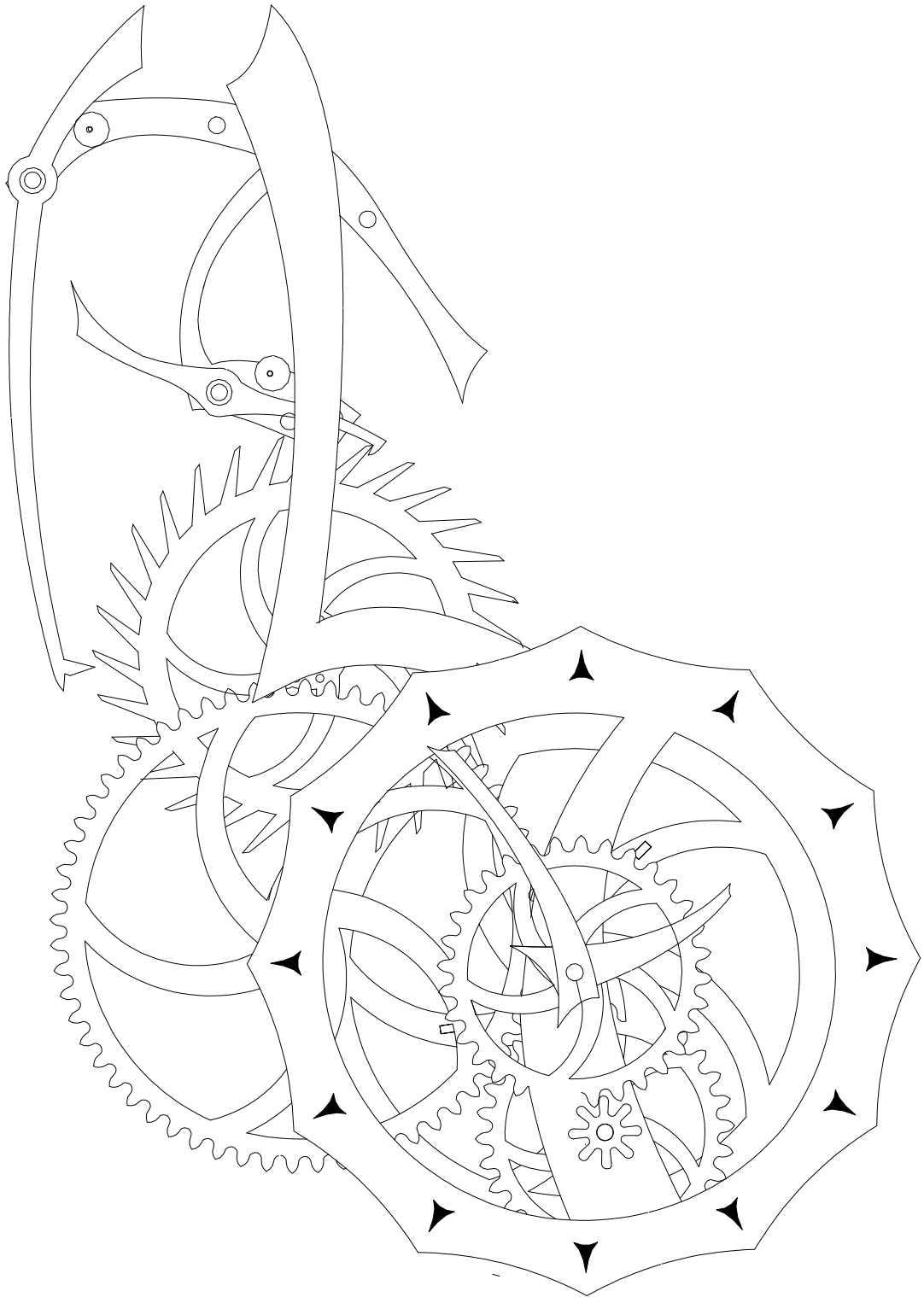
The Tranquility Clock



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clocks, kits, and do it yourself patterns

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 Tranquility 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. Of particular interest is its 'grasshopper' escapement. It is based on the famous escapement which was developed by John Harrison. In the late 1700's, Harrison devised the grasshopper escapement in his quest to make an accurate, seaworthy clock and claim the "Longitude Prize". The goal of his articulated escapement was to eliminate sliding friction at the pallets, which was a significant source of error in the days when effective lubrication had not been developed.

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, including the operation of the unique grasshopper escapement.

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
- knife
- hammer
- clamps (small spring clamps work well)
- 3-4 lbs of metal shot (available from sporting goods or firearms stores)
- wood glue
- sandpaper (100, grit, 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.

2) You may 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 may 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.

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. Note that the backsides 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.

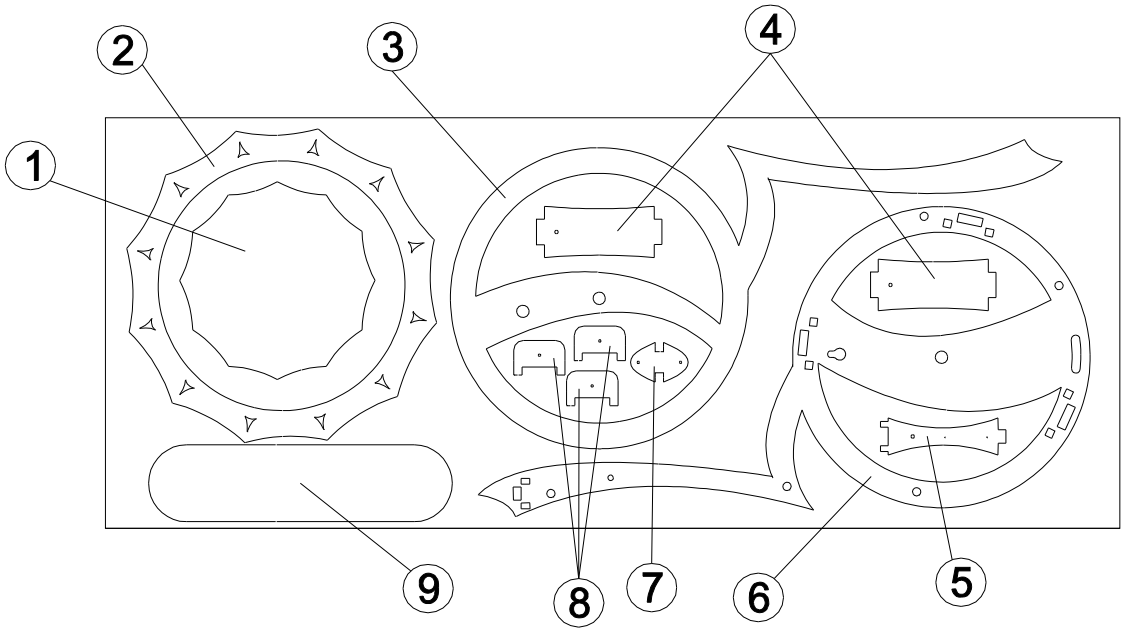
6) Some of the parts fit together tightly. It may be necessary to gently tap them together with a hammer. If the fit seems too tight, some light sanding may be necessary to insure a proper fit.

7) Once the clock is assembled and mounted, there likely 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.

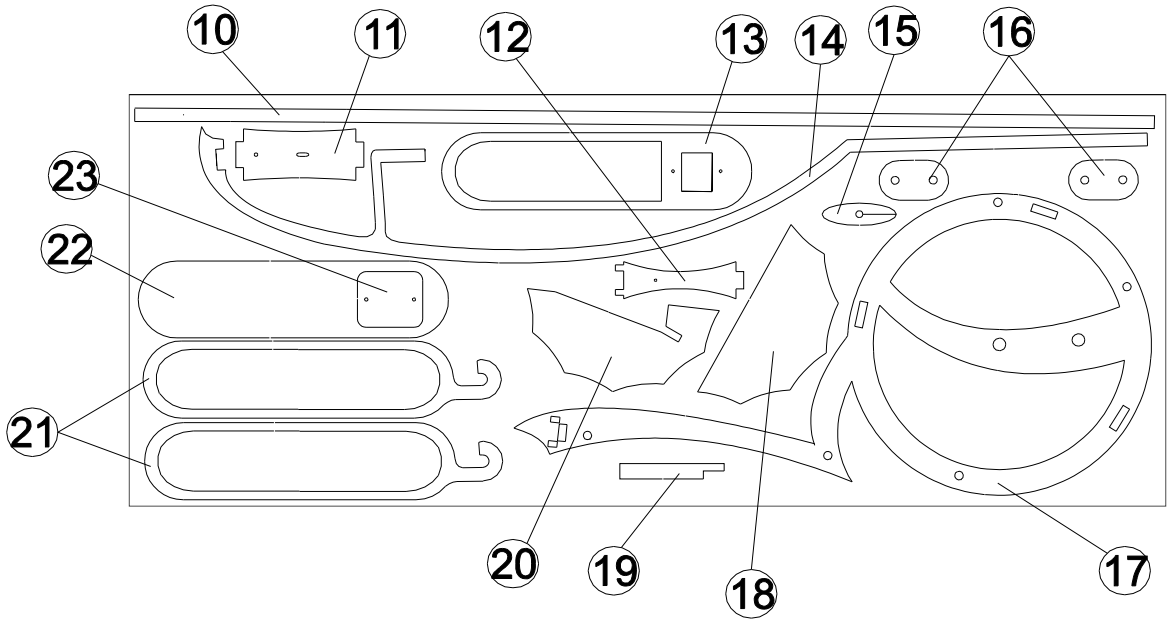
8) A duplicate copy of the part list numbering (Part Locator) is included on the last page of this manual. This is intended to be removed from the manual so that it can be referred to during assembly without having to flip back and forth in the manual.

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

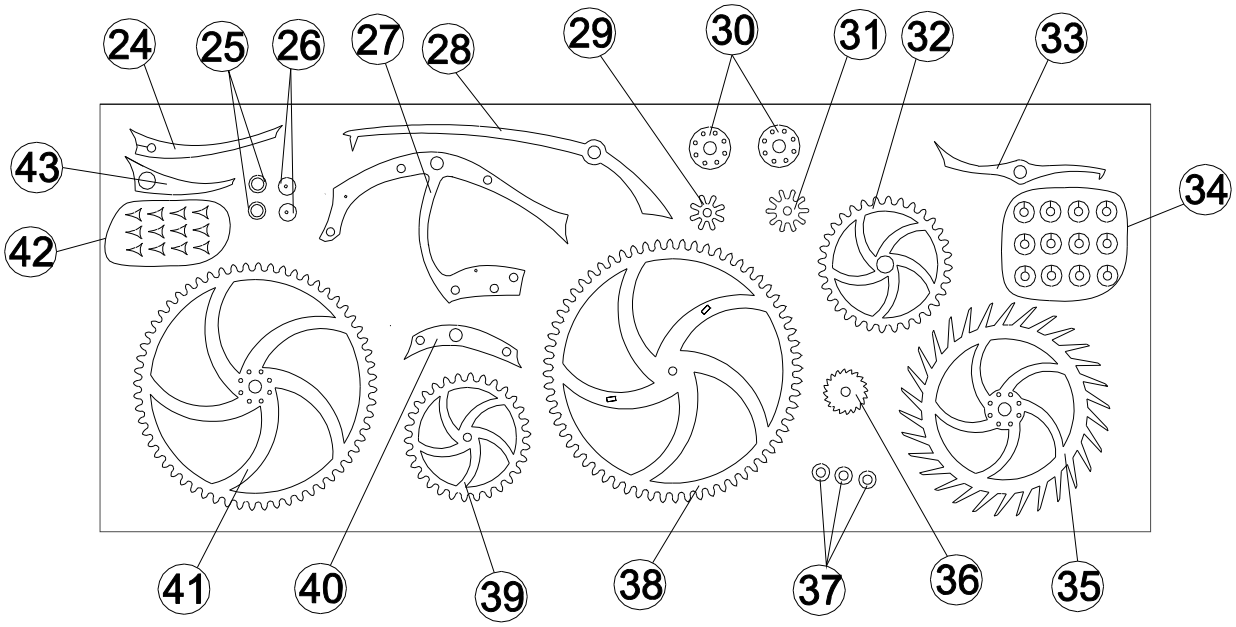
Part List



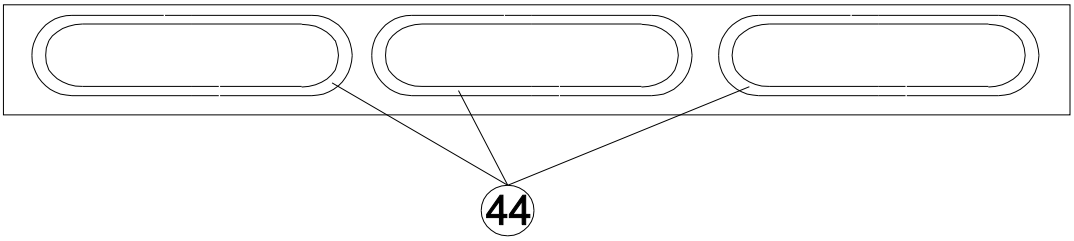
1. Bob front face
2. Dial
3. Front frame front
4. Pillars
5. Pendulum support plate upper
6. Rear frame
7. Pendulum bracket
8. Pillar anchors
9. Weight shell front cover



10. Pendulum shaft lower
11. Pillar w/ slot
12. Pendulum support plate lower
13. Weight shell back
14. Pendulum shaft upper
15. Winding pull middle
16. Weight pulley sides
17. Front frame rear
18. Bob rear A
19. Pendulum clamp
20. Bob rear B
21. Weight shell hook pieces
22. Weight shell rear cover
23. Weight shell cover plate

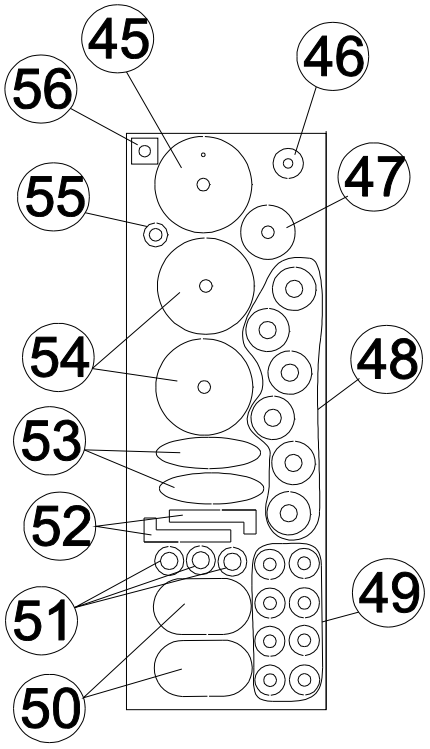


24. Minute hand
25. Stop extensions
26. Stop bases
27. Escapement frame
28. Entry pallet arm
29. 8-tooth gear
30. Pinion hubs
31. 10-tooth gear
32. 32-tooth gear
33. Exit pallet arm
34. Set washers
35. Escape wheel
36. Rachet
37. Hour pipe sections
38. Great wheel
39. 30-tooth gear
40. Escapement brace
41. 60-tooth gear
42. Dial markers
43. Hour hand



44. Weight shell middle pieces

45. Weight spool interior divider
46. Mounting washer
47. Weight spool hub
48. Pulley wheel sides
49. Spacer washers
50. Weight pulley covers
51. Pulley wheel hubs
52. Pawls
53. Winding pull faces
54. Outer spool sides
55. Winding spool hub
56. Arbor sizing jig



Hardware

19' braided cord
20 nylon shoulder washers
2 - #8 x 1 5/8" screws
10 - #4 x ½" screws

