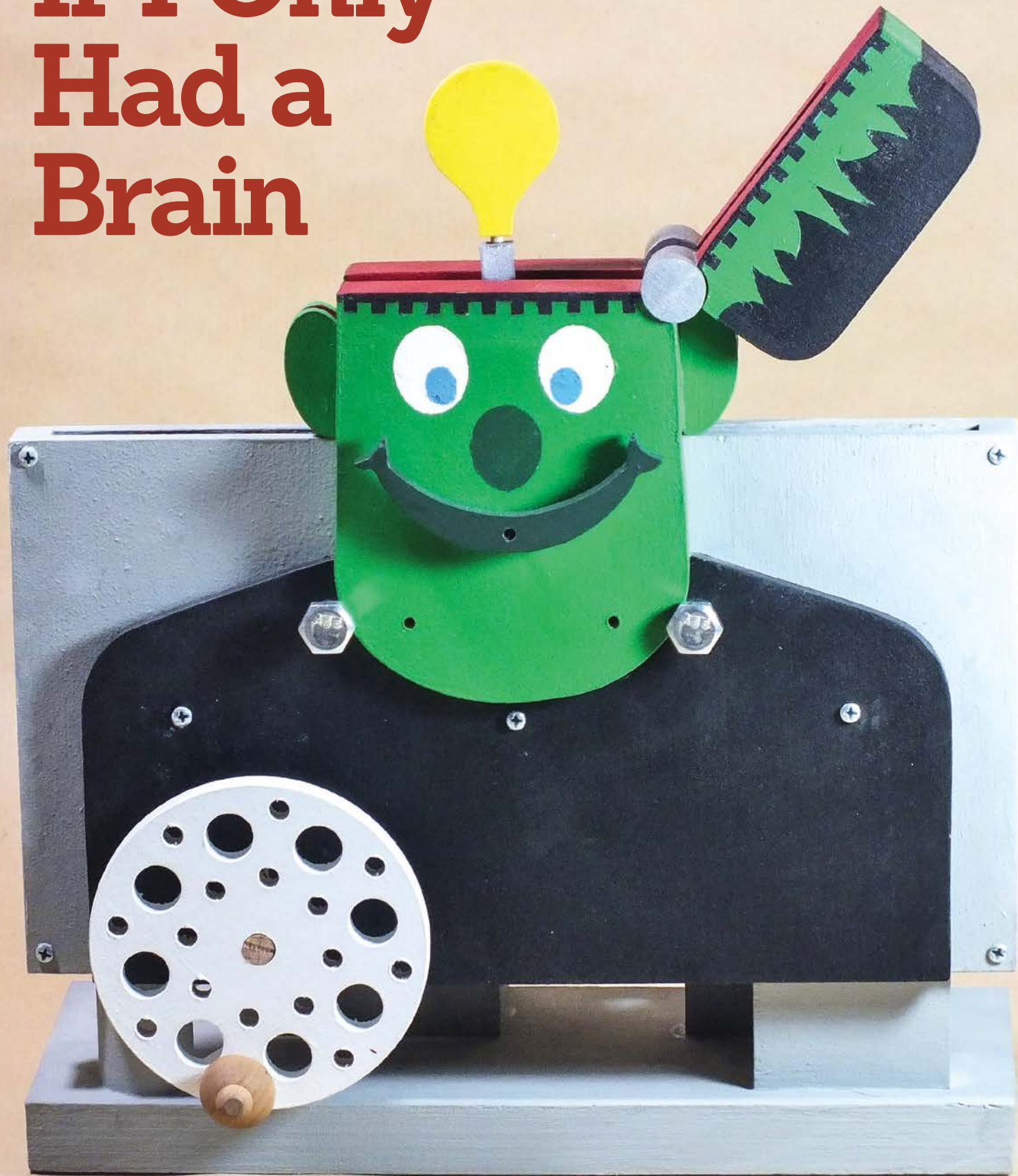


If I Only Had a Brain



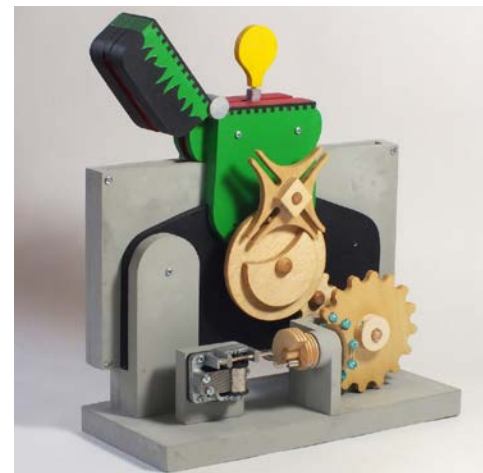
An elegant drive mechanism powers this “punny” monster music box

