PROJECTS by CARVEWRIGHT™

Naked Clock

PROJECT INTERMEDIATE DIFFICULTY

This unique clock not only tells the time, but reveals its inner workings while doing so. You can see the wooden gears moving the second hand, and the gears that drive the minute and hour hands too.

Using a small electric synchronous motor, this clock keep perfect time and never needs to be wound. The clock is about 22” tall and 14” wide, and makes an interesting conversation piece to showcase your woodworking talents.

All of the wood parts are made with the CarveWright/CompuCarve machine using only the two standard bits – 1/8” cutting and 1/16” carving – plus a few hand tools and a drill press.

Materials List

Project Files

- frame.mpc
- gears.mpc
- clock_parts.mpc
- motor_mount_round.mpc
- pinions_hands.mpc

Boards:

- (1) 3/4” x 3.5”W x 49”L
- (1) 1/4” x 12” x 32” Baltic birch plywood
- (1) 3/4” x 9.5”W x 36”L
- (1)1/2” x 5.5”W x 19”L
- (1) 3/4” x 10.5”W x 21”L

Materials:

- hardware (see instructions)
- 1 RPM synchronous motor
- electrical cord
- finishing materials

Hand Tools:

- hammer
- small hand saw
- hacksaw
- file
- screw driver

Power Tools:

- Drill press
- Cordless drill
- Sander (optional)

Step 1

Materials

Start by deciding what materials you will use for your clock.

For the large and medium gears, I highly recommend using ¼” Baltic birch plywood. Baltic birch is special plywood that is constructed from multiple thin layers that are free of voids. This makes the plywood dimensionally stable, and gears cut from it will be flat and true. Some home centers may carry it, but it can also be ordered and shipped from many sources.

For the pinions, choose a hardwood. I used oak. You’ll need ½” thick material. I was able to obtain this from the local home center, but the actual thickness of the board was 7/16”, not ½”. You may be able to obtain true ½” material from a scroll saw wood supplier or elsewhere. Either thickness will work.

Note: The lengths of brass tube specified in the instructions are for 7/16” pinions and hubs. If you use ½” lumber, you will need to lengthen the tubes used in the main gear assembly a bit.

Hardwood is recommended for the frame.. I used maple for my clock frame. Most any wood may be used for the cap, ring, and base. I used clear pine. These parts are all made from standard 1” boards (actual thickness ¾”).

To build and assemble the clock, you’ll need the following hardware. I found all but the motor at my local hardware store. Brass tubing may also be found at hobby shops. Note that the wall thickness of the ¼” and 7/32” tubing is critical, as the smaller-diameter tubing must snugly fit into the larger-diameter tubing. I used tubing made by K&S Engineering. See the references section for motor suppliers.

<u>Hardware</u>
(1) ¼” diameter brass tubing, .014” wall, 12” long
(1) 7/32” diameter brass tubing, .014” wall, 12” long
(1) 3/16” diameter brass tubing, 12” long
(1) 1/8” diameter brass tubing, 12” long
(1) soft spring, about 5/16” diameter and 1½” long (e.g., Hillman #6)
(2) nylon or metal washers, ¼” inside diameter
(1) # 4 machine screw 1¼” long
(1) # 6 machine screw 2½” long
(3) # 8 flat-head wood screws 1¼” long
(3) # 4 round-head sheet metal or wood screws ½” long
(2) # 6 round-head sheet metal or wood screws 1” long
(1) small washer, about ¼” outside diameter
(1) 6-foot two-wire extension cord
(2) crimp-type wire splices
(1) electric synchronous motor, 1 RPM, CCW rotation

Step 2

Frame

For the frame parts you'll need a standard 4 foot long 1 x 4 board (actual dimensions ¾" x 3½" x 49") and the project file frame.mpc. Note that the project is laid out on a slightly smaller virtual board. This is to ensure that the project will fit on your board even if it is slightly irregular in size.

All of the project pieces have been laid out so as to keep boards under the rollers. If you are an experienced user, you may adjust the projects and/or use a sled to minimize waste as you see fit. Less experienced users should follow the directions as written. The projects have been laid out to avoid excessive waste.

When you load the board and run the project, respond 2) No to the prompt

Stay Under Rollers?
1) Yes 2) No

Because of the way the project is laid out, the board will stay under the rollers anyway. If your board is larger than the virtual board, select the option to Place on Corner if asked. Respond No to the Cut To Size prompt.

You'll use the 1/8" cutting bit only for this step. After the board is cut, use a small hand saw or razor knife to cut the tabs and separate the parts from the board.

Step 3

Gears

The gears are cut from a ¼" piece of Baltic birch 12" by 32". This thin stock cannot be loaded into the machine by itself.

Make a simple sled by cutting a piece of ½" or ¾" plywood, and temporarily fasten the birch to the plywood. Make sure the plywood is smooth on the bottom, warp free, and cut square. This will ensure that the board will track properly in the machine.

Fasten the birch to the plywood base with four countersunk screws in the corners of the plywood. You may instead use tape on the plywood edges or double-sided tape on the surface of the sled. Whatever method that you use, make sure that the birch is securely attached. (Note that the project uses tabs to keep the gears in place, so double-sided tape is not required if you use screws or edge taping to secure the birch.)

Load the sled into the machine and use the gears.mpc file. Again, respond No to Say Under Rollers? and Place on Corner if your board is oversized. At the prompt Select Cut Through Depth, choose 1) Project.

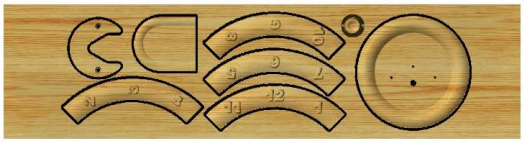
This gears project specifies three bits: A 1/8" vector bit, a 1/8" cutting bit, and a 1/16" drill bit. Select and load the 1/8" cutting bit for the first two.

Because the gears are going to be pressed onto brass tubing when assembling the clock, their center hole diameters must be precise – even more precise than the CarveWright is capable of doing. We need to use precise drill bits. However, we are going to use the CarveWright to drill a small 1/16” pilot hole for us to locate the positions of these critical holes.

If you have a 1/16” cutting bit, use it. If you don’t, no problem – we are going to trick the machine. When prompted to select the 1/16” cutting bit, go ahead and select it; but when prompted to *load* the bit, load your 1/16” carving bit instead. Don’t worry; we’re only going to drill a very shallow pilot hole, and the carving bit will do just fine.

After the gears are cut, remove the plywood from the sled, and carefully remove the gears by cutting the tabs. Sand the gears as needed.