Dowels

1/4" diameter
- 6 - 1"
- 2 - 1 1/4"
- 1 - 1 ½"
- 5 - 3 3/4"
- 1 - 5 5/8"

1/8" diameter
- 8 - 1 ½"
- 8 - 2 ½"

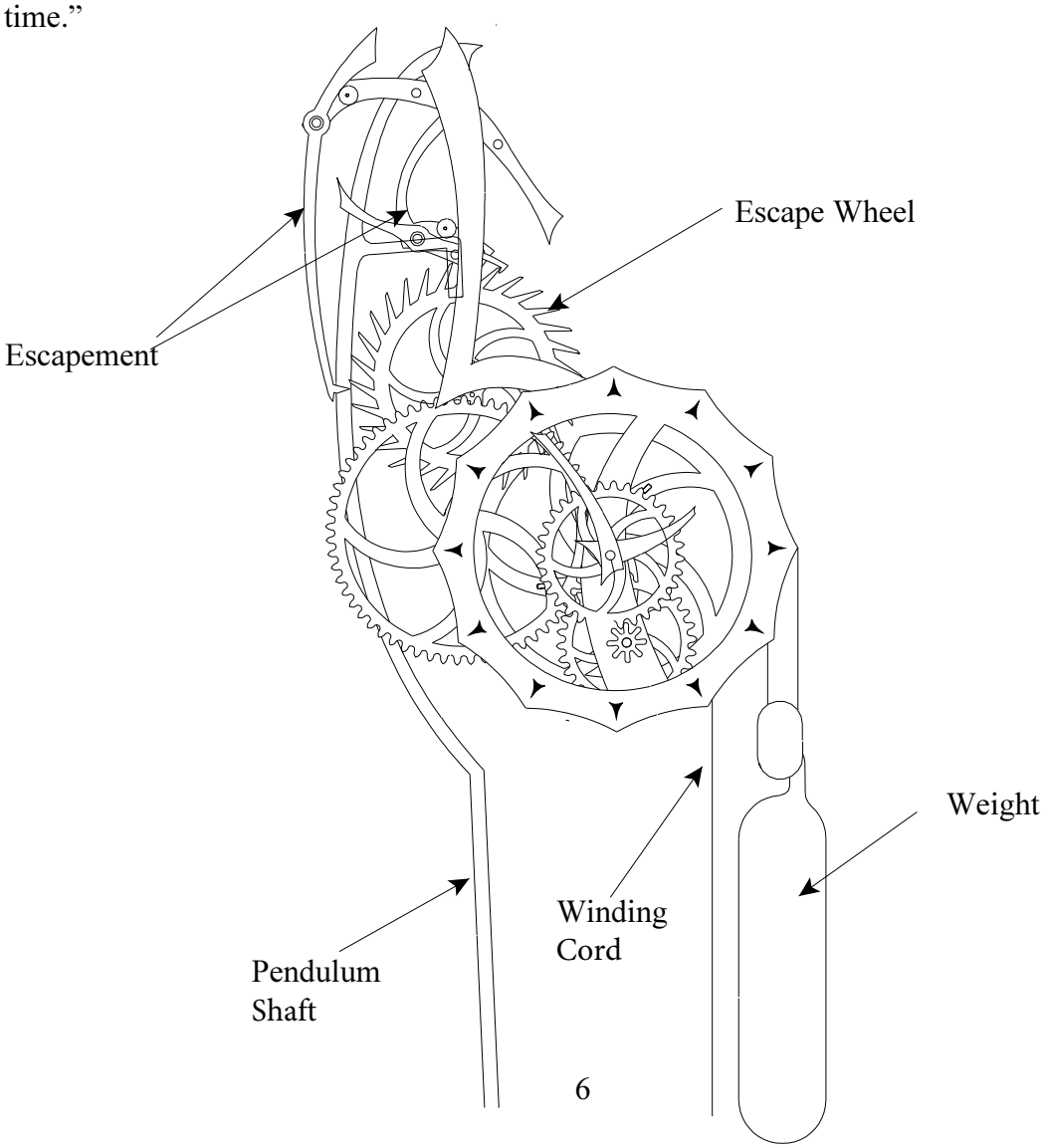
How the Tranquility Clock Works

It will be helpful to have an understanding of how the Tranquility clock works. This knowledge will be beneficial in assembling the clock.

The Tranquility 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, 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 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).

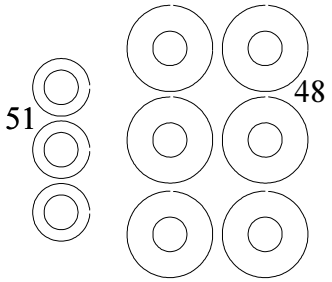
The faster the pendulum moves back and forth, the faster the escape wheel (and the entire gear train) will be allowed to advance. The pendulum swing period is determined by its length (or, more precisely, the length from its pivot point to its center of gravity). Increasing the pendulum length increases 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."



Pulley Wheel Assembly

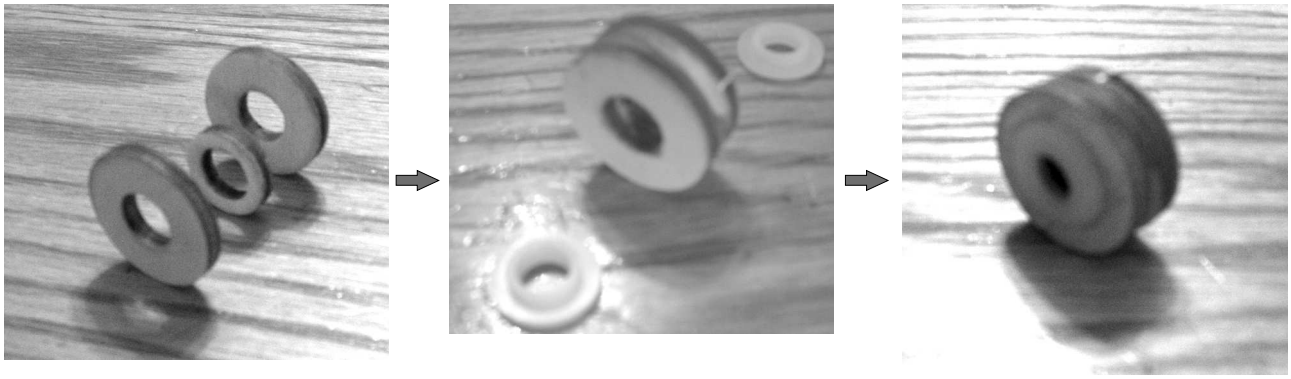
Parts (for three identical pulley wheels)

3 - Pulley hubs (#51)
6 - Pulley wheel sides (#48)
6 - Nylon shoulder washers



Assembly Procedure

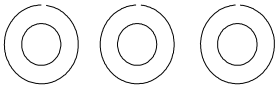
1) Glue together the three pulley pieces with the smaller diameter pulley hub (#51) sandwiched between the two larger pulley wheel sides (#48) with all three holes aligned. After the glue has dried, the pulley edges can be sanded and finish applied. Next, apply a small amount of glue around the rim of 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 washer seats completely into the hole. Repeat this process twice to make a total of three identical pulley wheels.



Hour Pipe

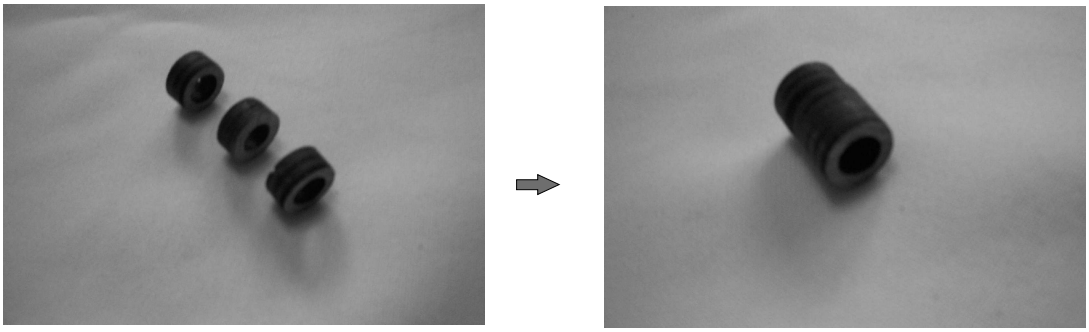
Parts

3 - Hour pipe sections (#37)



Assembly Procedure

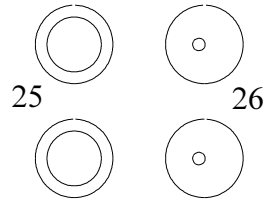
Glue together the three hour pipe sections (#37). Clear any glue squeeze out from the center.



Stops

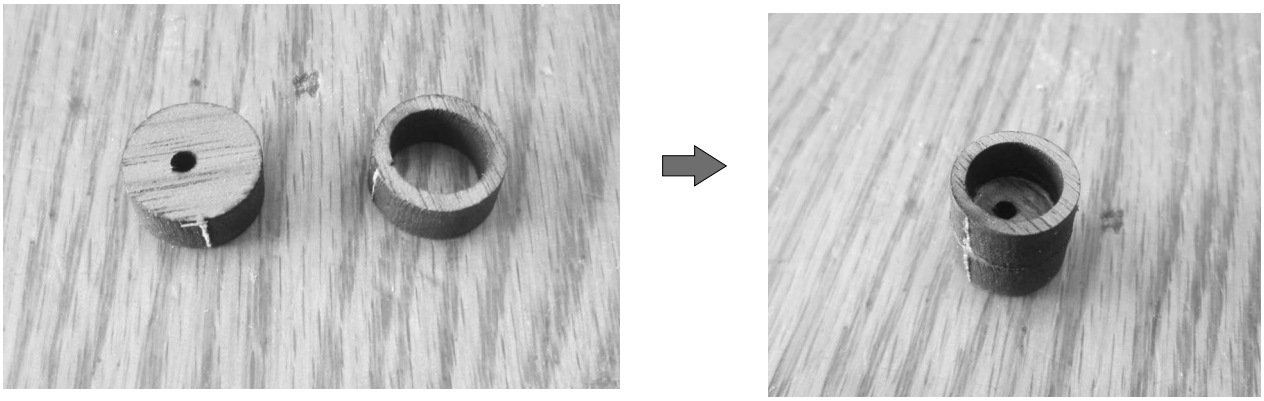
Parts

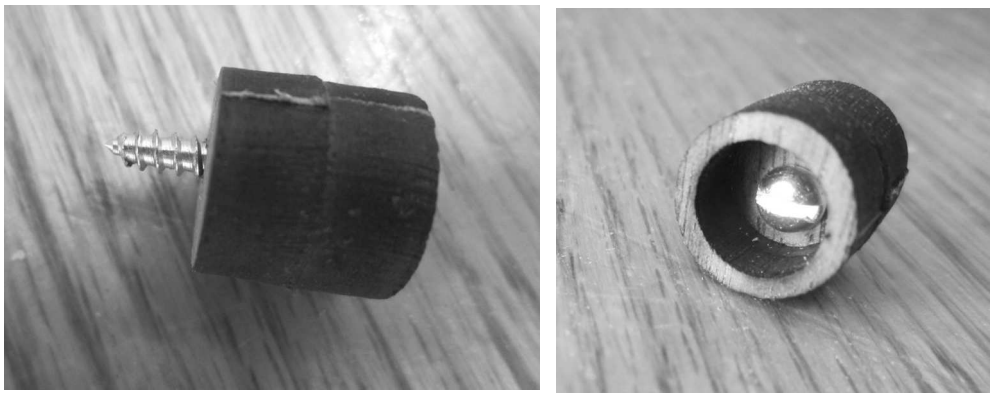
2 - Stop bases (#26)
2 - Stop extensions (#25)
2 - #4 x ½" screw



Assembly Procedure

Glue a stop base (#26) to a stop extension (#25). Drive a #4 x ½" screw through the stop base, entering from the side with the extension and exiting through the opposite face. (Note: the pilot hole in the stop base is intentionally off center.)

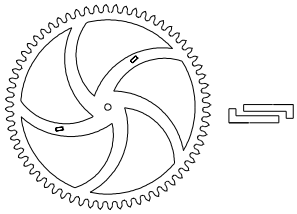




Great Wheel Pawls

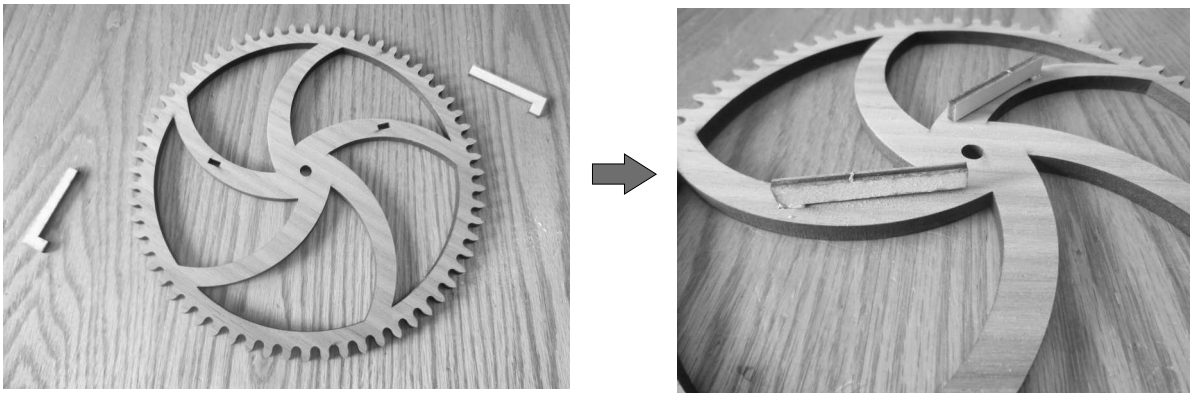
Parts

1 - Great wheel (#38)
2 - Pawls (#52)



Assembly Procedure

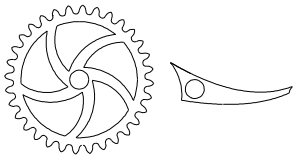
Lay the great wheel on a flat surface **with the spokes oriented as shown below**. Glue the pawls (#52) into the slots in the great wheel (#38), applying glue only to the tab that enters the slot in the great wheel spoke. It might be necessary to tap them with a hammer to fully seat the pawls.



Hour Hand / Gear

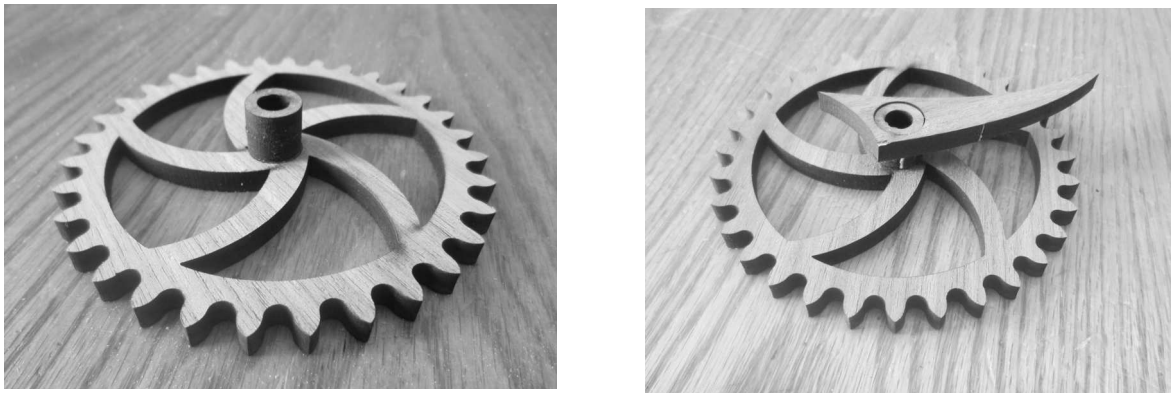
Parts

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



Assembly Procedure

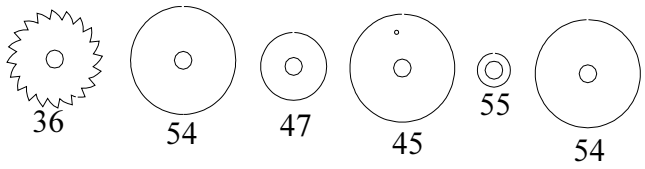
Glue the hour pipe into the 32-tooth gear (#32). Press the hour hand (#43) onto the hour pipe **but do not glue the hand to the pipe**. The hand must be friction fit so that it is loose enough to be able to be repositioned. If the hand fits too tightly, lightly sand the hour pipe.