By John W. Hutchinson
Photos and illustrations by John W. Hutchinson

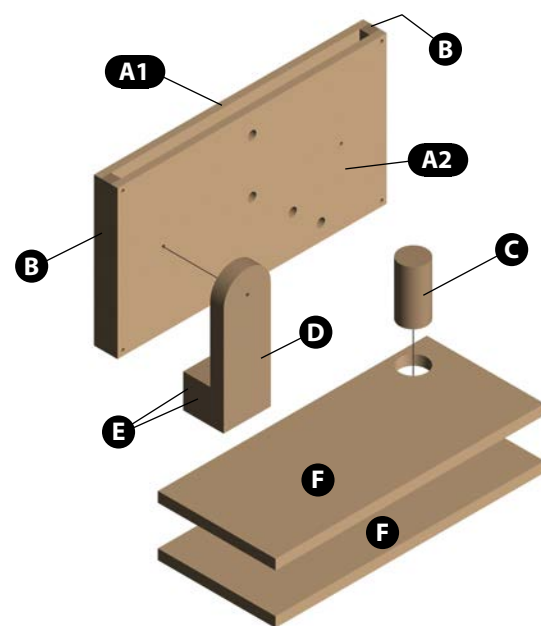
I wasn't surprised when I read that Halloween is the fourth most-popular holiday, next to Christmas, Thanksgiving, and Easter. In my family, monsters and goblins have always run a close second to Santa. Last Christmas, I made an animated trio of angels descending a stairway from heaven to the tune of “Hark! The Herald Angels Sing.” It was a hit with the gang, so for Halloween this year I decided to create an animated Halloween-themed extravaganza. My daughter suggested a Frankenstein monster, but I vetoed the idea because I couldn't find an appropriate tune to go with him. And then one day, as I was browsing the list of hand-cranked musical movements at kikkerland.com, I stumbled upon “If I Only Had A Brain.” Oh, yeah! This is where I'd typically say, “And the rest is history,” but I'd like to think that Frank will become a part of my family's history ... “Remember crazy ol' Grampa John?”

With the turn of a crank, and help from a watchmaker's mechanism, Frank's moods swing from happy, with a bright-idea light bulb, to sad, with a clueless question mark—they are punctuated with snarky half-smiles in between.

I hope you'll welcome a Frank into your home.

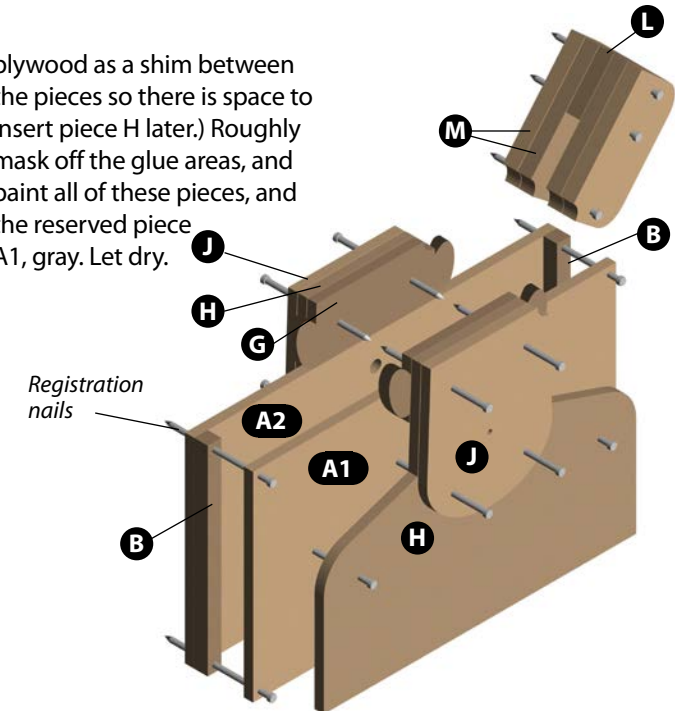


MAKING THE COMPONENTS



▲ **Step 1: Build the screen and base.** Cut pieces A through F and drill the holes as marked. Set aside one piece A (A1, the front face of the screen). Refer to the diagram and glue together pieces A2-B to form three sides of a box (do not glue on the front face); D-E to form a support, and F-F to form the base. Glue the bottom of box A2-B to supports D-E and C, and glue the supports to base F. (Align the back of the box and the upright D with a nail, and use a scrap of 1/4" (6mm)