Step 4

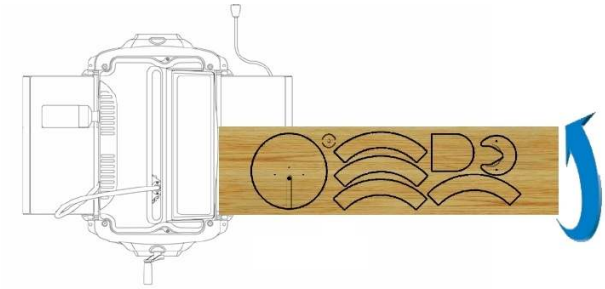


Clock parts

A bunch of clock parts are cut from a standard 1 x 10 board (actual dimensions ¾” x 9½” x 36”) using the file clock_parts.mpc. Bits specified are 1/8” cutting bit, 1/8” vector bit, 1/8” drill bit, 1/16” drill bit, and 1/16” carving bit. Select and load your 1/8” cutting bit for the first three. Specify the 1/16” cutting bit, but again load your 1/16” carving bit if you don’t have a 1/16” cutting bit. Select and load the 1/16” carving bit for the carving bit.

The project includes a motor mount for pear-shaped synchronous motors. If you are using a round motor instead, delete the *motor mount* groups on the front **and** the back of the project, then copy and paste the group *motor mount round* from the project motor_mount_round into the same area (the round motor mount has no cuts on the back side).

This is a two-sided project, so you’ll load your board with the back of the parts face up in the machine.



When the back side is done and the machine prompts you, flip the board as shown and continue with the top surface. After the board is carved and cut, remove it from the machine and carefully cut the tabs to separate the parts from the board.

Step 5

Ring assembly

Sand the ends of each ring piece flat and square, but leave the other surfaces for now. The ends must be true for a good fit. Without gluing, trial fit the pieces on your workbench and carefully trim the parts as needed.

Lay some waxed paper down on your bench, covering the joint areas of the ring. Mix up some extended-time (60 minute) epoxy, and apply it liberally to the end of each piece. Fit the pieces together and clamp. Check to make sure that the pieces remain flat – clamp or weight them down as needed.

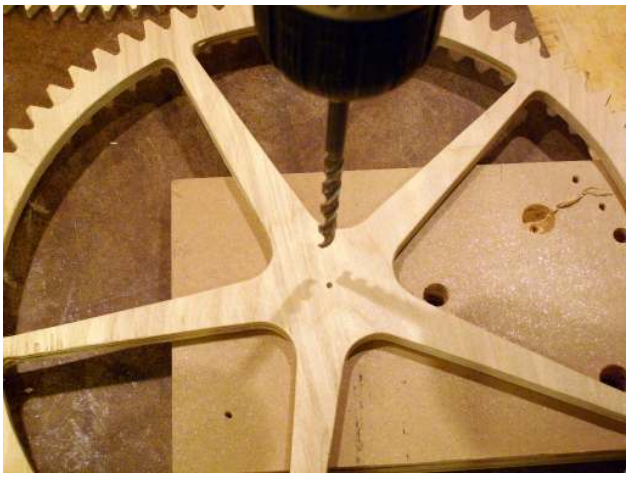
Step 6

Pinions and hands

The pinions, hubs, hands, and other parts are carved and cut from ½" stock. If you are using true ½" material, load a 5½" by 19" piece directly into the machine, and use the pinions_hands.mpc file.

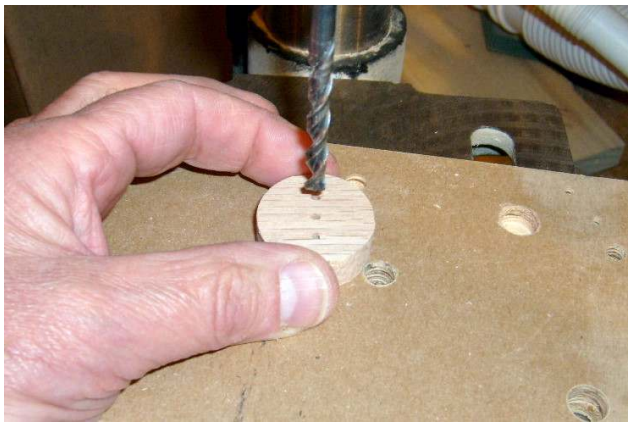
If your material is actually 7/16" thick, like mine was, you'll need to use a sled. Make one like you did for the gears. Use the pinions_sled.mpc file. At the prompt Select Cut Through Depth, choose 1) Project.

Step 7



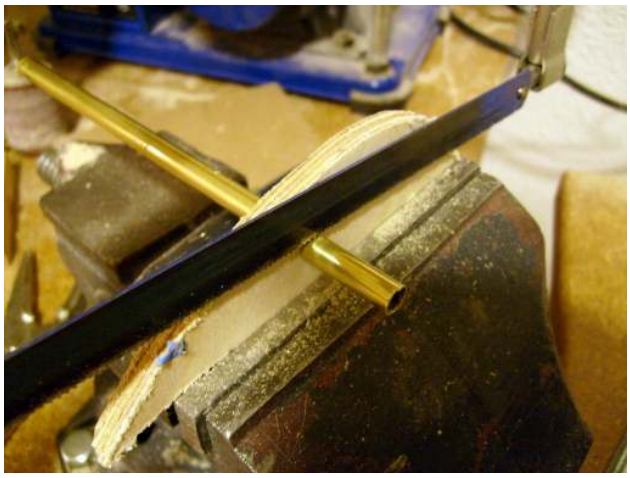
5-arm star gear assembly

Drill a 7/32" hole in the center of the 5-arm star gear, using the pilot hole as a guide.



Drill a 7/32” hole in the center of the hub with the three pilot holes. Drill 5/32” holes in the outer two pilot hole locations. For all drilling, use a drill press whenever possible to ensure that the holes are absolutely perpendicular to the surface of the parts.

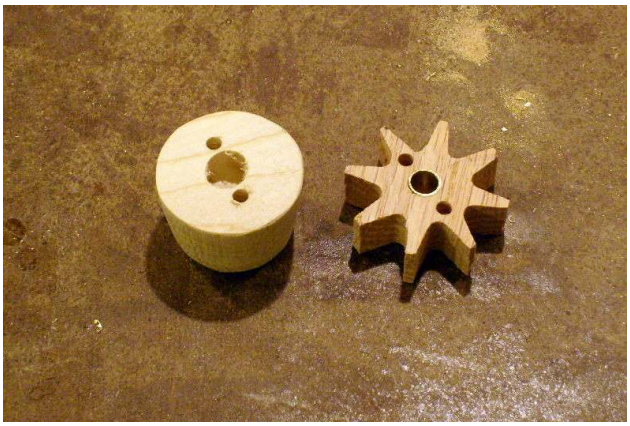
Cut a piece of 7/32” tube 7/8” long.