Weight Spool Assembly

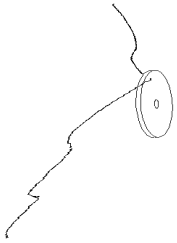
Parts

1 - Rachet (#36)
2 - Outer spool sides (#54)
1 - Weight spool interior divider (#45)
1 - Weight spool hub (#47)
1 - Winding spool hub (#55)
cord

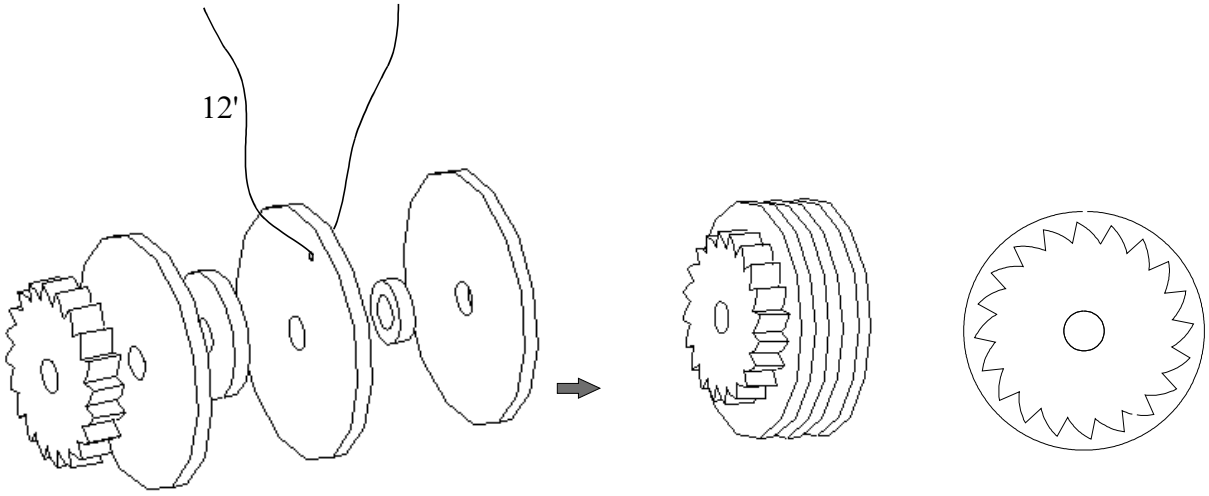


Assembly Procedure

1) Thread the winding cord through the small hole in the winding spool interior divider (#45). Pull a few feet of cord through the hole so that it does not slip back through during spool assembly.



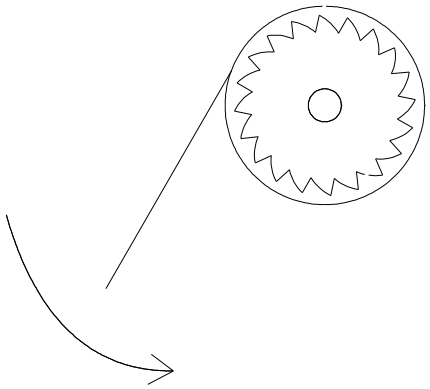
2) Glue the rachet (#36), outer spool sides (#54), winding spool interior divider (#45), weight spool hub (#47), and winding spool hub (#55) together in the order shown. **Be careful to orient the rachet teeth as shown**. Use a piece of 1/4" dowel or a drill bit to help align the pieces and to clear the center hole of excess glue (remove dowel before glue sets). **It is critical that the glue bond between all of the spool pieces are solid–ensure adequate glue coverage and clamp time**.



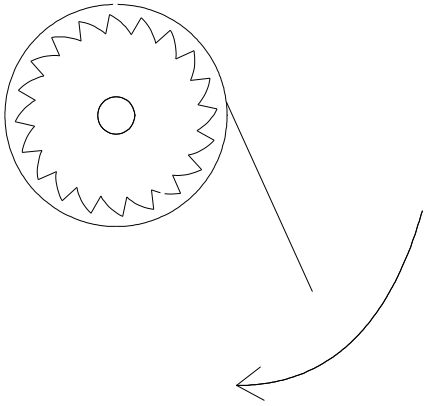
3) If desired, apply finish to the weight spool (if desired, cord can be removed to stain and then reinserted with tweezers or similar tool).

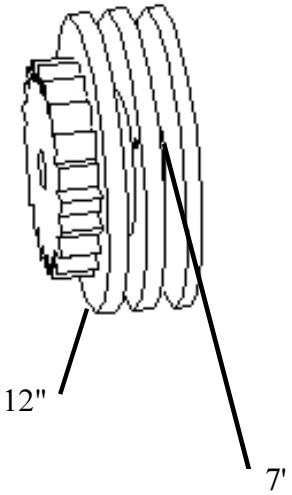
4) Pull the cord through the spool divider until there is approximately 12 feet of cord on the rachet side of the spool divider.

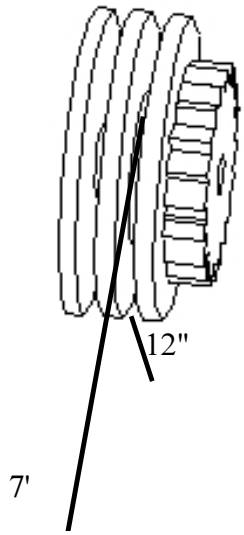
5) Hold the spool so the rachet is facing you (as pictured below). Wrap the 12' of cord protruding from the rachet side of the spool around the larger hub in a counter-clockwise direction. Continue winding until about 12" of cord remains.



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).





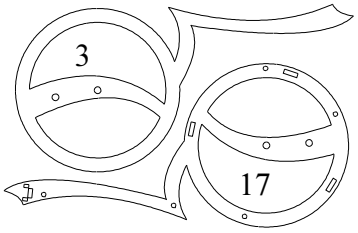


7) Secure the two strings with a piece of tape so they do not unwind during the upcoming assembly sequence.

Frame

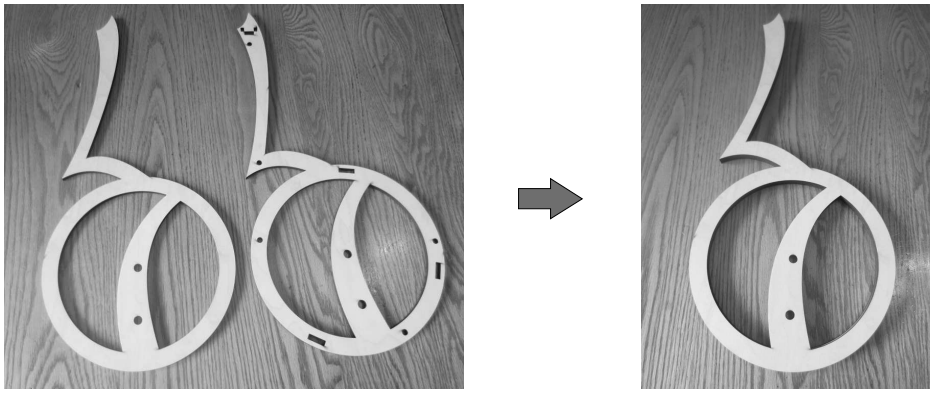
Parts

1 - Front frame rear (#17)
1 - Front frame front (#3)



Assembly Procedure

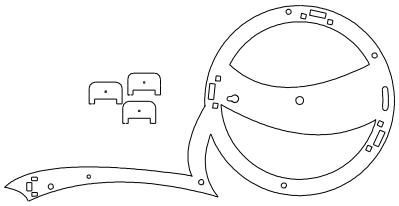
Glue the front frame rear (#17) to the front frame front (#3) **so the orientation matches the photos shown below.** Avoid getting glue in the slot and hole areas of the front frame rear (#17).



Perform any desired sanding of the front frame.

Parts

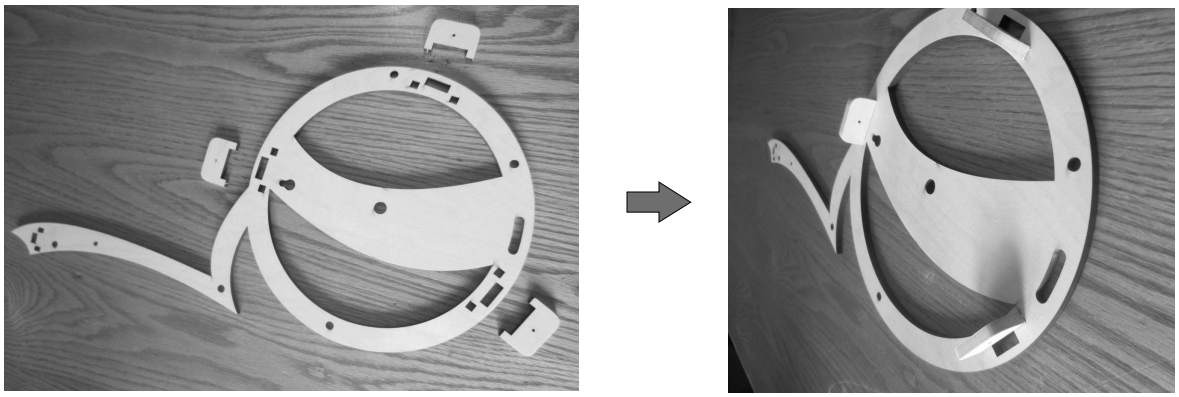
1 - Rear frame (#6)
3 - Pillar anchors (#8)



Assembly Procedure

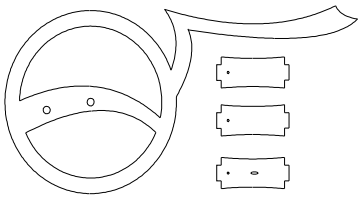
Perform any desired sanding of the rear frame.

Make sure the rear frame (#6) is oriented with the correct face upward as shown in the photo below. Glue the three pillar anchors (#8) into the slots, tapping them down with a hammer to seat them completely into the slots.



Parts

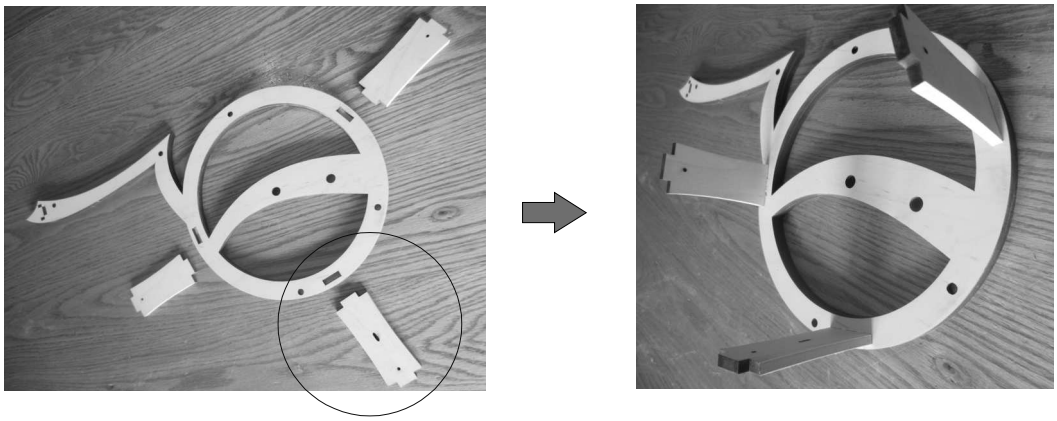
1 - Front frame (previously assembled)
2 - Pillars (#4)
1 - Pillar w/ slot (#11)



Assembly Procedure

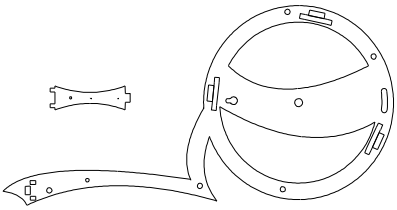
Perform any desired sanding of the pillars, including the curved edges.

Glue the three pillars (#4, #4, #11) into the slots in the front frame **with the holes in the pillars opposite the end engaged with the frame slot**. Also, be sure the pillar with the slot (#11) is in the slot indicated in the photos below.



Parts

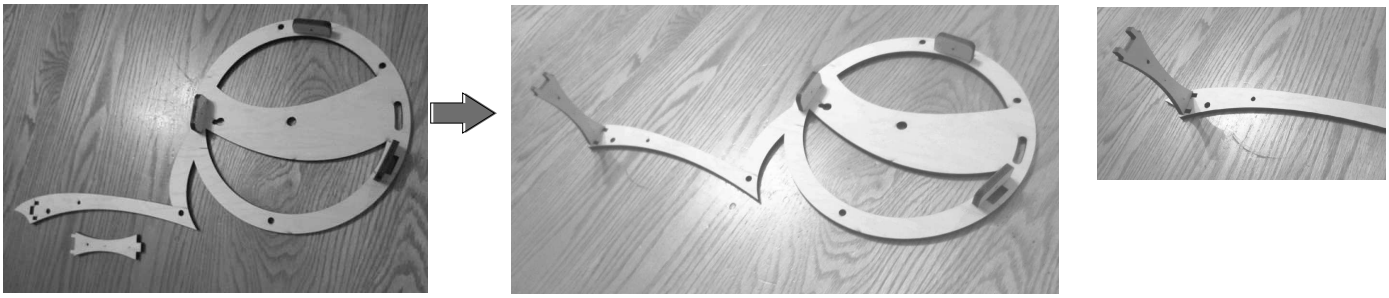
1 - Rear frame (previously assembled)
1 - Pendulum support plate upper (#5)



Assembly Procedure

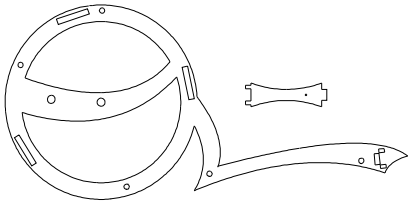
Perform any desired sanding of the pendulum support plate upper, including the curved edges.

Glue the pendulum support plate upper (#5) into the slot in the rear frame (be sure it is the rear frame as pictured below and not the front frame) . The pendulum support plate upper protrudes from the same face as the pillar anchors. If tapping in with a hammer, do not strike the small tabs with the hammer.



