with about 2 lbs of metal shot. When filled, the weight shell should weigh about 2.5 lbs.

8) Use two #4x1/2" screws to secure the weight shell cover plate to the back of the weight shell.



Mounting and Preliminary Testing

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 the solid mounting.
   b) Choose a location which is free from obstructions to 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 78" above the floor. Leave approximately 1/4" of the screw protruding from the wall. Drive the other 1 5/8" screw into the wall 14" below the first screw. These screws should fit snugly into the keyhole slots in the back of the frame. Adjust the screw depth until the screw seats firmly into the narrow portion of the keyhole slot. Hang the clock on the wall.

3) The weight pulley is suspended by the weight cord. Make sure the string passes under the pulley wheel rather then beside it.

Caution: Before hanging the weight on the clock, be sure that the verge is positioned so that the verge pallets will catch the crown wheel teeth. Test by pulling down on the weight cord to verify that the verge rotates back and forth rather than the gear train spinning freely.

4) Hang the weight shell hook on the lower dowel of the weight pulley. Release the weight shell but be ready to catch it immediately if the clock wheels spin freely.

5) At this point, the foliot should be swinging (rotating) back and forth while the verge pallets catch and release teeth of the crown wheel. If the foliot hits the wall, reposition the foliot by rotating it on the verge rod. Once the correct position is established, make aligning marks on the foliot and verge rod. Twist the foliot off the verge rod and glue it back on, aligning the marks. Retest before the glue sets.

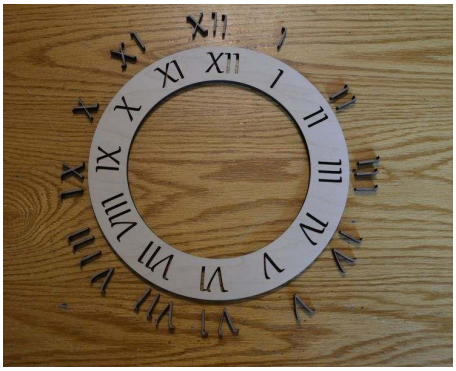
6) It might be necessary to fine tune the position of the verge by adjusting the verge bearings. Loosen the screw in one of the bearings to reposition the bearing closer or further from the crown wheel. When a tooth meets a verge pallet, the tooth should make contact about 1/8" along the verge pallet. If the verge locks up with both pallets in contact, it will be necessary to move the verge bearing slightly away from the crown wheel. The amount of tooth contact should be approximately equal on both pallets. It might take some back-and-forth fine tuning to get the bearing positions correctly adjusted.

7) View the clock from the side. Verify that the cord that supports the verge is vertical. Move the cord forward or backward in the slot as needed.

8) Unwind the long, left side cord from the cardboard to let the cord hang freely. Attach the end of the cord to the cardboard by slipping it into the slit in the cardboard.

9) Let the clock run for at least several hours to be sure the main movement is functioning properly. If you have difficulty getting the clock to run, refer to the Troubleshooting section later in this manual.

Dial



Parts

1 - Numerals set (#48)

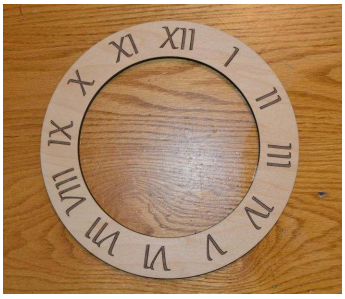
(The numerals are delicate. Remove them from the panel by using a small slot screwdriver to push them through from the backside, working little by little to keep to the numerals from wedging.)

1 - Dial (#7)

Procedure

1) Flip the dial face down on the table (the numbers will be backwards on the dial). Apply a small amount of glue to the edges of the numerals and carefully press them into place in the dial. If necessary, use a piece of scrap wood and a hammer to carefully tap them in to bring them down to the tabletop.