To assist in cutting the tubing, drill a 7/32” hole in some scrap, and insert the tubing through the hole. Clamp the scrap in a vice. With the scrap as a guide for your hacksaw blade, cut the tubing. You may find it easier to cut if you periodically rotate the tubing. File the end of the cut piece, and remove any burrs inside and outside the tube.

Insert the tube into the hub, with ¼” of the tube protruding. You may need a hammer to drive it home. If so, protect the end of the tube with scrap wood.

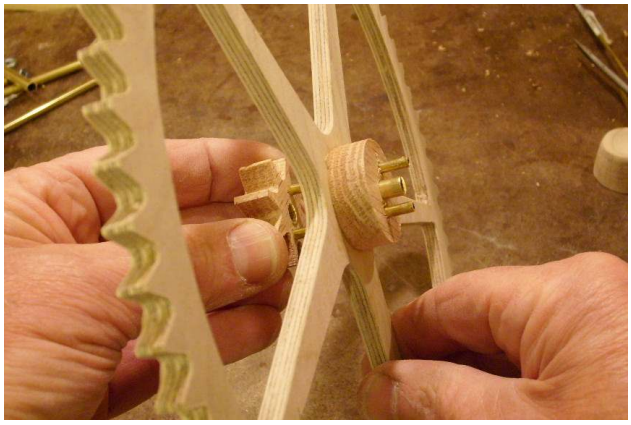
Apply wood glue to the surface of the hub. Align the tube and the hole in the gear and press them together. Make sure the tube is flush with the back of the gear. The tube should protrude from the top of the hub. Clamp the hub to the gear and wipe off any excess glue. Allow the glue to set. Then drill 5/32” holes through the gear using the holes in the hub as guides.



Drill a 1/4” hole in the center of the hub 8-tooth pinion with the three pilot holes. Cut a length of ¼” brass tubing to match the thickness of your pinion, and insert it into the center of the pinion as shown.

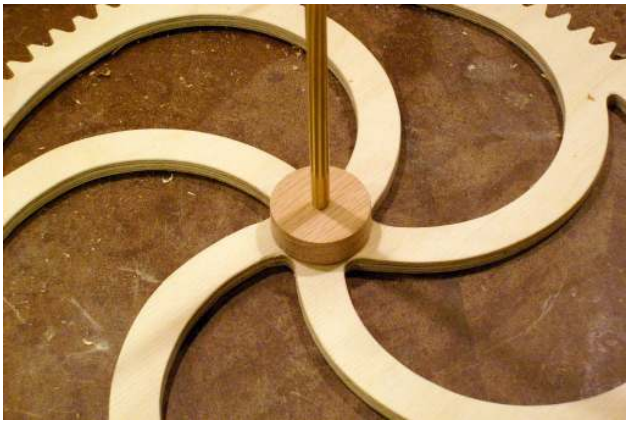
Drill 1/8” holes ¼” deep in the outer positions of the pinion. Drill 1/8” holes ¼” deep in the back of the button using the pilot holes.

Cut two lengths of 1/8” brass tube 1¾” long. Insert them into the pinion as shown. You may secure the tubes with a drop of superglue each.



Insert the pinion assembly through the back of the gear and hub as shown.

Step 8



5-arm spiral gear assembly

Using the pilot hole made by your machine as a guide, drill a 7/32” hole in the center of the 5-arm spiral gear. Do the same in the center of the hub with just the one pilot hole.

Cut a piece of 7/32” brass tube 3¾” in length.

Insert the brass tubing into the hub, and then glue the hub to the gear as you did for the spiral gear. (Note the direction of the spiral arms.)

Step 9

3-arm star gear assembly

Drill a ¼” hole in the center of the 3-arm star gear. Do the same in the center of the small spacer, and through the hour hand. Cut a piece of ¼” brass tubing 1” long. Insert the tubing into the gear, and then glue the spacer to the gear. Likewise, glue the hour hand to the spacer. Align the hour hand and the arms of the star gear in a manner that is pleasing to you. Clamp and allow the glue to set.

The brass tube should be flush with the back of the gear and the top of the hour hand. Use a file to trim it down if it is too long.

Step 10

3-arm spiral gear assembly

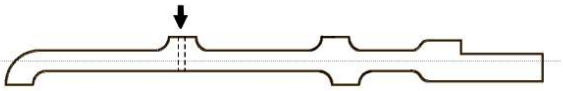
Drill a 7/32” hole in the center of the 3-arm spiral gear. Cut a piece of 7/32” brass tube ½”long. Insert it into the 3-arm spiral gear, securing it with a drop or two of superglue. Drill a 7/32” hole into the 8-tooth pinion, as deep as possible without drilling all the way through.

Step 11

12-tooth pinion assembly

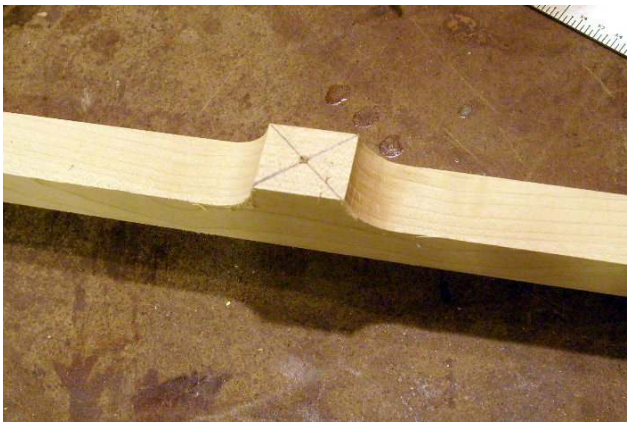
Drill a 3/16” hole in the center of the 12-tooth pinion, 3/8” deep, but don’t drill it all the way through. Cut a piece of 3/16” tube 4-3/8” long. Insert it into the hole. You may secure it with a drop or two of superglue.