Parts

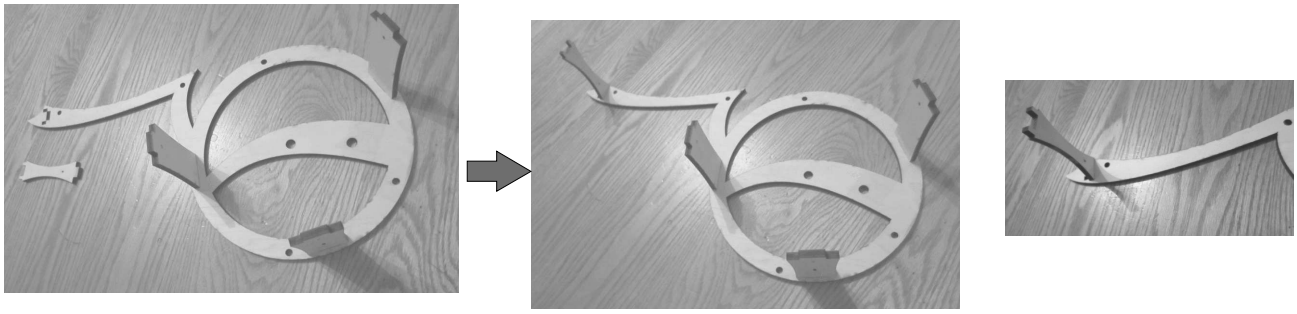
1 - Front frame (previously assembled)
1 - Pendulum support plate lower (#12)



Assembly Procedure

Perform any desired sanding of the pendulum support plate lower, including the curved edges.

Glue the pendulum support plate lower (#12) into the slot near the top of the front frame. The pendulum support plate protrudes from the same face as the pillars. If tapping in with a hammer, do not strike the small tabs with the hammer.



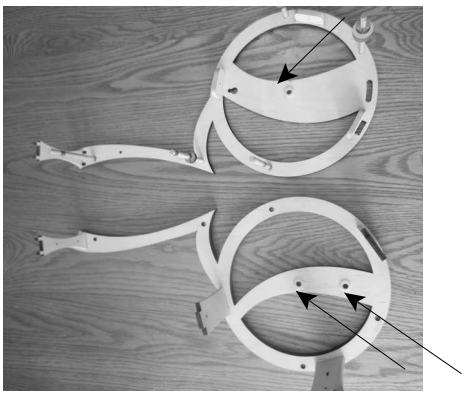
Apply finish as desired to the completed frame units.

Parts

1 - Front frame (previously assembled)
1 - Rear frame (previously assembled)
4 - nylon shoulder washers

Assembly Procedure

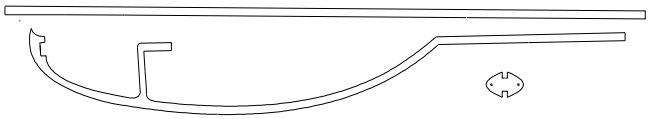
Install a nylon shoulder washer into each 3/8" diameter hole on the inside face of the front and the rear frame (the inside faces are shown facing up in the lefthand photo below). It might be necessary to either press the washer firmly into place or to tap it into place with a hammer. Also install a shoulder washer in the front face of the front frame, into the hole closest to the outside circle as shown in the right hand photo below. Be sure the washers seat completely into the holes.



Pendulum Shaft

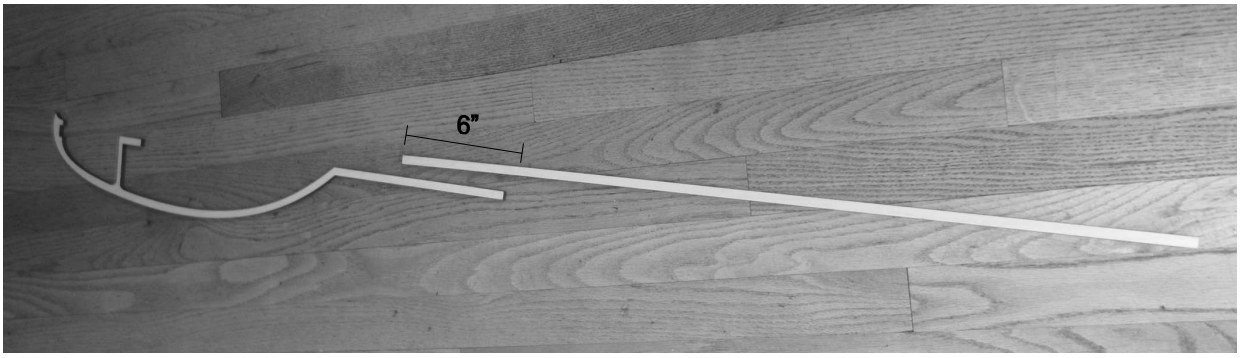
Parts

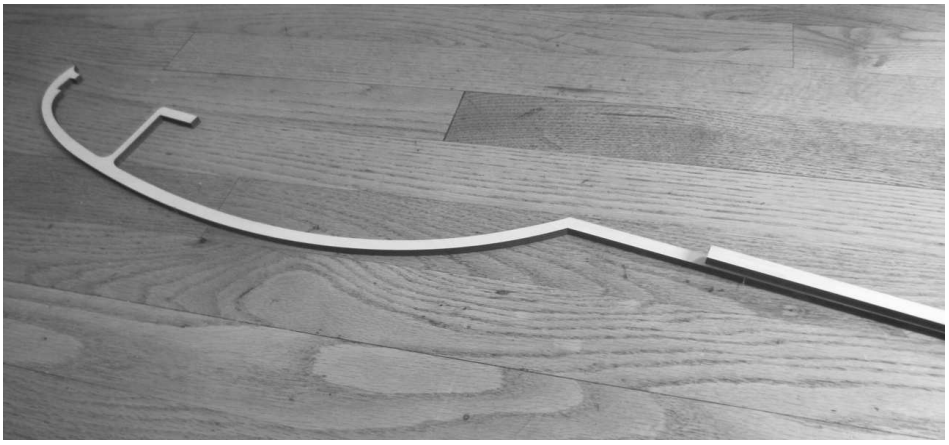
1 - Pendulum shaft upper (#14)
1 - Pendulum shaft lower (#10)
1 - Pendulum bracket (#7)
2 - #4 x ½" screws



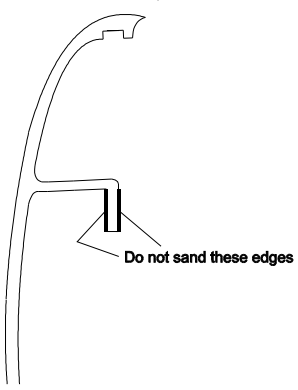
Assembly Procedure

Glue the pendulum shaft lower (#10) to the pendulum shaft upper (#14), oriented as shown in the photos below, with 6" overlap.



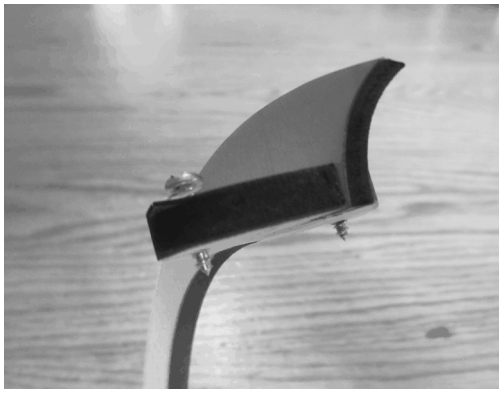


Perform any desired sanding of the pendulum shaft, except in the section indicated in the diagram below:



Perform any desired sanding on the pendulum bracket (#7). Drive a #4 x ½" screw through each of the two holes in the pendulum bracket (#7). Do not drive the screws all the way down, but instead leave about 1/16" between the screw head and the pendulum bracket.

Glue the pendulum bracket (#7) to the pendulum shaft upper (#14) with the screw tips pointed toward the pendulum shaft (as shown in the photo below).

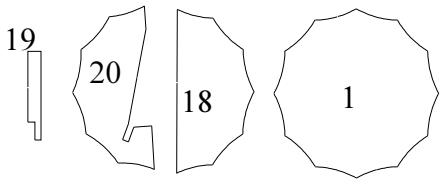


Finish the pendulum shaft as desired.

Pendulum Bob

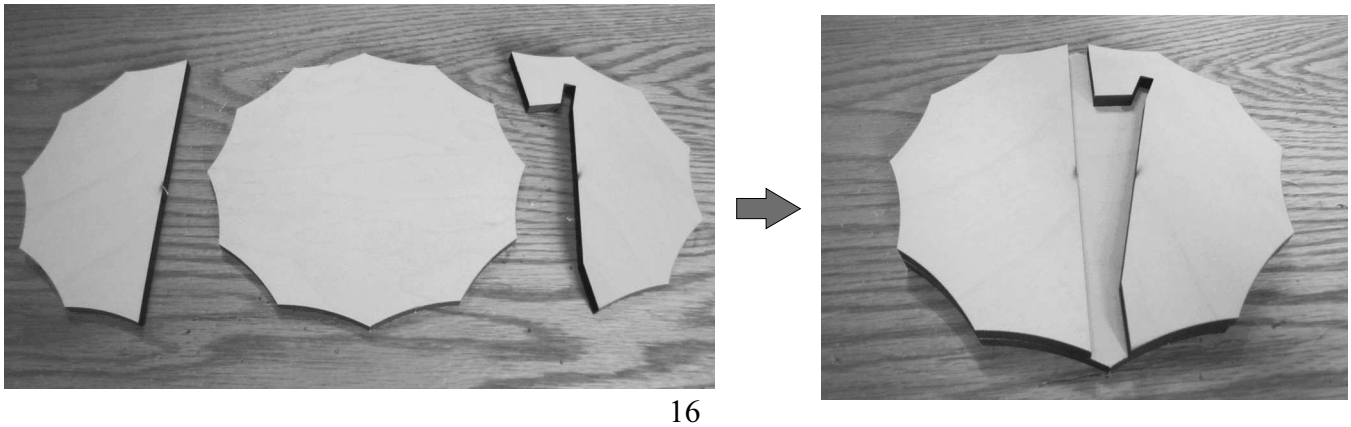
Parts

1- Bob front face (#1)
1 - Bob rear A (#18)
1 - Bob rear B (#20)
1 - Pendulum clamp (#19)

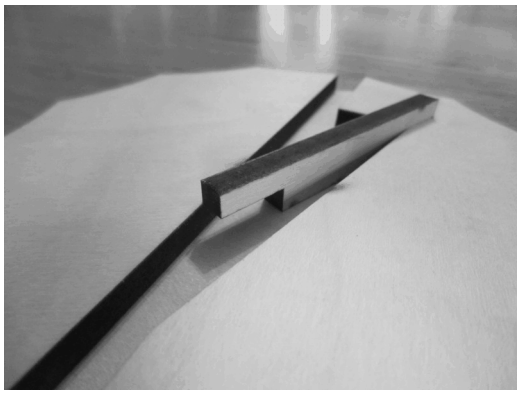


Assembly Procedure

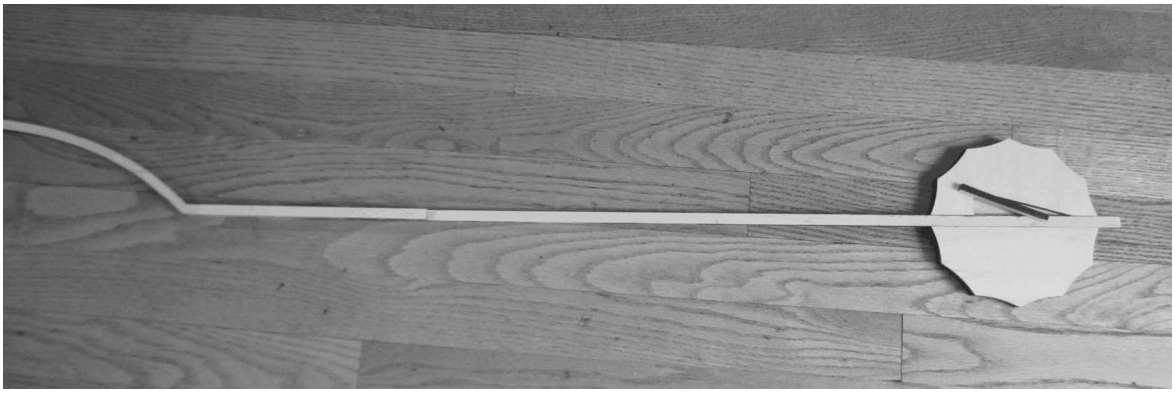
Glue the bob rear A (#18) and the bob rear B (#20) to the bob front face (#1), lining up the outside edges. Be sure that the pendulum shaft lower (#10) can fit in the gap between the two pendulum rear pieces. Sand and finish the pendulum bob if desired.

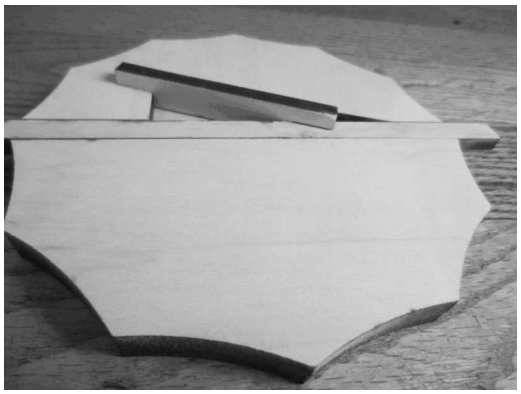


Glue the pendulum clamp (#19) into the slot in the back of the pendulum with the notch in the clamp oriented over the gap as shown below. Apply glue only where the clamp fits into the slot.



After the bob glue has dried, install the pendulum shaft by pulling the clamp back and passing the shaft through the slot in the bob as shown below. Be sure the shaft is oriented as shown below.

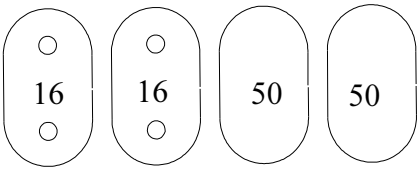




Weight Pulley

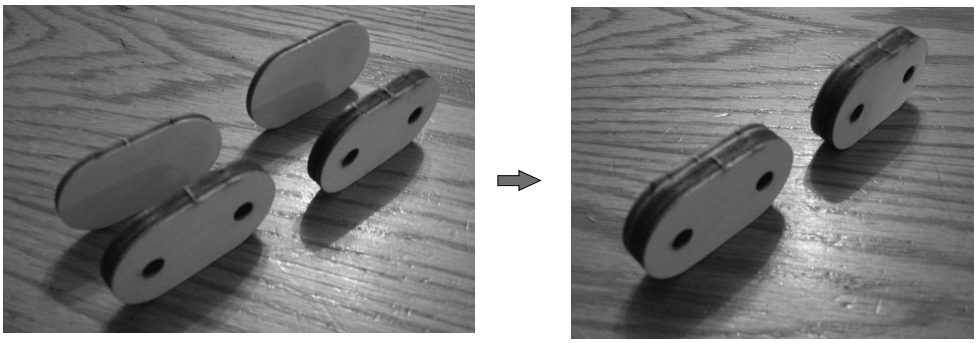
Parts

2 - Weight pulley sides (#16)
2 - Weight pulley side covers (#50)
2 - 1" dowels
1 - Pulley wheel (assembled previously)



Assembly Procedure

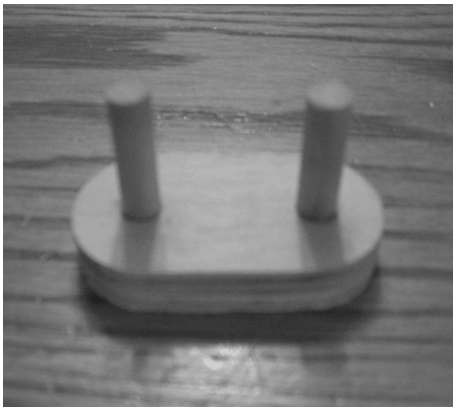
1) Glue the weight pulley sides (#16) to the weight pulley side covers (#50), making sure all edges are aligned.