plywood as a shim between the pieces so there is space to insert piece H later.) Roughly mask off the glue areas, and paint all of these pieces, and the reserved piece A1, gray. Let dry.

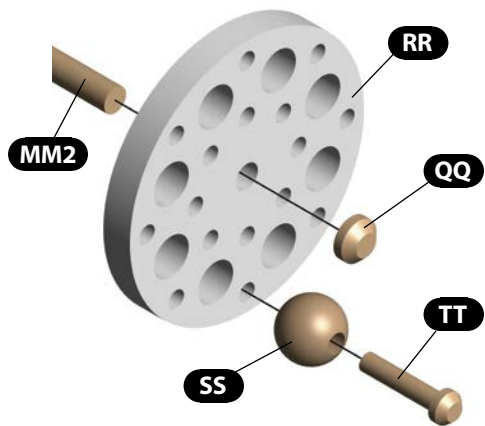


▲ **Step 2: Paint and assemble Frank.** Cut pieces G through P, and drill the holes as marked. Use nails and the registration holes to align the pieces as shown (see Tip). Glue two head subassemblies (pieces H, J, and G) and one head top subassembly (pieces M and L), keeping them aligned. Referring to the photos and paint guide, paint the face on one torso-head subassembly; paint the other head green, and

paint both torsos black. Paint the head top subassembly (it looks the same on both sides). Paint the mouth (K), and set it aside. When the paint is dry, use nails to align the torso-head subassemblies and glue them together. Do not glue the front screen assembly to the main piece yet.

TIP **DRILLING REGISTRATION HOLES**

Drilling the 1/8" (3mm) registration holes accurately is key to a successful Frank. Use 10d bright finish nails (.120" diameter) to align the layers during the progression of glue-ups.



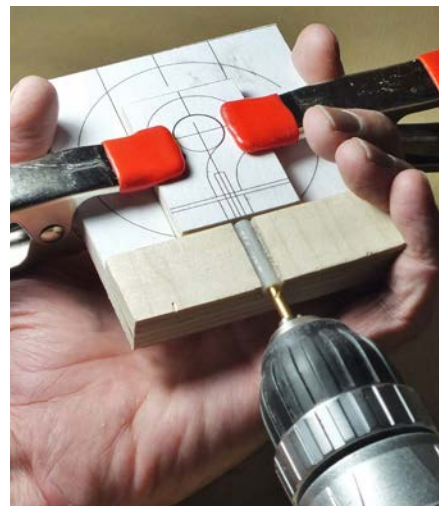
▲ Step 3: Make the crank.

Continuing the Frankenstein movie theme, the main crank assembly is my interpretation of a film reel. Cut the crank disc (RR), drill the holes as marked, and paint it white; let the paint dry. Glue piece RR to driveshaft MM2 and cover the end with cap QQ. Size the hole through the crank knob (SS) so it spins freely on the crank axle (TT). Glue the crank axle into the crank disc.

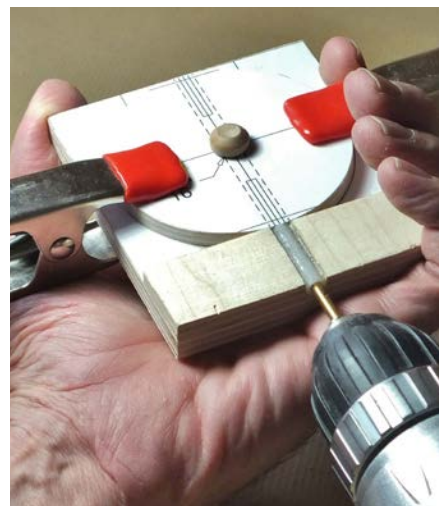


▲ Step 4: Make a jig to drill the light bulb, question mark, and rotor components. As with clamps,

a guy can never have too many jigs. Glue a crosshairs pattern to a scrap of plywood. Drill a 23/64" (8.3mm)-diameter hole at the center. Along the bottom edge, glue two small rectangles of 1/4" (6mm)-thick plywood on either side of a nylon spacer (see Materials list).