Step 12

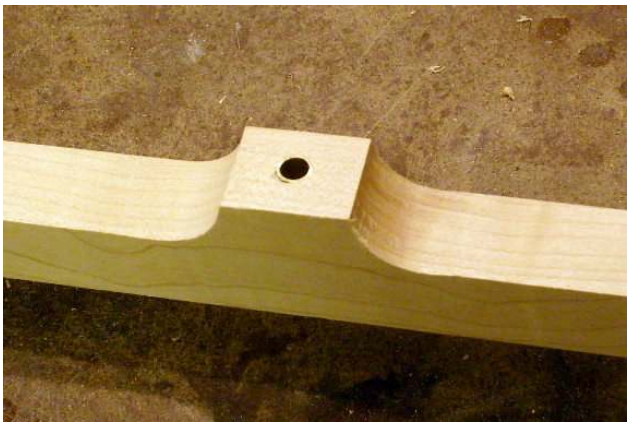


Frame bearing

Locate the indicated protrusion on the frame.

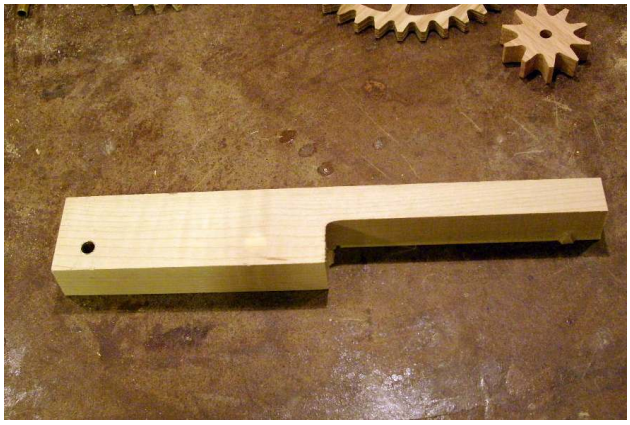


With a ruler and a pencil, mark the center. Using a drill press, drill a ¼” hole through the frame.



Cut a piece of ¼” brass tube 1-1/4” in length. Insert the tube into the hole in the frame. Place a piece of scrap on top of the tube, and gently hammer the scrap to drive the tube home.

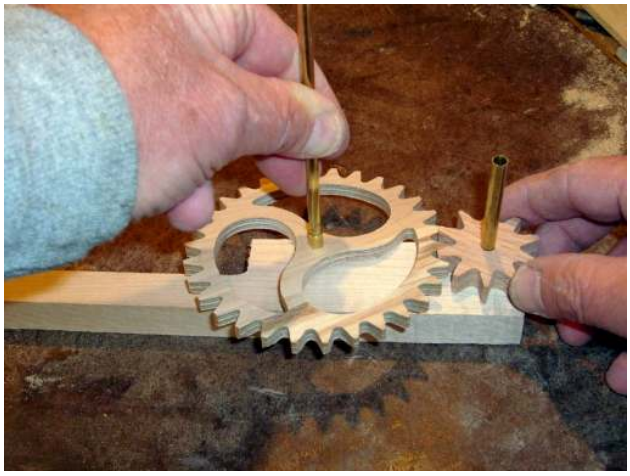
Step 13



Front gear post hole

To ensure smooth gear operation, we're going to make and use a jig to drill a couple of critical holes.

To make the jig, drill a ¼' hole in the end of an L-shaped piece of ¾" scrap, about 1" wide by 7" long. I got my scrap from the leftover frame board. Cut and insert a short length of ¼" brass tube into the hole, much like you just did for the frame.



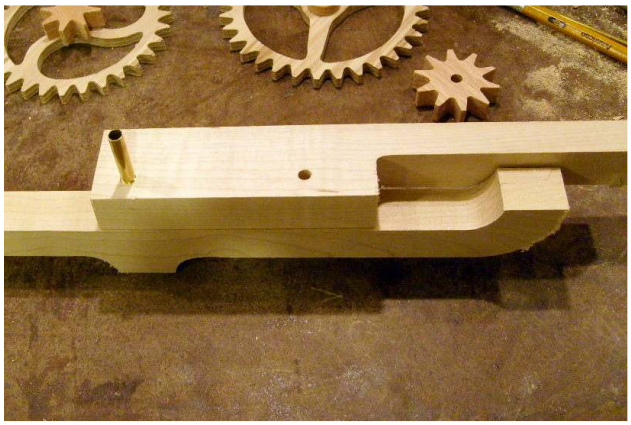
Drill a 7/32" hole through the center of the 10-tooth pinion gear. Temporarily slide this gear onto a short piece of 7/32" tube, so that tube protrudes on both sides of the gear. Insert the tube and gear into the ¼" bearing in the scrap.

Take the 3-arm spiral gear and temporarily insert a piece of 3/16" tube in it. Place this gear on the scrap and mesh it with the pinion. Hold the gear in place by pressing down on the 3/16" tube. Manually rotate the pinion and check the gear mesh. The mesh must not be too loose or too tight. There can be no binding. You may need to sand some teeth for a good fit. When you think the mesh is right, mark a centering hole for the 3-arm spiral gear (you may be able to press hard on the temporary 3/16" tubing to leave an impression). Drill a 3/16" hole at that spot. Insert a short piece of 3/16" diameter brass tube into the hole.

Slip the 3-arm spiral gear over the tube, and recheck the fit of the gears. Rotate the pinion by hand for several revolutions until you are satisfied in a good fit. The gears should mesh smoothly and not catch. At the same time, there should not be excessive play or slop in the gears (some play is normal).

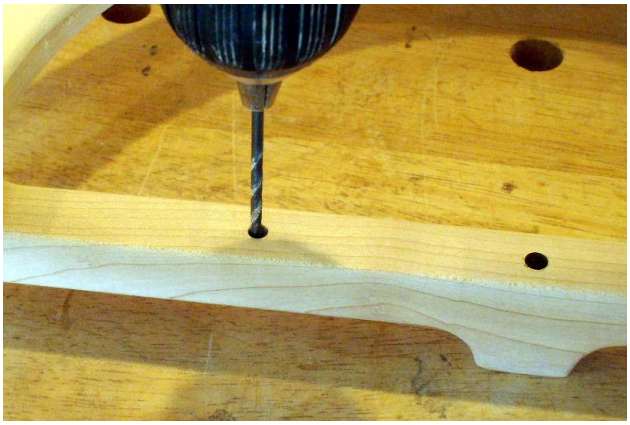
If the gears mesh too loosely or too tightly, remove the 3/16" brass tubing from the jig, and repeat the process, this time drilling a hole to one side of the bad hole, but closer or farther from the ¼" bearing as needed. Insert the 3/16" tubing and test the fit.