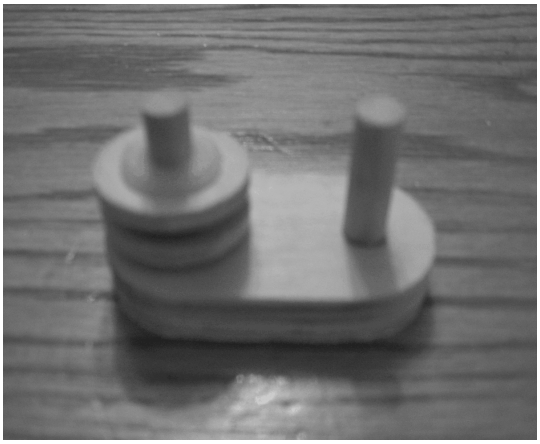
2) Sand the edges of the two weight pulley side units and apply finish as desired.

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

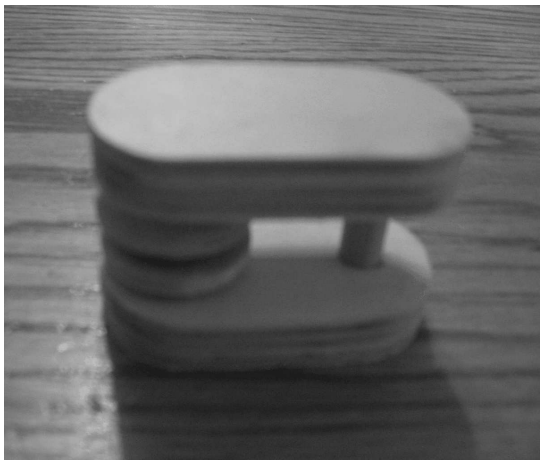
4) Glue the two 1" dowels into one of the weight pulley sides.



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



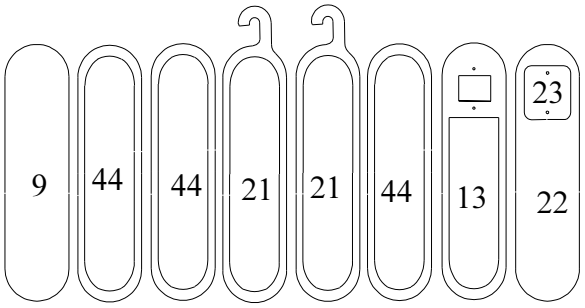
6) Complete the weight pulley unit by gluing dowels into the remaining weight pulley side piece. Be sure that the pulley wheel is not pinched tightly, but that it can spin freely.



Weight Shell

Parts

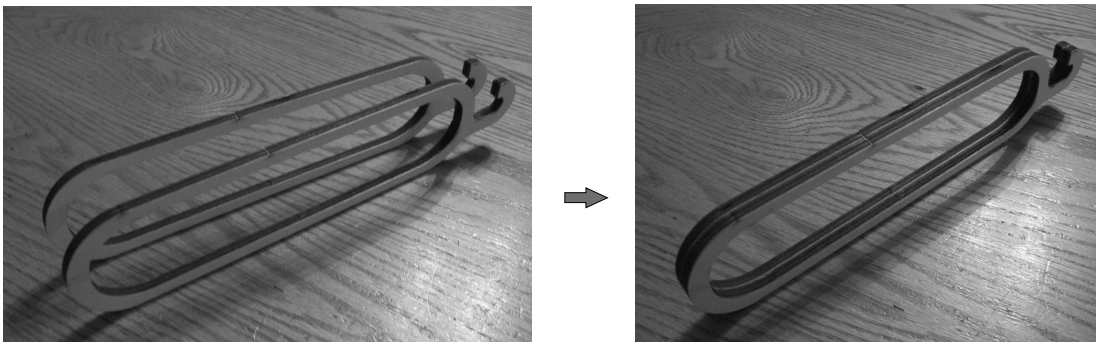
3 - Weight shell middle pieces (#44)
2 - Weight shell hook pieces (#21)
1 - Weight shell back (#13)
1 - Weight shell rear cover (#22)
1 - Weight shell front cover (#9)
1 - Weight shell cover plate (#23)
2 - #4 x ½" screws



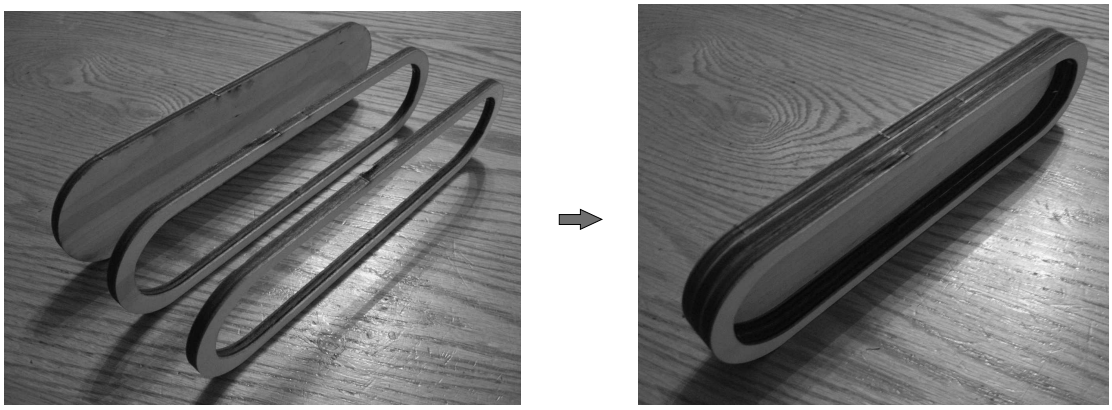
Assembly Procedure

When gluing the weight shell pieces together, be sure to get a solid glue bond on all mating surfaces and insure adequate clamp time.

1) Glue together the two weight shell hook pieces (#21), aligning all edges.

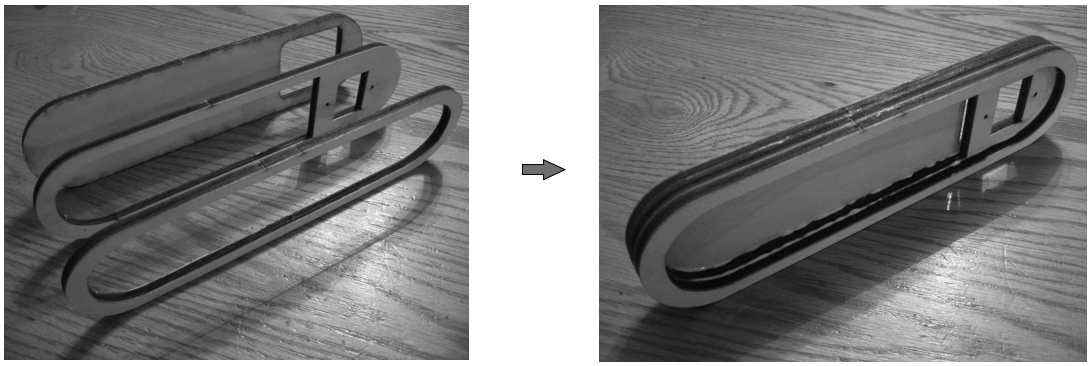


2) Glue together two of the weight shell middle pieces (#44) and the weight shell front cover (#9).



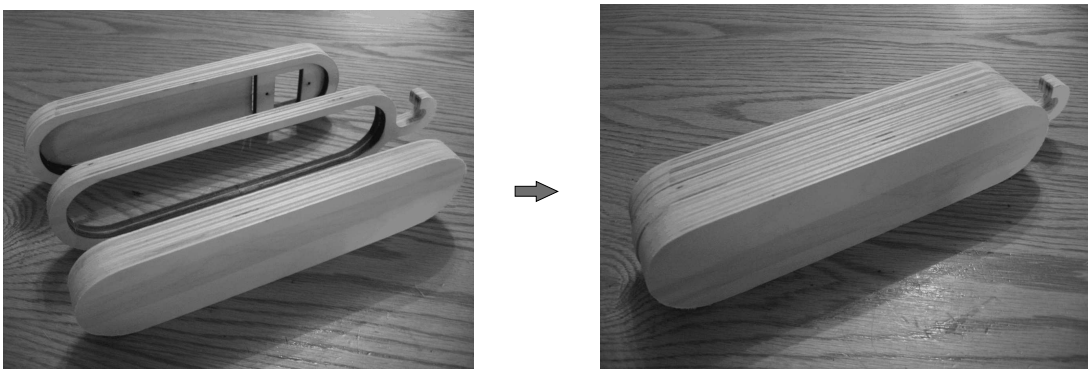
3) Separate the weight shell cover plate (#23) from the weight shell rear cover (#22).

4) Glue together the remaining weight shell middle piece (#44), the weight shell back (#13), and the weight shell rear cover (#22) in the sequence shown below. Clear any glue squeeze out from the recess in the rear cover (into which the cover plate will fit).



5) Sand the perimeters of the three weight shell subassemblies.

6) Glue together the three weight shell subassemblies with the front and rear covers on the outside faces.



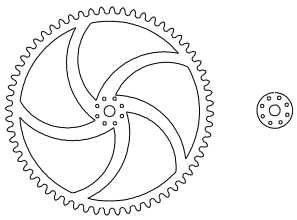
7) Do any needed touch up sanding on the completed weight shell. Apply finish to the weight shell and weight shell cover plate as desired.

8) Fill the weight shell with approximately 3.5 to 4 pounds of metal shot. Secure the weight shell cover plate into the recess in the back of the weight shell with two #4x½" screws through the predrilled holes.

Lantern Pinions

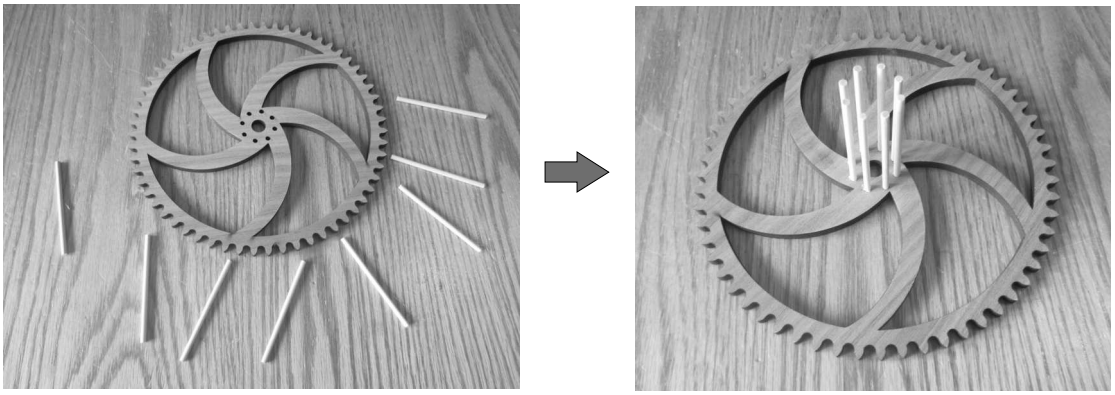
Parts

1 - 60-tooth gear (#41)
8 - 1/8" x 2 ½" dowels
1 - Pinion hub (#30)
2 - Nylon shoulder washers

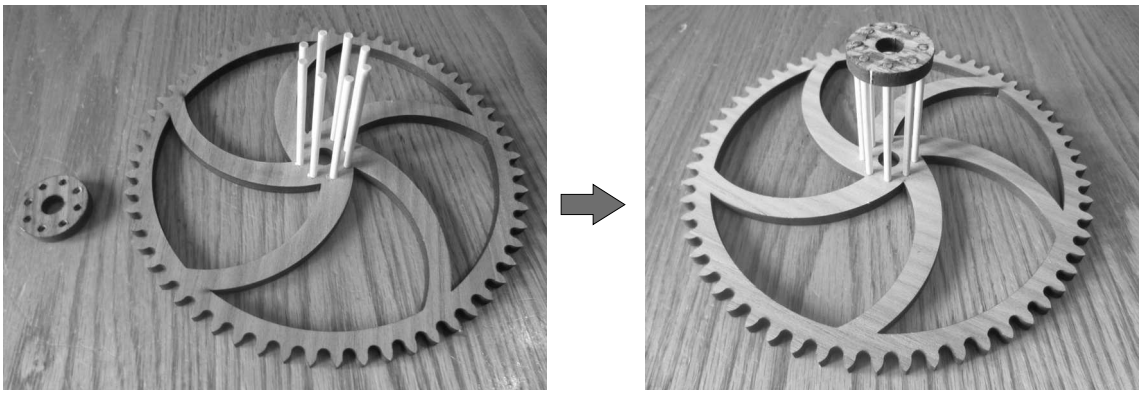


Assembly Procedure

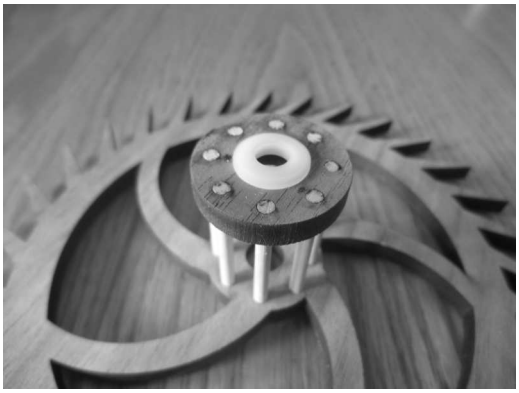
Lightly sand the 1/8" x 2 ½" dowels with 600 grit sandpaper to polish them smooth. Use a toothpick to apply glue to the insides of the eight holes in the 60-tooth gear (#41). Carefully tap the 1/8" dowels into the holes in the 60-tooth gear, driving them until they bottom out in the holes.



Use a toothpick to apply glue to the insides of the eight holes in the pinion hub (#30). Carefully tap the pinon hub onto the dowels protruding from the 60-tooth gear. It will work best to tip the pinion hub to engage one or two dowels, and then gradually work the successive dowels into position, one at a time. When all eight dowels have engaged their holes, tap the pinon hub down until the ends of the dowels are all flush with the pinion hub. Clean up any glue squeeze out.

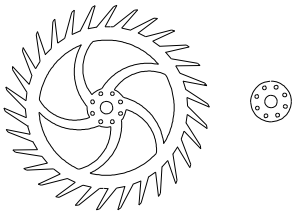


Glue a nylon shoulder washer into the outer face of the pinon hub and the outer face of the 60-tooth gear.