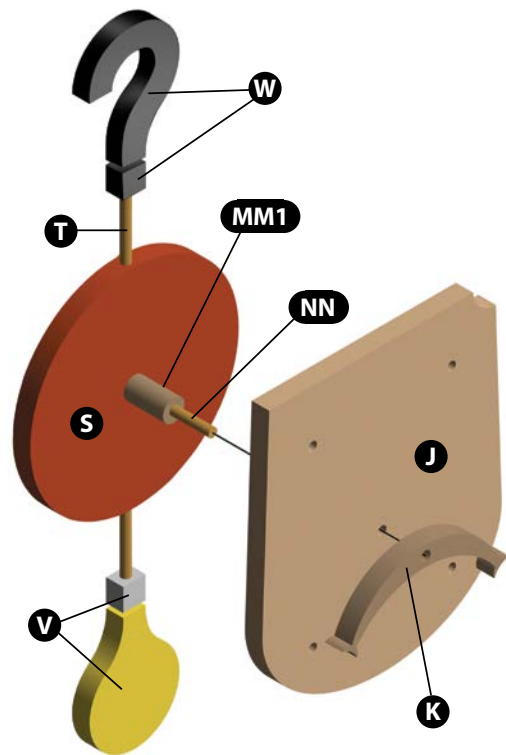


▲ Step 5: Drill the holes in the light bulb (V) and question mark (W). Apply the light bulb and question mark patterns to their blanks. Align and clamp each blank to the jig, and drill 3/64" (3.5mm)-diameter by 3/4" (19mm)-deep holes as marked. Then, cut the pieces. *Note: Cut the bottom square off each piece as marked; reserve the squares.* Paint the pieces, including the squares.



▲ Step 6: Drill the holes in the rotor disc. Use the same jig and drilling

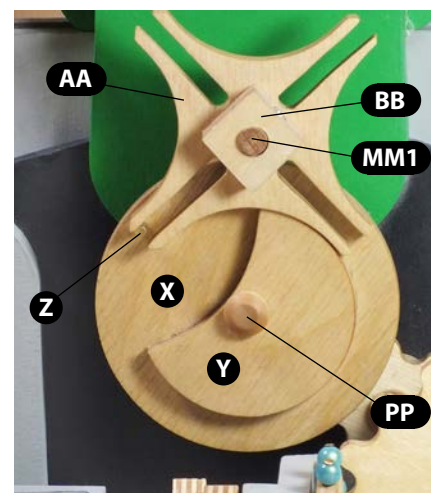
technique for the rotor disc (S). Align the disk with a section of 5/16" (8mm)-diameter toy axle before clamping and drilling 7/8" (22mm)-deep holes.



▲ Step 7: Install the rotor assembly.

Use cyanoacrylate (CA) glue to attach a rotor rod (T) to the hole in the light bulb. Thread the matching square onto the rod, use a shim to space it 1/16" (2mm) from the bottom of the bulb, and glue. Repeat for the question mark, and then to glue the rods into the holes in edge of the rotor disc (S). Push rotor driveshaft MM1 through the back wall of the screen and dry-fit the rotor assembly to it. Fit the front screen assembly (A) in place and adjust driveshaft MM1 so it clears the wall; remove the wall and glue MM1 to disc S. Drill a 1/8" (3mm)-diameter hole in the end of MM1 and insert extension NN. Replace the wall and dry-fit the mouth (K) onto extension NN. Make sure the mouth clears the face and rotates freely. Glue the wall to the box, and glue the mouth to the extension rod. Glue the hinges (N) to the curve in the top of the head, leaving space for the rotor assembly to pass between.

MAKING THE DRIVE & GEARS

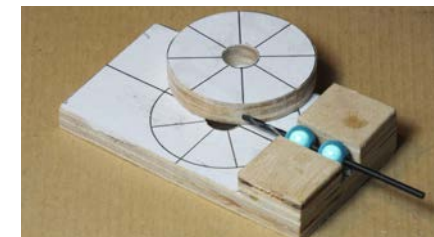


▲ Step 8: Make the Geneva Drive.