When satisfied with the fit, slide the 3-arm star gear assembly onto the shaft. Place the 8-tooth pinion onto the protruding tube of the 3-arm spiral gear, but don't glue the pinion. Test the fit of these newly-added gears by rotating the 10-tooth pinion. Make corrections as required.



When satisfied with the fit of both sets of gears, remove the gears and the 3/16" brass tube. Insert a piece of 7/32" tubing into the frame bushing, and slip the jig over that scrap tube. Center the 3/16" hole over the frame, and clamp the jig in place. Using the scrap as a guide, drill a 3/16" hole into the frame through the scrap hole. Drill only 3/8" deep into the frame.

Cut a piece of 3/16" brass tube 1" long. Temporarily insert this into the hole. Test fit the gears in the frame just like you did in the scrap. Remove the tube.



With a 3/32" drill, make a new concentric hole inside the 3/16" hole that you just drilled into the frame. Drill at least ¼" deeper than before, but take care not to drill through the back of the frame. This will be a pilot hole for a screw when the clock is assembled later on.

Step 14

Rear gear post hole

To locate and drill for the rear gear post, repeat the process that you just did. This time, insert the 5-arm spiral gear assembly into the ¼" bearing. Next, insert the 12-tooth pinion assembly into the center of the 5-arm spiral assembly. Using a

3/16” tube for a shaft, position the 5-arm star gear assembly on the scrap. Check the fit of both gear pairs (look underneath the star gear for the 8-tooth pinion fit).

After you have created the jig to locate the rear gear post hole, drill this 3/16” hole only 3/8” deep into the frame. Cut a piece of 3/16” tube 2-1/8” long, and temporarily insert it into the hole. Test fit the gears in the frame. Remove the tube.

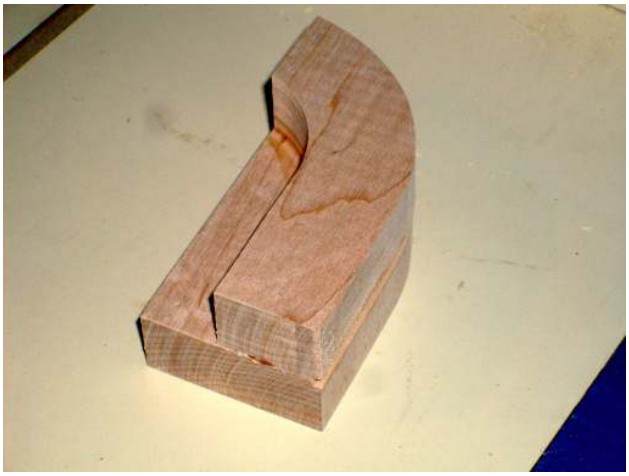
With a 7/64” drill bit, make a new concentric hole as deep as you can without drilling through the back of the frame.

Step 15

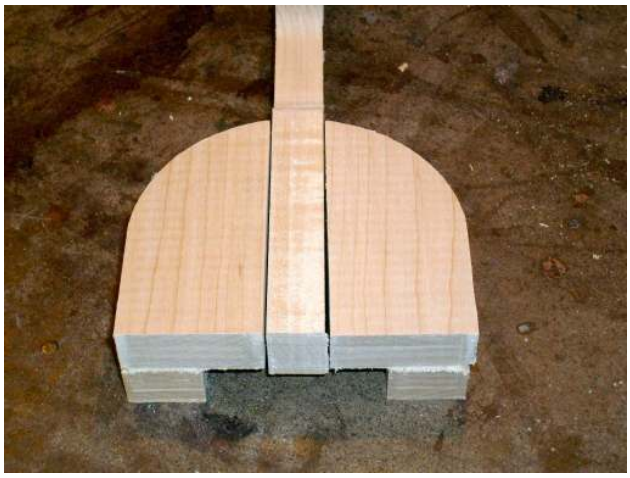
Frame assembly

If you wish, you may round over the edges of the frame colored in red as shown. Sand the frame pieces, keeping the other edges square.

Locate the frame support pieces, and pair up the left- and right-side parts. Note that the routed edge on each pair of parts will face each other when assembled.



Apply wood glue to the J-shaped part and press it onto its mating part, and clamp. When the glue in those parts has set , you may also round over the outer edges of the J, front and back, if you wish.



Glue the supports to the base of the frame as shown.

Step 16

Ring and frame assembly

The ring is fastened to the frame with short dowels. A dowel centering pin makes this job easier.

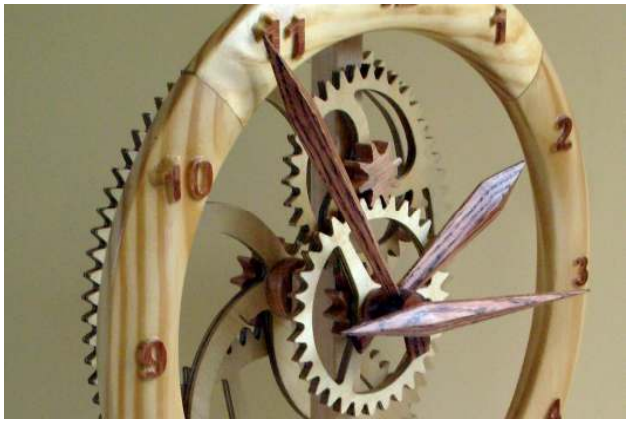
Mark the center of the ring behind the 12 and 6 positions, and drill a 5/16” hole about 3/8” deep. Drill a 5/16” hole about ½” deep in the center of the top of the frame as shown. Insert a dowel in the top of the ring, and a centering pin into the bottom of the ring. Temporarily fasten the top of the ring to frame using no glue. Center the 6 o’clock part of the ring over the frame, and press so that the jig leaves an impression in the frame. Drill a dowel hole at the impression. Disassemble, apply glue, assemble, and clamp the ring to the frame.

Step 17

Cap

Attach the cap to the front of the frame. I drilled pilot holes from the cavity at the back of the frame into the back of the cap and used a couple of wood screws, but if you’re using the same wood for the cap as for the frame you can just glue it on.

Step 18



Finish

Now would be a good time to apply finish. Since everyone seems to have their own favorites, I won't bother with instructions.

I will offer one technique that I used to make the numbers stand out. I applied three coats of Minwax Polyurethane to the numbers ring. After the third coat, I sanded the surface of the numbers only until the finish was gone. Then, I carefully applied a penetrating Minwax dark stain to the surface of the numbers, promptly wiping the any excess off the surface of the polyurethane. I followed with additional coats of polyurethane.