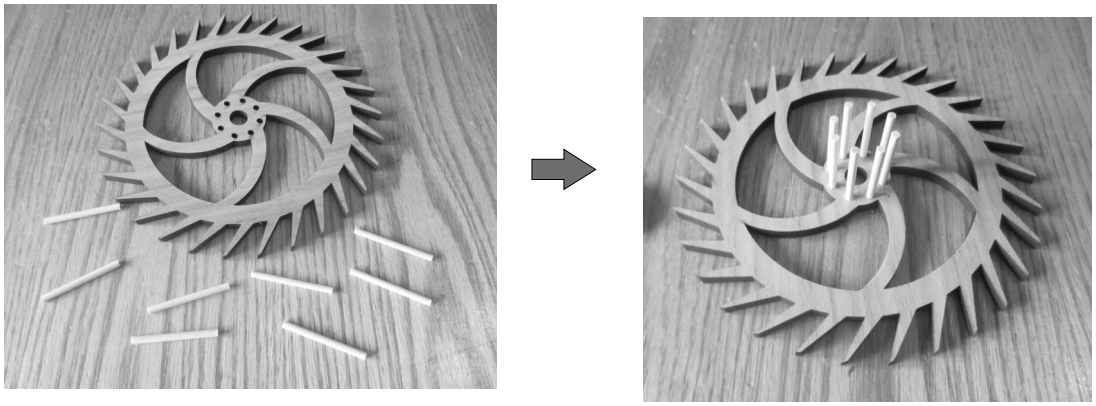
Parts

1 - Escape wheel (#35)
8 - 1/8" x 1 ½" dowels
1 - Pinion hub (#30)
2 - Nylon shoulder washers

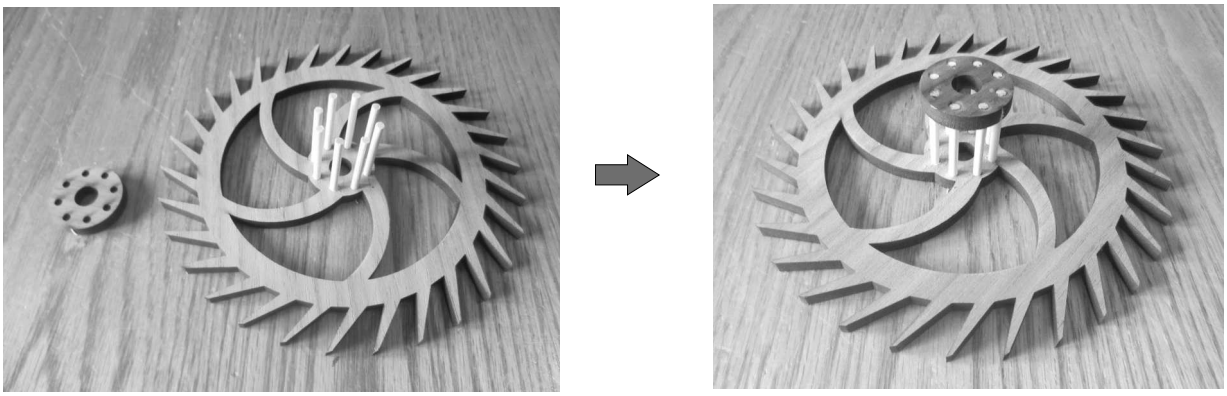


Assembly Procedure

Lightly sand the 1/8" x 1 ½" dowels with 600 grit sandpaper to polish them smooth. Use a toothpick to apply glue to the insides of the eight holes in the escape wheel (#35). **Make sure the escape wheel is oriented with the correct face up as shown below**. Carefully tap the 1/8" dowels into the holes in the escape wheel, driving them until they bottom out in the holes.



Use a toothpick to apply glue to the insides of the eight holes in the pinion hub (#30). Carefully tap the pinon hub onto the dowels protruding from the escape wheel. It will work best to tip the pinion hub to engage one or two dowels, and then gradually work the successive dowels into position, one at a time. When all eight dowels have engaged their holes, tap the pinon hub down until the ends of the dowels are all flush with the pinion hub. Clean up any glue squeeze out.



Glue a nylon shoulder washer into the outer face of the pinion hub and the outer face of the escape wheel.

Arbor Preparation

Parts

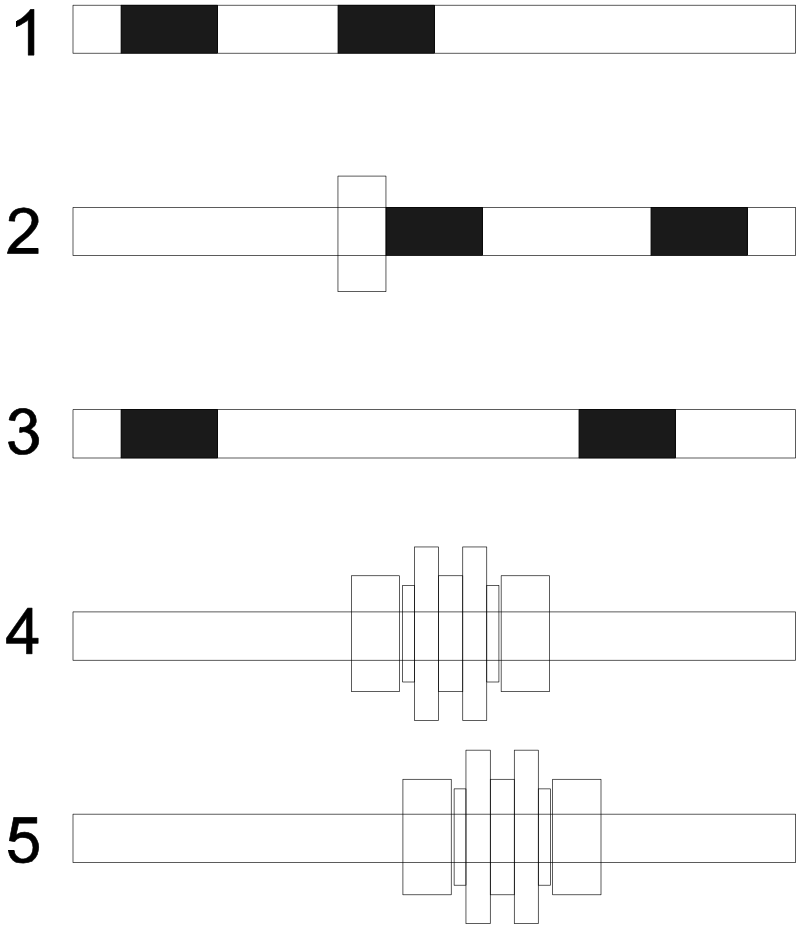
5 - 3 3/4" dowels
1 - 1 ½" dowel
1 - Arbor sizing jig (#56)

Procedure

Label one end of each of the 3 3/4" dowels with the numbers 1 through 5. The labeled ends will be the left ends of the arbors as shown in the diagram below.

Use 100 grit sandpaper to sand each of the above arbors until the entire dowel is able to slip easily through the hole in the arbor sizing jig (#56). Sanding is best accomplished by wrapping a strip of sandpaper around the dowel and then sliding and rotating the dowel in the sandpaper.

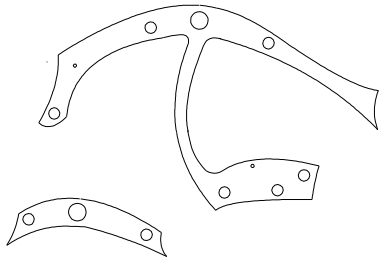
After the dowels are able to slip easily through the arbor sizing jig (#56), use a succession of 150, 220, 400, and 600 grit sandings to smooth and polish the sections of the 3 3/4" and the 1 ½" arbors that are shown shaded black in the diagrams below. Apply graphite to the shaded regions of the 3 3/4" and the 1 ½" arbors by coloring that section of the arbor with a pencil. Install pulley wheels (assembled previously) on arbor #4 and #5, and set washers (#34) on arbor #2, #4, and #5 in the locations shown on the diagram below. The set washers should fit tightly; do not glue them yet in case their positions need to be adjusted. (If the set washers are too tight, insert the blade of a slender slot screwdriver to expand the washer slightly; if too loose, add a film of glue to the arbor to build it up.) Be sure the pulley wheels can spin freely on arbors #4 and #5.



Escapement

Parts

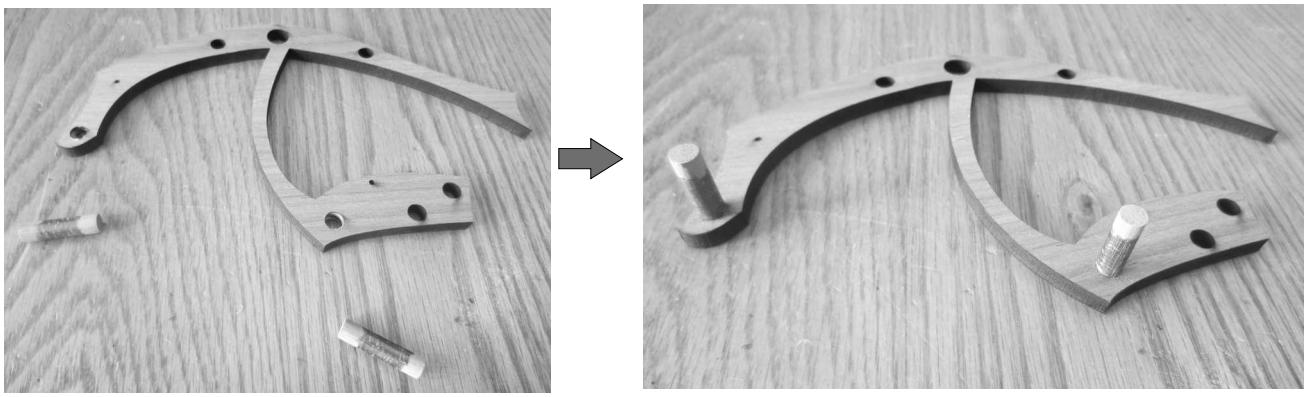
1 - Escapement frame (#27)
1- Escapement brace (#40)
4 - 1" dowels
2 - 1 1/4" dowels
Stops (assembled previously)
1 - Arbor sizing jig (#56)
2 - Nylon shoulder washers



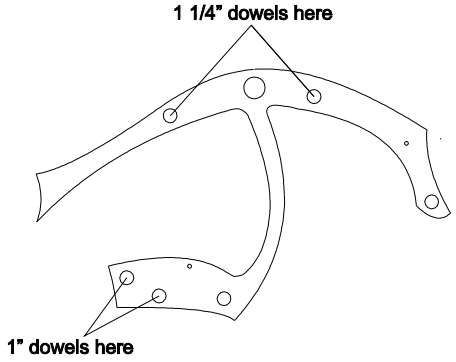
Assembly Procedure

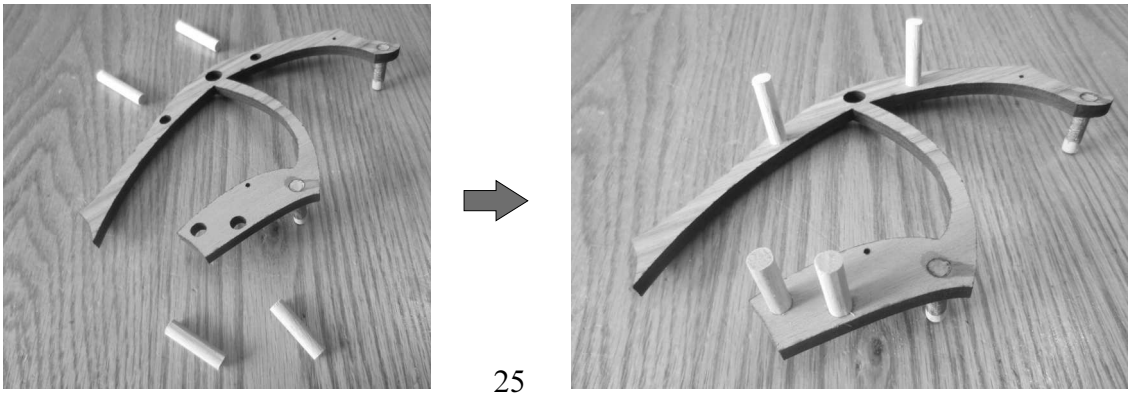
Using the same process that you used to prepare the 3 3/4" arbors, sand 3/4" of two of the 1" dowels until they can pass through the arbor sizing jig. Then, continue increasing grits to sand the middle ½" of these dowels. Finally, apply pencil lead to the middle ½" of these dowels.

With the escapement frame (#27) oriented as shown below, glue the two 1" dowels into the holes shown, with the unsanded portion of the dowels into the escapement frame holes.

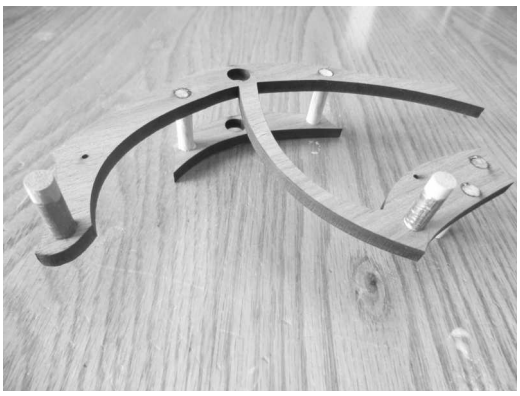


Flip the escapement frame over and glue the two 1 1/4" dowels into the escapement frame holes as shown below. Also, glue two 1" dowels into the escapement frame holes as shown below:



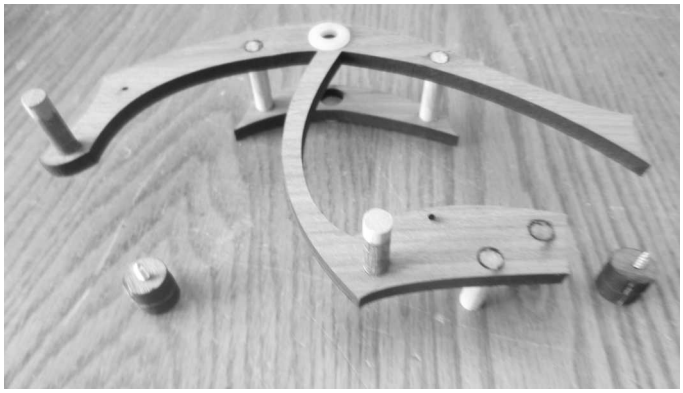


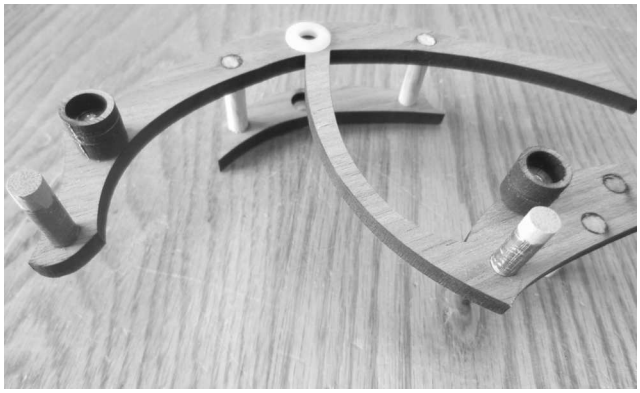
Glue the 1 1/4" dowels into the escapement brace (#40)**. Be sure that the escapement brace is oriented so the large hole in the escapement brace and escapement frame line up with each other.**



Glue a nylon shoulder washer into both of the outside faces of the escapement frame.

Screw the two stops into the front face of the escapement frame (the side that has two dowels protruding). Do not screw the stops all the way down, but leave a small amount of clearance between the stop and the escapement frame.