Cut pieces X through BB; you will also need PP and a scrap of 5/16" (8mm) dowel. Use the dowel to align driven wheel AA and washer BB; wood glue BB to AA and remove the dowel. Use axle PP to align blocking disk Y and drive wheel X; glue Y to X, but do not glue the axle. Push pin Z into place. Making a successful Geneva Drive requires a fair amount of accuracy, but in the end you'll be pleased with what I consider to be the most elegant of all motion transfer mechanisms.

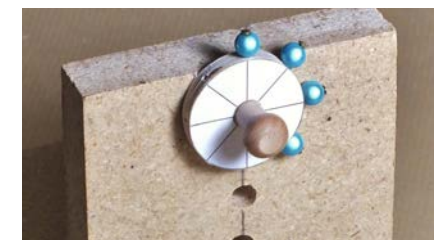
TIP **WHAT'S A GENEVA DRIVE?**

I used a Geneva Drive mechanism to change Frank's smile and lightbulb to a frown and question mark. The name derives from the device's earliest application in mechanical watches; Geneva, Switzerland, is a center of watch making. In the most common arrangement, used here, the driven wheel has four slots and advances by one step of 90° for each rotation of the drive wheel. Another application of the Geneva Drive is in movie projectors: instead of running continuously through the projector, the film is advanced frame by frame using a Geneva Drive.



▲ Step 9: Make the bead gear jig.

The plastic beads that will eventually become the "teeth" for the bead gear are the perfect tools for a simple drilling jig. Glue a copy of bead gear pattern (DD) to 1/4" by 2" by 3" (6mm by 51mm by 76mm) plywood. Drill a 23/64" (8.3mm)-diameter center hole. Insert a 1/16" (2mm) and then use gel CA glue to bond the beads to each other and to two 1/4" (6mm)-thick by 3/4" (19mm)-square plywood blocks (don't glue the bit). Center the bit on the bead gear pattern as shown and glue the blocks in place. Use a 5/16" (8mm)-diameter toy axle as the pivot pin. Check the jig; the tip of the drill bit should align with the center ply of the plywood.



▲ Step 10: Make the bead gear. Attach the pattern and cut the perimeter of the bead gear (DD). Align

the cut piece in the jig with the pivot pin and clamp it in place. Make eight indexed holes around the perimeter as marked: drill, rotate, clamp, etc. Next, thread each bead onto a #18 by 3/4" (19mm) brass escutcheon pin, and use gel CA glue to bond the pins and beads to the wood.



▲ Step 11: Make the spur gears.

There's no need to fear a gear; keeping the pattern in place and avoiding tearout are 99% of the battle. Follow this procedure for pieces Q (cut two), R, and CC. Apply a thin film of white school glue to the blank, and then blot a paper pattern into place. (To remove the pattern at the end of the machining process, rest it on a damp paper towel and then wipe.) Next, cover a sacrificial backing board—I use 1/8" (3mm) plywood—with double-face tape and attach the blank to create zero-clearance, anti-tearout support.



Drill the center hole and tooth valleys with brad-point bits as marked on the patterns.



Now you're ready to cut the circle that defines the perimeter of the gear. Starting

on the inside of a drilled hole, rather than the edge of the blank, keeps vibration to a minimum.



Pop the rough gear out, and then trim the remaining nubs with a scroll saw.



File and/or sand any irregularities on a holding fixture with a $\frac{5}{16}$ " (8mm)-diameter axle inserted through the axle hole. Do not remove the sacrificial backer until you've completed this refinement process. Note: The "files" that I find most useful for this step are large, homemade emery boards. They're strips of $\frac{1}{4}$ " (6mm) Baltic birch plywood faced on alternate sides with 80- and 180-grit sandpaper.



When you're satisfied with quality of your work, separate the finished gear from the sacrificial backer with a sharpened metal putty knife. Don't try to pop them apart. A gentle sliding motion is all that's required.