Step 19

Front gear post

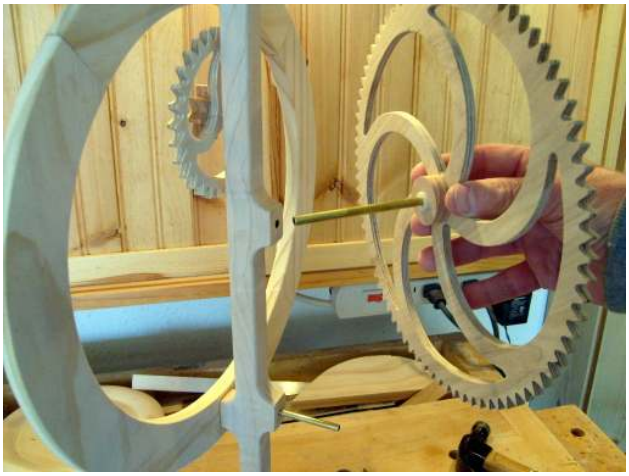
Reinsert the 1" long piece of 3/16" brass tube. Check to make sure that 5/8" is exposed. Adjust as necessary.

Slip the 3-arm spiral gear assembly on the tube.

Secure the gear with a # 4 machine screw 1¼" long. You can use a wood screw if you can find one of the correct size. Actually, a machine screw works quite well.

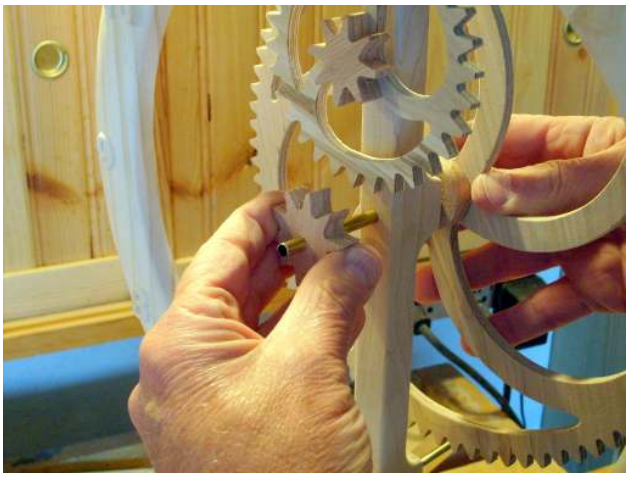
Install the 8-tooth pinion by slipping it over the shaft of the 3-arm spiral gear assembly. Secure it to the spiral gear with a couple drops of super glue while taking care to get no glue on the shaft. Make sure the finished assembly spins freely. The spiral gear should be "floating" a bit off the surface of the frame.

Step 20



Main gear set assembly

Slide a nylon washer onto the shaft of the 5-arm spiral gear assembly. Insert the shaft into the back of the frame bushing.



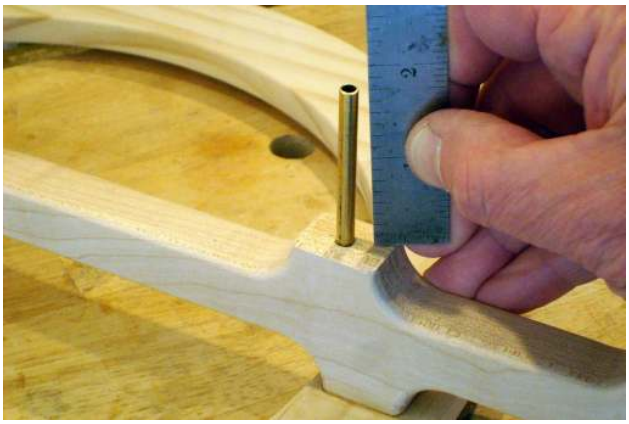
Slide the 10-tooth pinion onto the shaft from the front of the frame. Rotating the tube while pushing the gear may assist in sliding it on. Slide the gear it up to the frame, meshing it with the spiral gear and leaving only a little play against the frame.

Slide the 3-arm star gear assembly with hour hand onto the shaft, meshing with the pinion.

With the hour hand pointing to 12 o'clock, install the minute hand and align it to 12 o'clock position also.

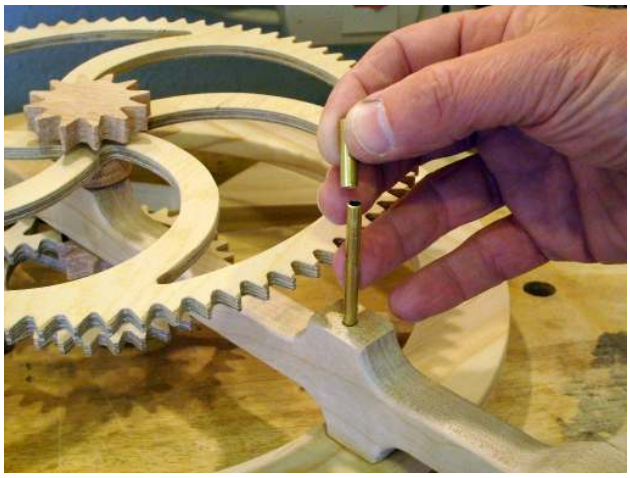
Slip a nylon washer on the shaft of the 12-tooth pinion, and then slide the shaft into the main gear assembly from the rear. Attach the second hand in front.