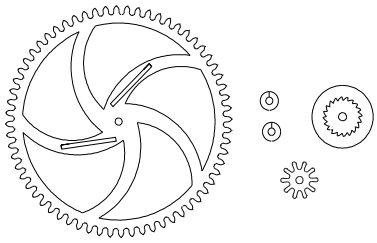




Great Wheel Arbor

Parts

1 - 5 5/8" dowel
1 - Great wheel (#38) w/ pawls installed
1 - 10-tooth gear (#31)
2 - Set washers (#34)
1 - Weight spool (assembled previously)
1 - Arbor sizing jig (#56)

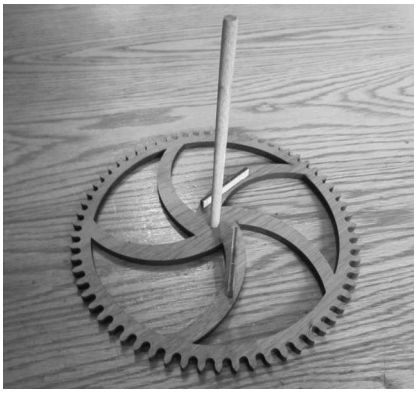


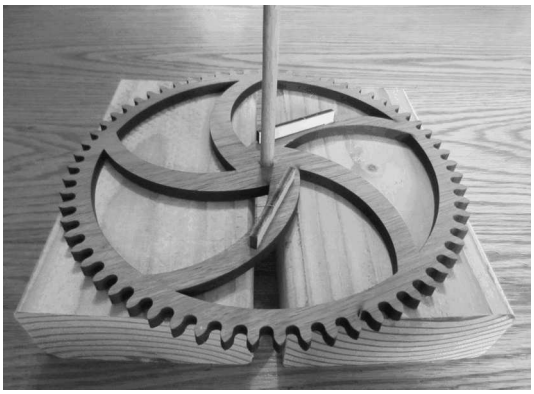
Assembly Procedure

(Study the diagram on the next page for an overview of the final results of the following procedure; refer to that diagram during the procedure.)

Label one end of the 5 5/8" dowel with a 'G'. Lay the 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).

Place the great wheel on a flat, sturdy surface with the pawl side up. Use a hammer to drive the 5 5/8" dowel into the center hole of the great wheel; try to keep the dowel perpendicular to the gear. Once the arbor bottoms out in the gear, place the gear on top of a pair of wood blocks (such as 2x4's, as depicted below). Separate the two scrap pieces about 1/4" so the arbor will be able to pass between them. Continue to drive the arbor through the gear until the gear is between the first pair of marks on the dowel (which will leave approximately 1 1/4" of dowel protruding through the gear).

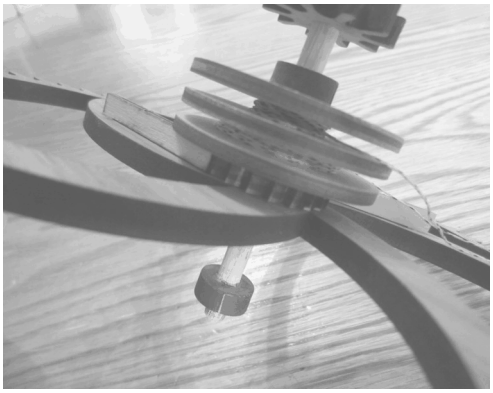




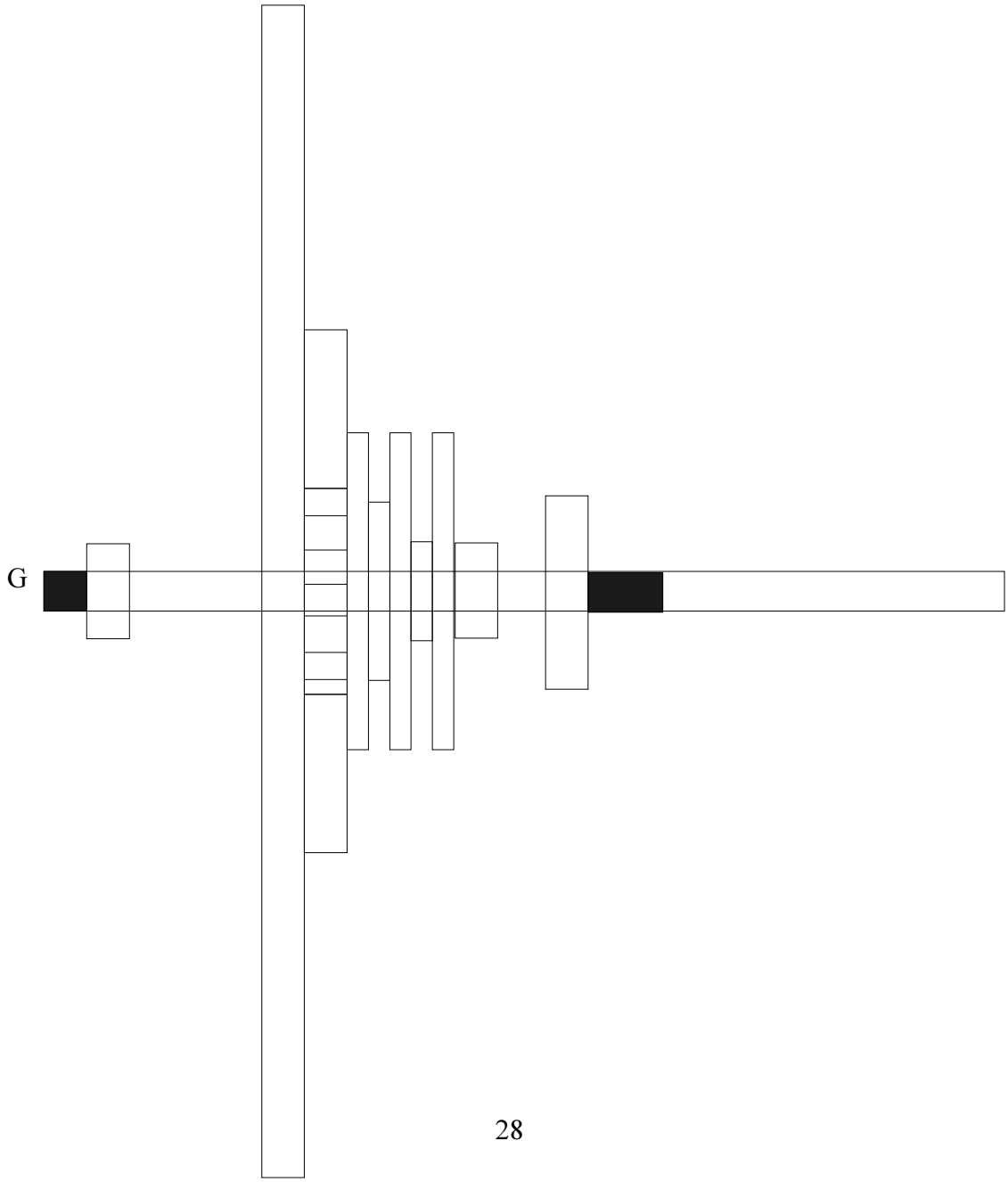
Slide the weight spool onto the long end of the arbor, rachet side first. Twist the spool so that the rachet teeth engage with the pawls. Slide a set washer (#34) onto the long end of the arbor until it is nearly in contact with the weight spool (the weight spool must be free to rotate, in one direction, on the arbor).

Sand the arbor to permit easier installation of the 10-tooth gear. Lay the 10-tooth gear on a flat, sturdy surface. Insert the long end of the arbor into the hole in the gear and use a hammer to drive the arbor into the gear. Once the arbor is fully inserted into the gear, use the same procedure that was used with the great wheel (supporting with blocks) to drive the 10-tooth gear until it is between the other pair of marks on the dowel.

Glue a set washer (#34) onto the ‘G’ end of the arbor so that 1/4" of dowel protrudes from the set washer. (Note: this is the only set washer that is glued upon initial installation.)



Use 100 grit sandpaper to sand the two ends of the arbor until the arbor sizing jig (#56) can slide completely onto both ends of the dowel. After this is achieved, use a succession of 150, 220, 400, and 600 grit sandings to smooth and polish the sections of the dowel that are shaded in the diagram on the next page. Apply graphite to the shaded regions of the dowel by coloring those sections of the dowel with a pencil



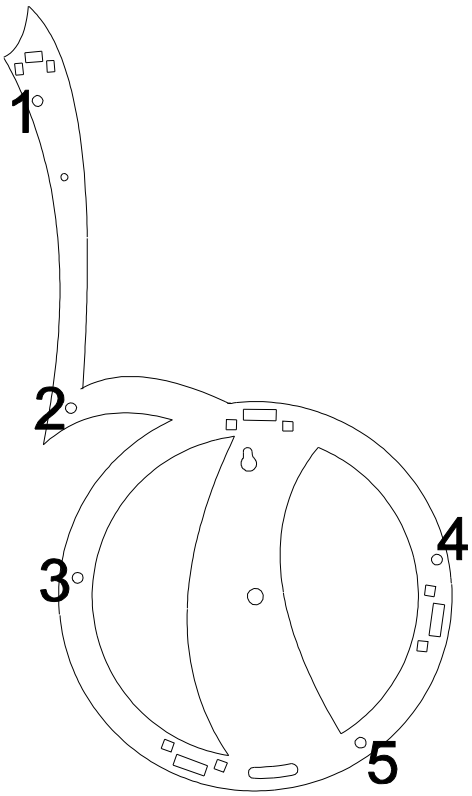
Frame Assembly

Parts

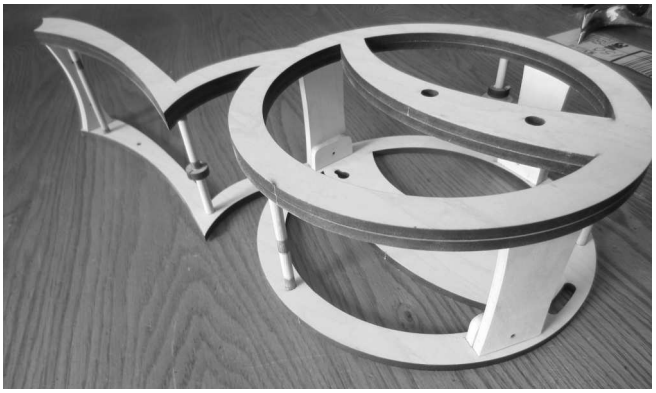
Front frame (previously assembled)
Rear frame (previously assembled)
5 - 3 3/4" dowels (previously prepped)

Assembly Procedure

Use a toothpick to apply glue to the five 1/4" holes in the rear frame. Lay the rear frame on a table, oriented with the side facing up as indicated in the diagram below. Install the five 3 3/4" dowels into the labeled holes with the numbered end of the dowel inserted into the corresponding hole shown in the diagram below. Proceed immediately to the next step before the glue has a chance to set up.



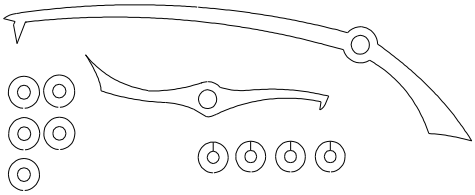
Connect the front and rear frames together by engaging the pillars into the pillar slots in the rear frame and the dowels into the corresponding holes in the front frame. The parts should engage easily; sand if needed. Keep some downward pressure on the frame to hold it together as you work the mating parts in one by one. **Do not glue the frames together**. Let the assembled frame rest until the arbor glue (rear frame) has cured. Then, separate the frame pieces from each other.



Final Assembly

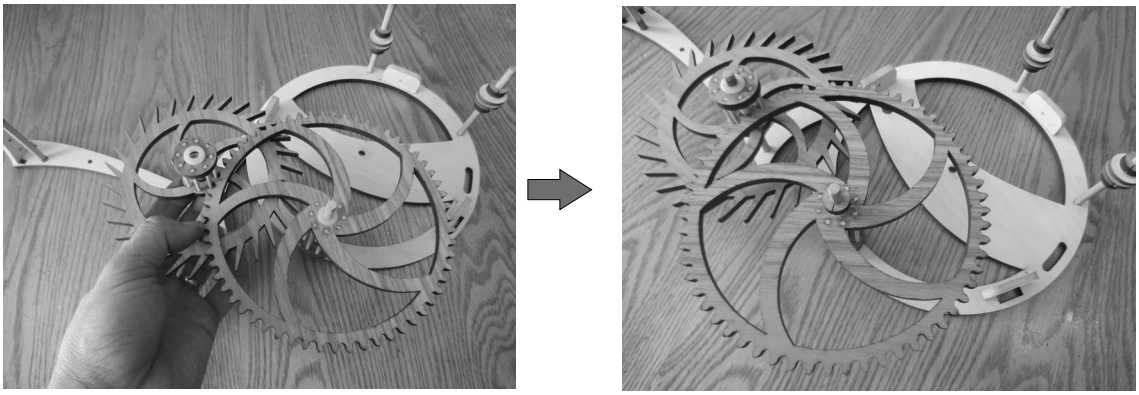
Parts

Rear frame (assembled previously)
Front frame (assembled previously)
Escapement frame (assembled previously)
Escape wheel unit (assembled previously)
Middle wheel unit (assembled previously)
Great wheel unit (assembled previously)
4 - Set washers (#34)
5 - Spacer washers (#49)
1 - Entry pallet arm (#28)
1 - Exit pallet arm (#33)
4 - Nylon shoulder washers
4 - #4x1/2" screws



Assembly Procedure

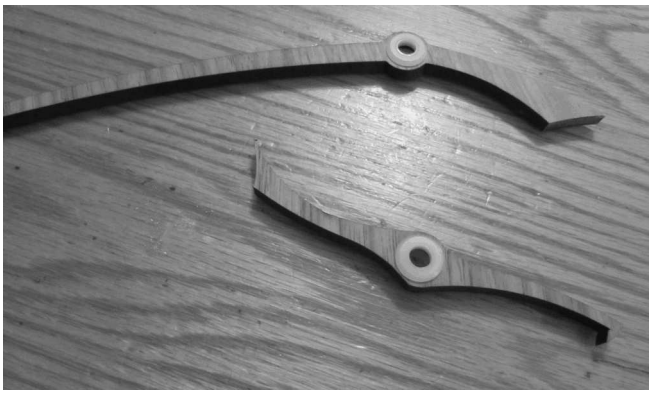
Lay the rear frame on a table with the dowels point up. Hold the escape wheel and middle wheel units together with the escape wheel pinion hub facing up and the middle wheel pinion hub facing down. Simultaneously slide the two wheels onto arbors #2 and #3. Press a set washer (#34) onto arbor #3 until it is nearly in contact with the 60-tooth middle wheel gear. Place a spacer washer (#49) onto arbor #2.



Insert the great wheel assembly into the nylon shoulder washer in the rear frame. It will be necessary to tip the arbor and then stand it up as it engages with the lantern pinions of the middle wheel. Place a spacer washer (#49) onto the great wheel arbor. Note: the 60-tooth gear and the 10-tooth gear are **not** supposed to contact each other.

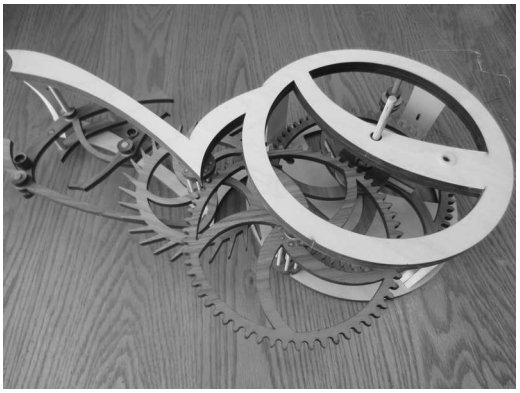
Place a spacer washer (#49) onto arbor #1 prior to placing escapement onto arbor #1. After the escapement is installed on the arbor, place a set washer (#34) onto arbor #1, leaving a small amount of clearance between the set washer and the escapement so the escapement can pivot freely.

Glue a nylon shoulder washer into both faces of the entry pallet arm (#28) and both faces of the exit pallet arm (#33). Be sure all four washer seat completely into the holes.