▲ Step 12: Finish the gears. While it might seem that any kind of applied finish would gum up the works, a light coat of water-based satin polyurethane actually improves the performance of the spur gears; it reduces friction by filling the microscopic nooks and crannies. Finish on the bead gear is purely cosmetic, but why not? There's nothing wrong with dressing them up. To hold the gears, insert short lengths of $\frac{5}{16}$ " (8mm)-diameter dowel through the axle holes. Additionally, they'll prevent the finish from contaminating the gear-to-axle glue surface. Note: You may want to glue the wooden washers to the gears as appropriate (see Steps 14 and 15) before applying any finish.

INSTALLING THE MECHANISMS

Step 13: Prepare the remaining pieces. Cut pieces U, FF through KK, and UU, and drill the holes as marked. If desired, mask off the glue areas of pieces FF, GG, KK, and UU, and paint them gray. Glue pieces FF and GG at a right angle and let dry.

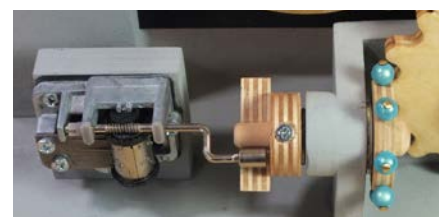
Step 14: Install the mechanisms. Sandwich the large spur gear (R) between two large gear washers (U) and glue the three together. Slide them onto the axle in the X-Y Geneva Drive assembly and glue the two assemblies together; do not glue the axle.

Thread an axle (PP) through a gear Q and a washer JJ, glue the washer to the gear, and push the axle into place in the torso/screen wall. Look into the screen from the top and trim PP so it doesn't protrude inside. Glue the axle, but do not glue the gear.

Insert the crank driveshaft (MM2) through the screen with the crank assembly on the front. From the back, place a washer JJ and then a gear Q onto the shaft; glue the washer and the gear to each other and the shaft.

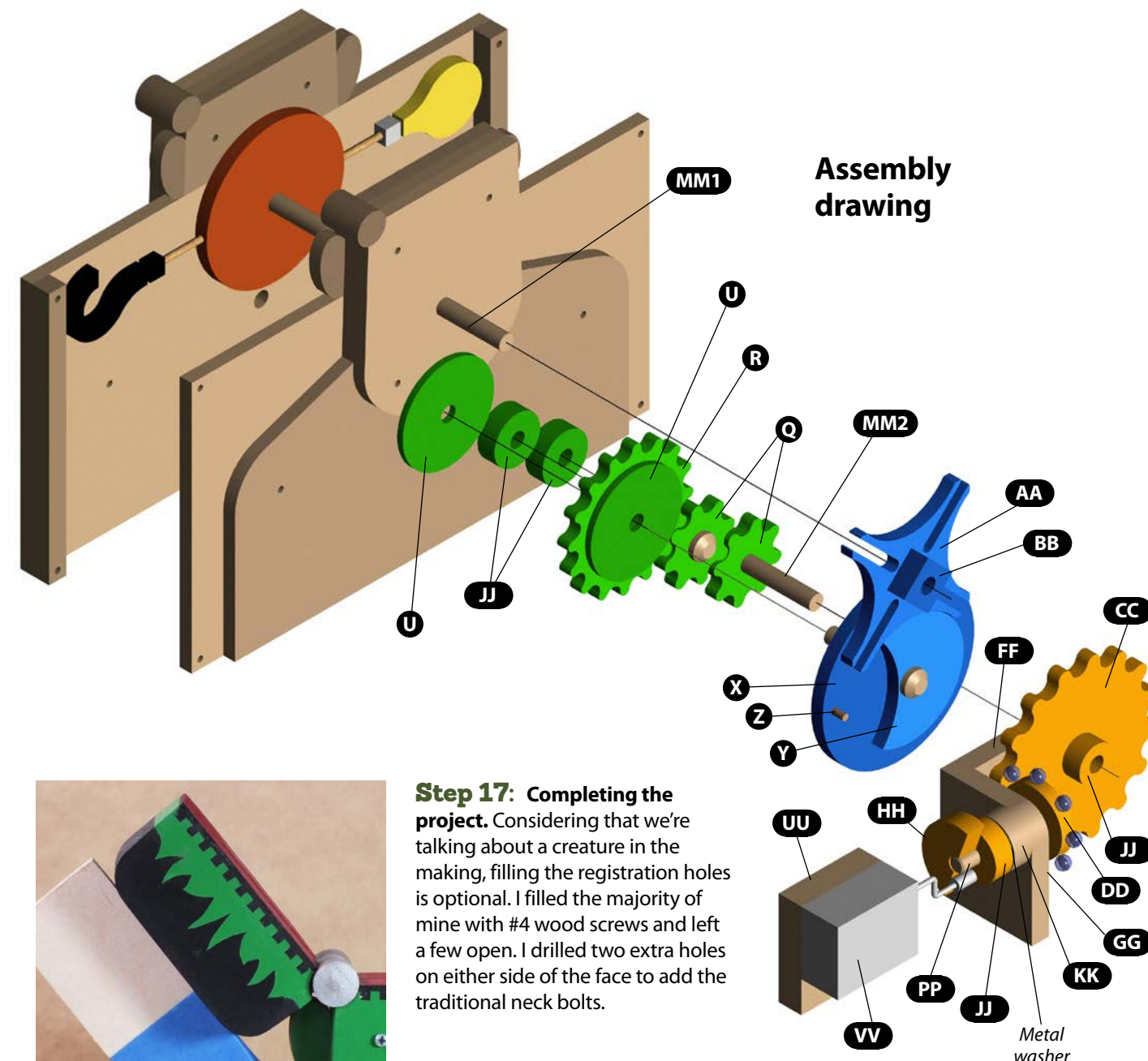
Push the Geneva Drive-spur gear assembly into place, add the Geneva Drive AA-BB assembly to the top drive-shaft (MM1), and twist the driveshaft to be sure the gears turn. When you have finished adjusting the mechanism, cut the driveshaft to length and glue the AA-BB assembly to it.