Step 21

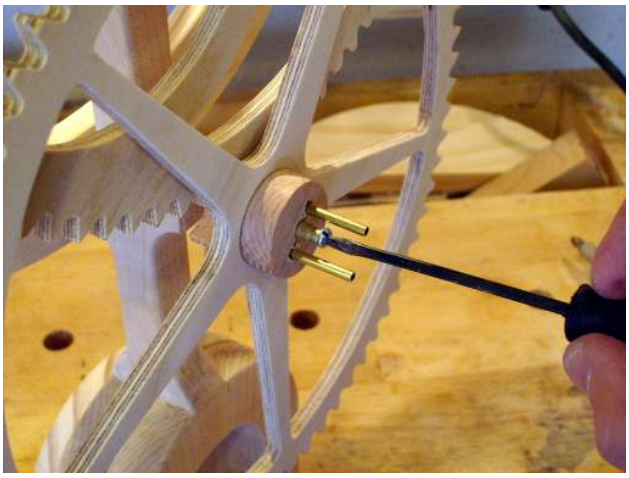


Secondary gear assembly

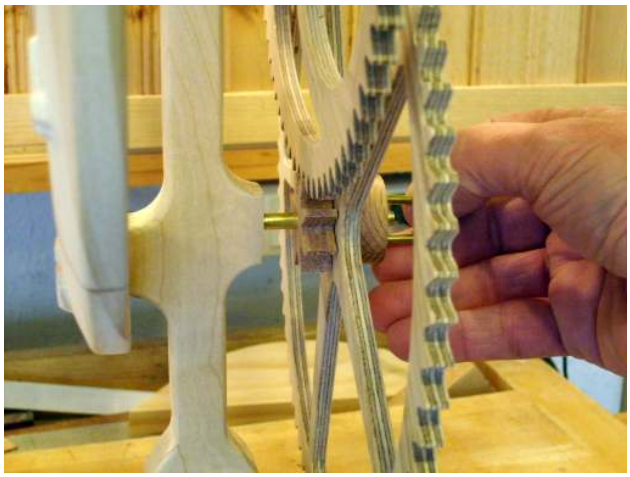
Reinsert the 2-1/8" length of 3/16" tube into the rear post hole. Check to make sure that 1¾" is exposed. Adjust the tube length as necessary.



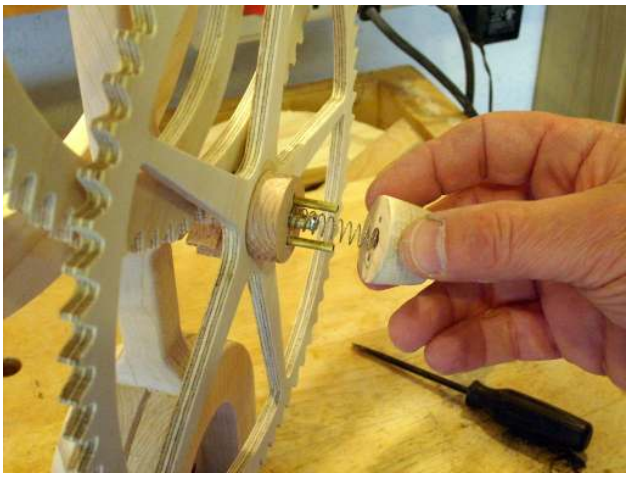
Cut a piece of 7/16” tube 13/16” long, and slip this spacer onto the shaft.



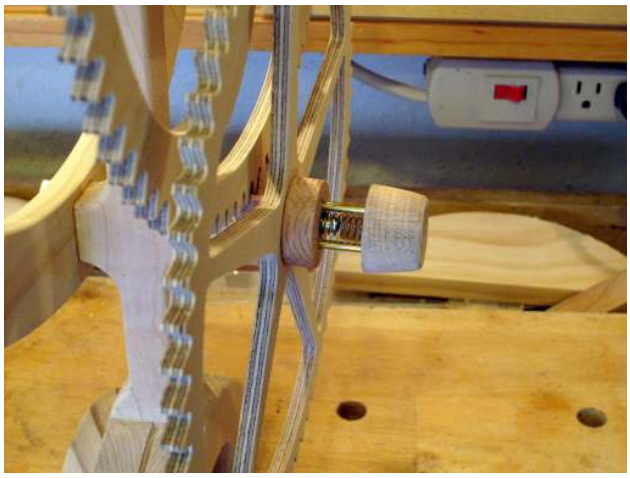
Secure the 5-arm star gear assembly to the shaft with a # 6 machine screw 2½” long.



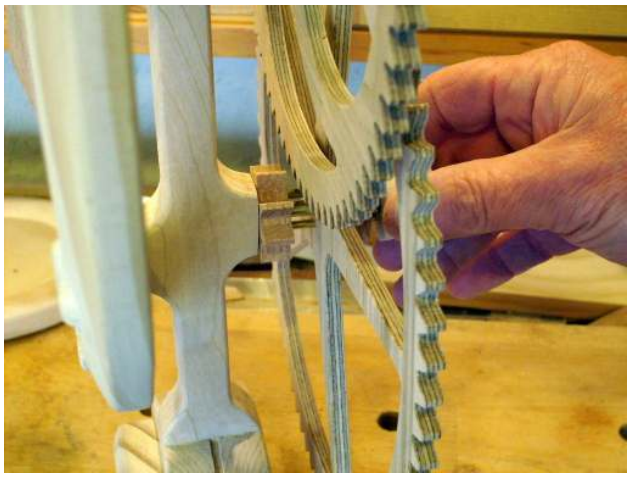
Install the 5-arm star gear assembly onto the shaft, making sure that the pinion’s bushing slides onto the spacer, and that the 5-arm star gear is up tight against the spacer.



Insert the spring into the recess in the button and over the stub of the shaft.

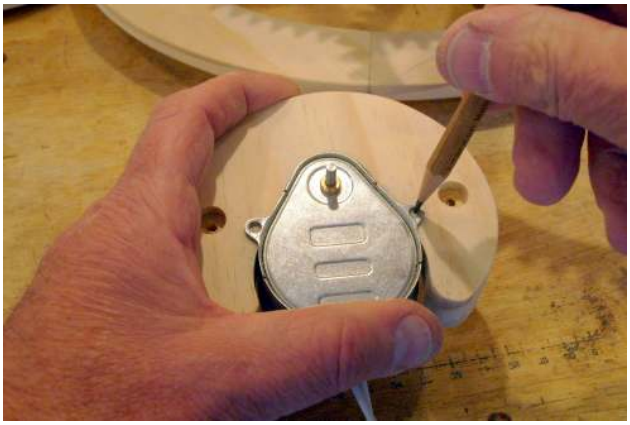


Press the button firmly onto the two 1/8” brass tubes. You may secure with superglue.



Press the button, and check to make sure that the pinion completely disengages from the 5-arm spiral gear. Also make sure that the button pushes and returns freely.

Step 22



Motor

The project files are set up for either a pear-shaped or a round Synchron brand synchronous gear motor. You may need to adjust the motor mounts to fit your particular motor.

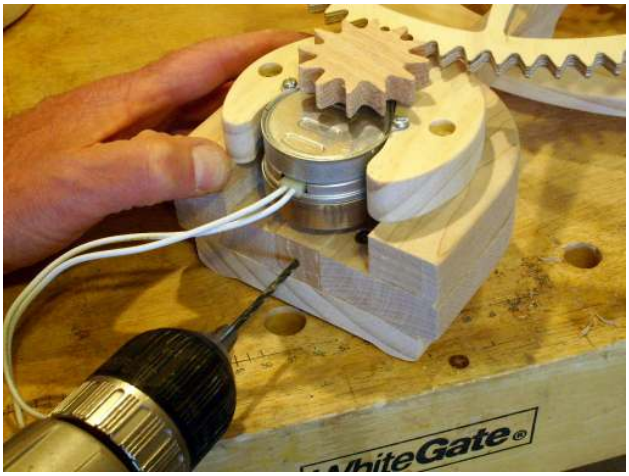
Place the motor in the motor mount as shown, and mark pilot hole locations for motor screws. Drill two pilot holes, and then fasten the motor to the motor mount with # 4 sheet metal screws ½” long.