2) Flip the dial right-side-up and wipe away any glue squeeze out with a damp rag.

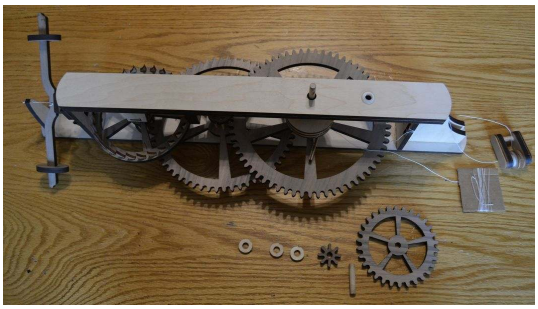


3) If desired, sand the outer and inner perimeter and apply finish to the top and edges of the dial.

Final Gears and Hands

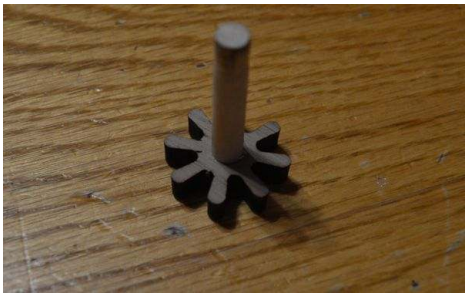
Parts

1- Assembled clock unit
1 - 30-tooth gear (#37)
1 - 8-tooth gear (#36)
1 - 1 1/2" dowel
3 - spacer washers (#59)
2 - set washers (#27)

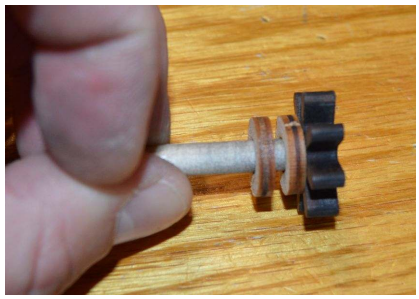


Procedure

1) Apply a small amount of glue to the inside hole of the 8-tooth gear. Drive the 1 1/2"dowel into the 8-tooth gear.

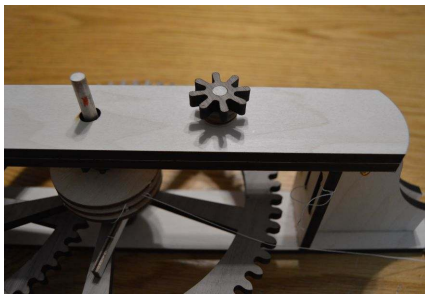


2) Place two spacer washers on the 1 1/2" dowel.

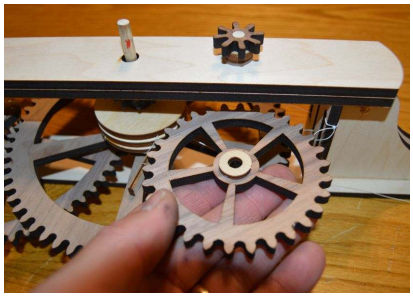


3) Tap the 1 1/2" dowel into the 30-tooth gear. Then twist the 1 1/2" dowel out of the 30-tooth gear. Check that the 30-tooth gear can now be pressed onto the 1 1/2" dowel by hand. Repeat the insertion/removal of the dowel if necessary.

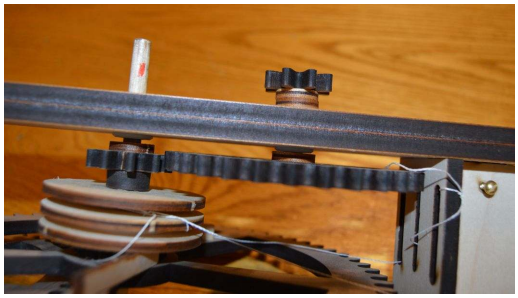
4) Insert the 1 1/2" dowel through the nylon shoulder washer in the front frame without allowing the washers to fall off.