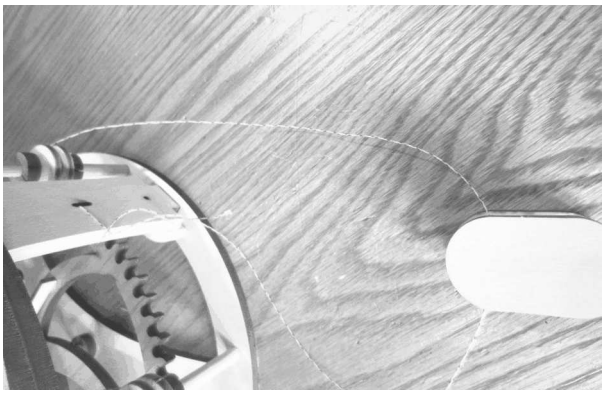
Place a spacer washer (#49) onto each of the two dowels protruding upward from the escapement frame. Then slide the entry pallet arm (#28) and exit pallet arm (#33) onto the escapement frame dowels, oriented as shown below. Press a set washer (#34) onto the two escapement frame dowels, leaving just enough clearance to allow the pallet arms to pivot freely.

Connect together the front and rear frames, making sure the pillars, dowels, and pendulum support plates all engage in their corresponding holes.



Drive a #4x1/2" screw into the predrilled hole in each of the three pillars to secure the pillars to the pillar anchors. Also, drive a #4x1/2" screw into the large hole in the top pendulum support plate.

The cord from the large hub passes over the pulley wheel on arbor #4 (above the pillar), between the dowels in the weight pulley, and then ties off on the slotted pillar. The cord from the smaller hub passes over the pulley wheel on arbor #5.



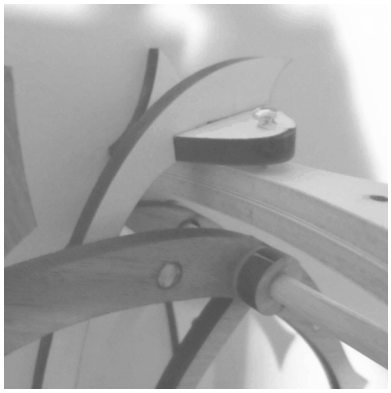
Mounting and Adjusting

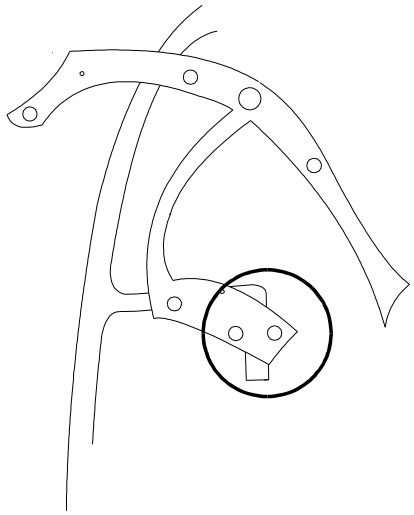
1) Determine the location to hang your clock. Be sure to consider the following:
   a) The clock must be mounted securely to the wall. Locate a stud within the wall for the solid mounting.
   b) Choose a location which is free from obstructions to the swinging pendulum or the descending weight.
   c) 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 the 1 5/8" screw into the wall at a height of approximately 74" 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 frame. Adjust the screw depth until the screw seats firmly into the narrow portion of the keyhole slot. Hang the clock on the wall.

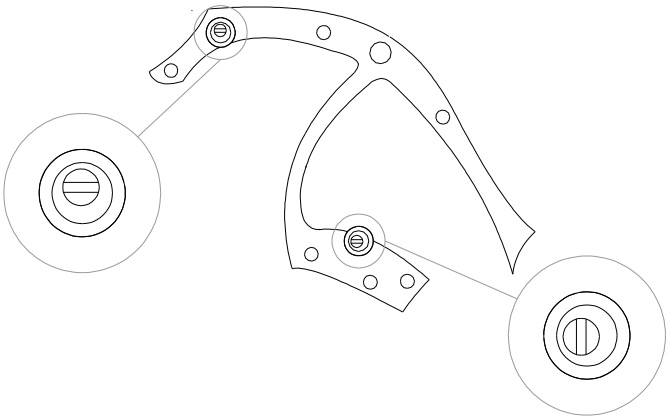
3) Adjust the orientation of the clock so that the slot in the bottom of the rear frame is approximately centered beneath the rear frame's keyhole slot. Use masking tape to secure the rear frame to the wall.

4) Mount the pendulum from the left side of the clock. The stub passes down between the two dowels that protrude from the back side of the escapement frame (there should be a small amount of clearance between the stub and the dowels; if the stub fits tightly, sand the edges of the pendulum shaft). The small screws in the at the top of the pendulum rest in the two small holes in the pendulum support plate at the top of the clock. Note that these screws are not screwed into the support plate but the tips merely rest in the holes so the pendulum is permitted to rock back and forth. If both screw tips do not seat fully into the holes, or if the pendulum does not hang vertically, raise or lower one of the screws in the pendulum bracket to make any needed adjustment.





5) Turn the screw in the escapement stops so they are oriented as shown in the diagram below. The stop on the left is turned so the rim farthest from the screw is down; the stop on the right is turned so the rim farthest from the screw is to the right.



6) 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 pallet arms are in the same plane as the escape wheel. Also, when making adjustments, be sure that the pallet are will not miss the escape wheel and cause the weight to drop rapidly to the floor.

7) Hang the weight shell hook on the lower dowel on the weight pulley, verifying that pallets one of the pallets is catching the escape wheel before releasing the weight..

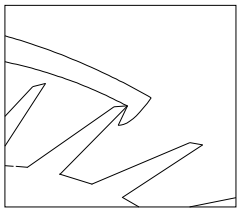
8) Gently push the pendulum to one side and release to start the clock's motion.

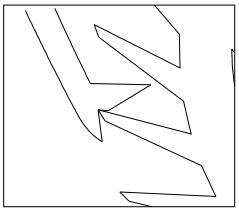
9) There are two adjustments required for the clock to run properly: 1) setting the clock 'in beat' by adjusting its orientation on the wall; 2) adjusting the escapement stops. Begin by getting the clock approximately into beat as follows:

If the escape wheel stops on the left pallet arm, then shift the bottom of the clock to the right; if the escape wheel stops on the right pallet arm, shift the bottom of the clock to the left. As you get close to having the clock in beat, it will require very small adjustments of the clock's position. Once the clock appears to be in beat, or close to it, secure the position of the clock on the wall with masking tape.

Next, adjust the escapement stops as follows:

The escapement stops control the engagement point of the pallet and the escape wheel teeth. For both pallets, the goal is to have the tip of the escape wheel teeth contact directly with the corner of each pallet, as shown below; there should be no sliding of the escape wheel teeth along the pallet faces. Rotating the escapement stops will change the contact point by stopping the pallet earlier or later. Carefully adjust both escapement stops until the proper contact is achieved at both pallets.

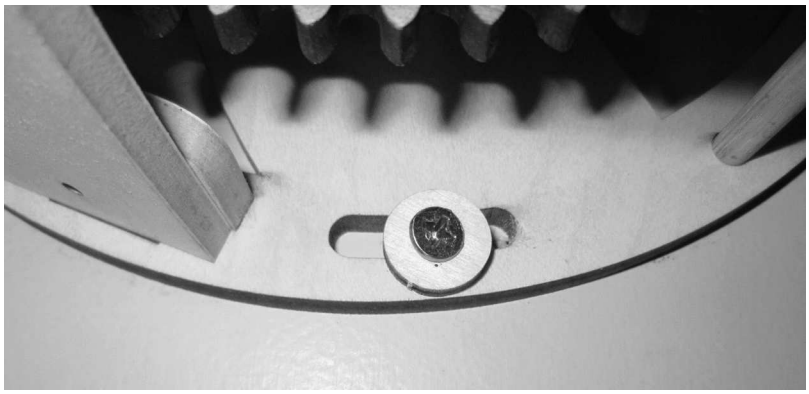




At this point, it might be necessary to go back and forth between the beat adjustment and the stop adjustment until the escapement is properly tuned.

10) 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.

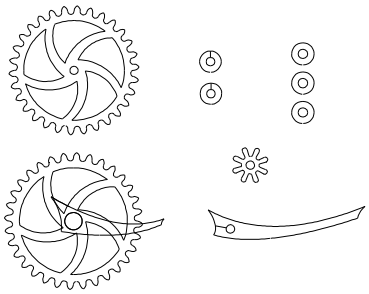
11) Place the mounting washer (#46) on a 1 5/8" screw and drive the screw into the wall through the center of the slot at the bottom of the rear frame. This screw secures the clock to the wall so that its beat adjustment can be maintained.



Final Gears and Hands

Parts

1 - 8-tooth gear (#29)
1 - 30-tooth gear (#39)
1 - 1 ½" dowel (prepared previously)
2 - Set washers (#34)
3 - Spacer washers (#49)
1 - Minute hand (#24)
32-tooth gear with hour pipe (previously installed)



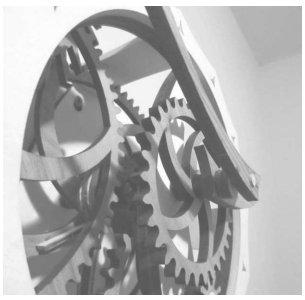
Assembly Procedure

It is not necessary to remove the clock from the wall to perform the next steps.

The ends of the 1 ½" dowel will be inserted into the 8-tooth and 30-tooth gears. Check these fits and sand the arbor ends as needed to permit the dowel to be able to press-fit onto the 8-tooth and 30-tooth gears.

Slide the 1 ½" dowel through the open shoulder washer in the front frame. On the interior side of the front frame, place a spacer washer on the 1 ½" dowel followed by the 30-tooth gear (the 30-tooth gear meshes with the 10-tooth gear above it. On the outside of the front frame, slide two spacer washers onto the 1 ½" dowel, followed by the 8-tooth gear. Be sure the gears are not pinching the frame, but instead have some clearance to allow the arbor to spin freely.

Slide a set washer onto the great wheel arbor, positioning it about 1/8" from the front frame. Slide the 32-tooth gear (with hour pipe) onto the great wheel arbor, followed by another set washer. Leave some clearance so the hour pipe will be free to rotate on the arbor. Finally, slide the minute hand onto the great wheel arbor.

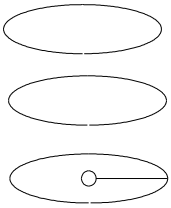


Both hands are friction fit so they can be repositioned. If the fit it too tight, some sanding may be required. If the fit is too loose, remove the hand and apply a thin film of glue to the surface where the hand was. Allow to dry completely and then replace the hand.

Winding Pull

Parts

1 - Winding pull middle (#15)
2 - Winding pull faces (#53)



Assembly Procedure

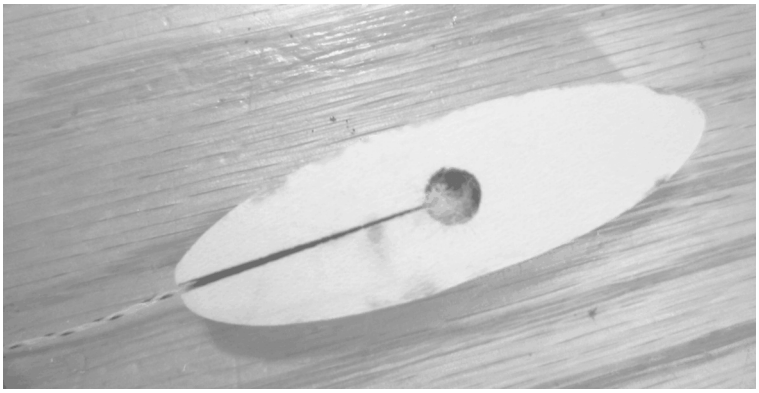
1) Hold the winding pull middle piece (#15) between the two winding pull side pieces (#53). With the pieces held together, sand the perimeter if desired and then apply finish as desired.

2) 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 (it might be necessary to wrap the cord around a piece of wood in order to maintain a solid grip on the cord).

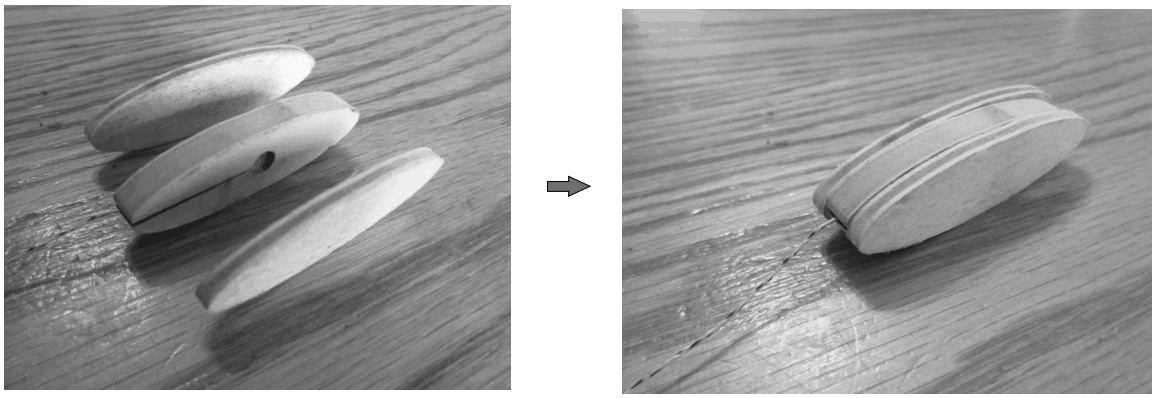
3) Verify that the winding cord passes over the pulley on arbor #5 of the frame.

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 piece (#15), with the knot located in the hole in the center piece. Make sure the knot cannot pull through the slot.



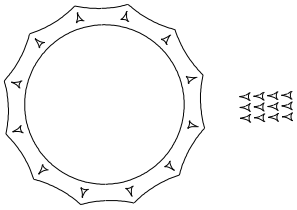
6) Glue the two winding pull faces (#53) to either side of the winding pull middle (#15).



Dial

Parts

1 - Dial (#2)
12 - Dial markers (#42)



Assembly Procedure

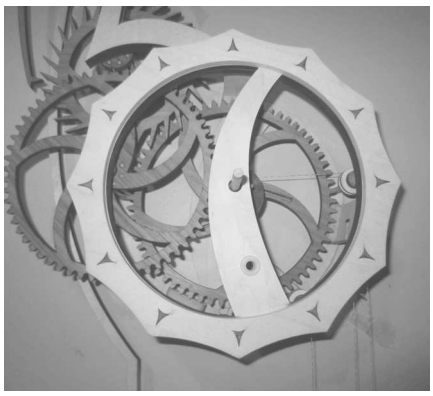
If desired, sand the edges of the dial (#2).

If desired, stain the dial markers (#42).

Glue the dial markers (#42) into the holes around the dial, setting the markers flush with the dial face.

Apply finish to the dial if desired.

With the clock mounted on the wall and properly running, glue the dial to the circular portion of the front frame, lining up the inside edges of the two circles and positioning the dial so that two opposite markers lie on a vertical line.



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 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 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 rewind 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 27 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, minute 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. 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 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.

Hands rubbing

Check that neither the hour nor minute hand is toed inward or outward, causing them to rub on each other or on the gears on the front of the clock. Adjust hand positions as necessary so that 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).

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 and Adjusting 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 the above section on 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 (the two dowels that protrude from the back of the escapement frame). 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 support 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 without a deliberate effort to do so.

Pendulum plumb

The pendulum bob must not rub against the wall or any gears. 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 Tranquility clock. Please drop us a note if you want to share any thoughts about the Tranquility clock or if you have any suggestions for improvements that can be made!

Part Locator

(To be removed from the manual)