Drill a hole in the remaining 12-tooth pinion to match the shaft of your motor. Mine had a 1/8” shaft with a flat. Secure the gear to the shaft with superglue.

If your motor has a gear pressed onto a shaft, drill a hole to match the outer diameter of that gear, very shallow to match the thickness of the gear. Secure with a small amount of epoxy glue.

Position the motor mount assembly so that the pinion meshes nicely (not too loose or too tight) with the 5-arm star gear. Mark and drill one mounting hole only into the frame for now. Secure with a # 6 sheet metal screw 1¼" long. Note that you can loosen the screw and pivot the whole motor mount assembly on this one screw to mesh the gears tighter or looser. This may be needed later.

Step 23



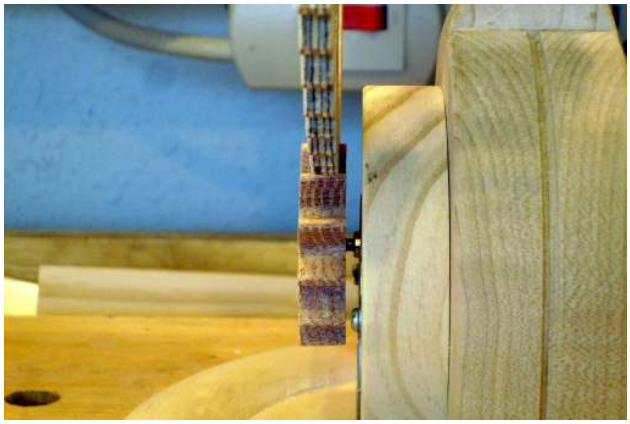
Frame to base

Drill a pilot hole for a #8 screw into the center of the frame as shown.

Thread the motor wires through the hole in the base.

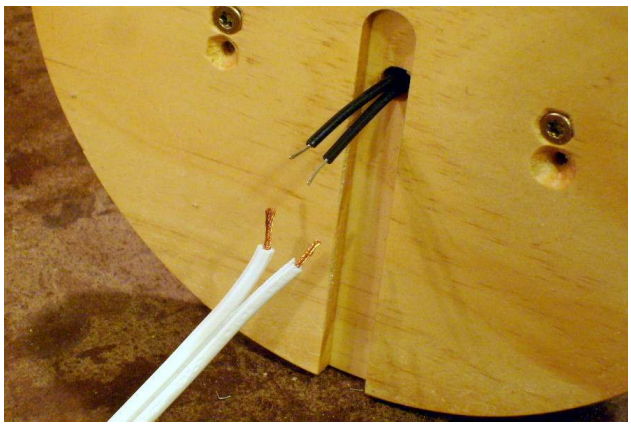
Countersink drill the mounting holes at the underside of the base. Fasten the base to the frame with a #8 wood screw 1¼" long.

Square the base with the frame, then drill two more pilot holes and secure with two screws.



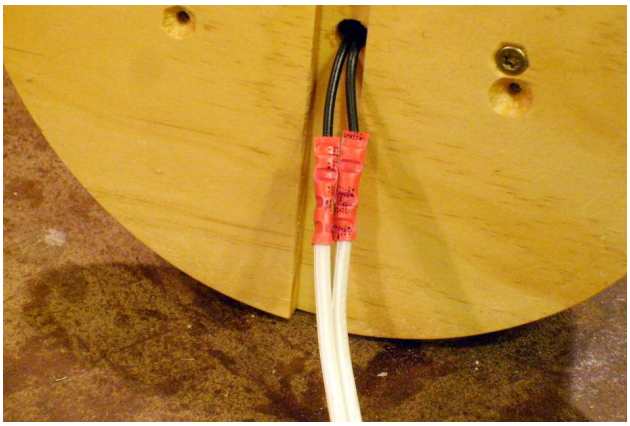
Check the alignment of the motor pinion and the 5-arm star gear. The 5-arm star gear should be centered on the width of the pinion. Shim the motor with washers if necessary.

Step 24



Wiring

Trim the motor wires so that, when folded over, they reach about halfway down the channel in the base. Strip the ends of insulation. Cut the receptacle end from a 6-foot extension cord and discard it, so that you are left with a 6-ft cord and plug. Strip the wire at the end of the cord.



Connect the motor and the cord wires. I used crimped wire splices, but you can also solder and insulate with shrink tubing.

Secure the cord to the base with a small washer and screw. Take care not to nick the insulation.

Step 25

Final check

Plug in the clock and check operation. Look for good mesh of gears and no signs of stalling. Set the time by pressing the button and rotating the minute hand manually, then release the button and ensure that the pinion engages.

You may want to check operation over several days. When you are satisfied, drill a pilot hole and install the second motor mount screw.

RESOURCES...

To power your clock, you'll need an electric synchronous 1 RPM motor with counter-clockwise rotation. A 1/8" shaft is preferred.

Manufacturers of this type of motor typically do not sell retail. However, these motors are used in time clocks and chart recorders. They can be procured from firms that sell and service this type of equipment. Here are a few sources:

Colman Mfg. Co.
www.cfmg.com
(800) 926-0123
Part no. 80-12

Signal Systems Incorporated
www.signalsystems.com
1-800-872-6066

American Time & Signal Co.
www.atsclock.com
800-328-8996

Prices for new motors from these suppliers are in the $25 - $40 range.

You may also find motors on eBay and from surplus shops. Try searching for synchronous motors, timing motors, clock motors, time card motors, and specifying 1 RPM to limit search results. Understand that surplus or older new motors from some sources such as these may or may not be suitable. I got some new, old stock motors from a surplus place, and they proved to be too noisy.

There are numerous resources for the CarveWright/CompuCarve owner to make their experience with these machines much more enjoyable.

Every owner should join the CarveWright User Forum (http://forum.carvewright.com/index.php) where fellow users share their experiences and

knowledge with these machines on a daily basis. It is a FREE service that you will surely appreciate. A handy Search Feature helps you find answers to any questions you may have.

You can also visit the forums for up-to-date status on this project, including motor suppliers.