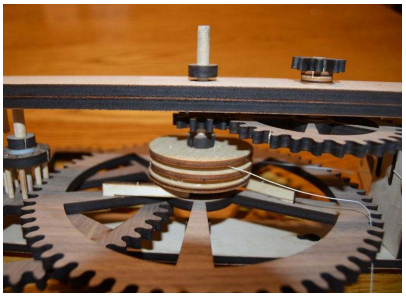
5) Place a spacer washer on top of the 30-tooth gear with the holes aligned.



6) Place the 30-tooth gear beneath the 1 1/2" dowel and engaging with the 10-tooth gear on the great wheel arbor. Push up on the 30-tooth gear and down on the 8-tooth gear to press the dowel fully into the 30-tooth gear.



7) Push a set washer onto the great wheel arbor, leaving it about 1/16" shy of the front frame.



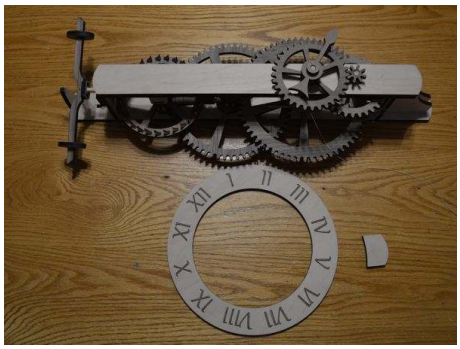
8) Slide the 32-tooth gear with hour hand onto the great wheel arbor, meshing the 32-tooth gear teeth with the neighboring 8-tooth gear.

9) Push a set washer onto the great wheel arbor until it is nearly in contact with the hour pipe. There must be some clearance allowing the 32-tooth gear to rotate on the arbor.

Optional Minute Hand

10) Historically, these types of clocks had only an hour hand, since their accuracy did not justify a minute hand. However, you may substitute a minute hand for the final set washer. The minute hand may be left permanently, or temporarily as an aid in adjusting the pace of the clock

Dial Installation

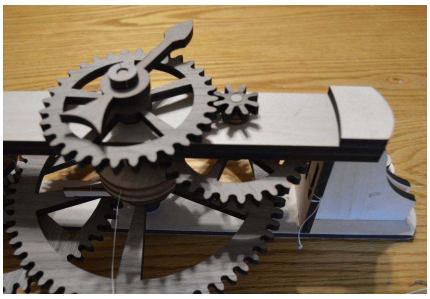


Parts

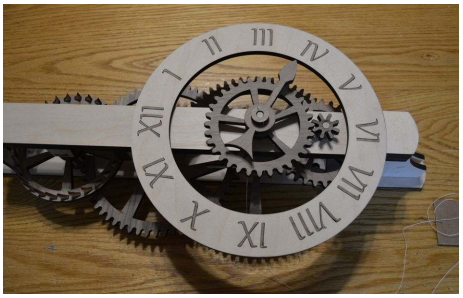
Dial (assembled previously)
Clock (assembled previously)
Dial placement jig (#1)

Procedure

1) Set the dial placement jig on the bottom of the front frame, lining up the edges of the jig with the edges of the frame. Tape it in place.



2) Place the dial on the frame with the 'VI' end of the dial against the dial placement jig.



3) Adjust the position of the dial so the 'XII' and 'VI' are centered on the front frame. Mark the location of the dial on the frame to indicate where glue will be applied.

4) Glue the dial in place, making sure the dial is against the dial placement jig and the numerals are properly aligned with the frame. Double check measurements from the front frame to the dial to verify centering on the front frame. Remove the dial placement jig.

Winding Pull

Parts

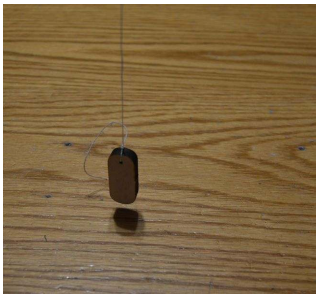
1 - Winding pull (#3)

Procedure

1) If desired, sand the outer edges of the winding pull and apply finish.

2) Wind the clock fully by pulling down on the cord on the left side of the clock. Wrap the cord around a piece of scrap wood to make it easier to pull.

3) Thread the end of the cord through the hole in the winding pull. Tie the cord with a triple knot so that the pull reaches the floor. Add a drop of CA glue to the knot.



4) After several windings, the excess cord can be cut off beyond the knot.

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 too 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 speed of a verge and foliot clock is governed by two factors: the distance of the foliot weights from the verge rod and the driving weight. Moving the foliot weights inward on the foliot arms causes the clock to run faster. Increasing the driving weight also causes the clock to run faster. If you have an appropriate amount of driving weight, positioning the foliot weights about 1" from the end of the foliot arms will result in approximately the correct pace. To fine tune the timekeeping, it is necessary to move the foliot weights inward or outward or to increase or decrease the weight. The verge and foliot design is not as accurate as modern clocks; you can expect variations of a few minutes throughout the day. Ideally, you can get these to average out and provide a reasonable timekeeper. It is best to wait for several hours before making adjustments.

TIP: Mark one spoke of the crown wheel. When the tooth at that mark strikes one of the pallets, start a stopwatch. Stop the watch when that tooth makes a complete revolution and strikes that same pallet again. This should be close to 1 minute.

TIP: To experiment with making small changes in the driving weight, hang a sandwich bag over the hook of the weight shell and add/remove pennies. This avoids having to open the weight shell.

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 pulley or weight spool. It may be necessary to restart the pendulum after winding. It might be necessary to lift the pulley wheel back onto the weight cord if it jumped off during winding. After winding, verify that both the weight and winding cords pass over their respective pulley on the frame. The clock should run for about 26 hours on one winding.

Your clock will wind easier after it has been wound a few times. If you find it very difficult to wind, you can carefully flex the pawls out away from the spool so that they are not grabbing the ratchet so forcefully.

4) Final gluing

The set washers may also be glued in place once their positions have been finalized. Note: <u>do not glue the following pieces: hour hand, 8-tooth gear on the short arbor at the bottom of the frame, and the set washers on either side of the 32-tooth hour gear</u>.

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:

Pallet Spacing

If the crown wheel locks up with both pallets in contact with crown wheel teeth, then the verge rod needs to be moved slightly away from the crown wheel. This is done by adjusting the verge bearing locations (the verge bearings are held in place by a small screw). The pallet should strike about 1/8" of the teeth. If the verge rod is moved too far, the crown wheel teeth will either miss the pallet or just nick it as it passes by and not properly rotate the foliot.

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 arbor can be jiggled back and forth between the frame pieces. If the spacers are pushed too tightly against the nylon bearings so that no back and forth movement is allowed, move one of the gears inward on the arbor to allow a small space between the spacers and the nylon bearings.

Gear alignment

Check to see that each gear is aligned with its mating gear. Reposition gears on the shaft as necessary so that mating gears fall in line with each other.

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 (see above section for possible causes of gear train problems).

Weight

There must be sufficient weight to overcome friction. 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.

Suspension cord plumb

It is important that the suspension cord is vertical. Look at the clock from the side and adjust the cord within the slot so that it is vertical. If it is loose in the slot, add a drop of glue at the top of the slot to secure the cord in place.

Verge height

The pallets need to be close to centered vertically on the crown wheel teeth as they strike the teeth. Move the suspension cord up or down in the slot to achieve this. If the knot is not against the support, add a drop of glue at the top of the slit to keep the cord from dropping down.

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 Diadem clock. Please drop us a note if you want to share any thoughts about the clock or if you have any suggestions for improvements that can be made!

Part Locator

(To be removed from the manual)