MOUNTING THE MUSICAL MOVEMENT



▲ Step 15: Connect the musical movement. Position the music gear mount assembly (FF-GG) so driveshaft MM2 extends through the hole in piece FF. Add the large music spur gear CC and washer JJ to the driveshaft. Adjust so the edge of piece GG aligns with the edge of the base, and glue and screw the mount assembly to the base. Thread axle PP through the bead gear, a metal washer, and through GG. Add painted washer KK, a metal washer, washer JJ, and music crank pusher HH to the axle. Glue KK to GG, and glue and screw JJ to the axle. Glue HH to JJ and the axle.

Position the musical movement on the movement riser (UU) so its drive-shaft, NOT the handle, is centered on wooden axle PP. Screw the musical movement to the riser, adjust the position of the riser, and glue and screw it to the base.



Step 17: Completing the project. Considering that we're talking about a creature in the making, filling the registration holes is optional. I filled the majority of mine with #4 wood screws and left a few open. I drilled two extra holes on either side of the face to add the traditional neck bolts.

TIP

HOW IT WORKS

The crank driveshaft (MM2) passes through, and is glued to, small driver gear Q. When combined, they transfer the rotation of the crank from the front to the back of the screen and set things in motion. Q transfers its rotation to an equal idler gear that rotates freely on axle PP. Rotation is finally transferred to large driven gear R. Because the ratio of this gear train is 8:8:16, the large driven gear rotates at half the speed of the crank. However, because the large music crank turns at twice the speed of the main crank. The musical movement will work only with a clockwise rotation of its crank. When viewed from the back, the large gear will be turning counterclockwise, but when paired with the right-angle bead gear, the direction of rotation is translated to clockwise. Another advantage to this right-angle setup is that it keeps the depth of the entire assembly to a minimum.

Parts List

	Item	Material	No.	Dimensions*	Presentation	Paint
A	Screen (1=front; 2=back)	¼" (6mm) plywood	2	5 ½" x 10" (140mm x 254mm)	Measured Drwg.	Gray
B	Screen Spacer	⅜" (10mm) square dowel	2	5 ½" (140mm) long	Dimensions	Gray
C	Support Column	1" (25mm) round dowel	1	2" (51mm) long	Dimensions	Gray
D	Support Slab – Large	½" (13mm) plywood	1	1 ¾" x 4 7⁄8" (44mm x 124mm)	Pattern	Gray
E	Support Slab – Small	½" (13mm) plywood	2	1 ¼" x 1 ¾" (32mm x 44mm)	Dimensions	Gray
F	Base	⅜" (10mm) plywood	2	4 ¾" x 10" (111mm x 254mm)	Measured Drwg.	Gray
G	Face - Half	¼" (6mm) plywood	2	1 ½" x 3 ¾" (38mm x 86mm)	Dimensions	Edges only†
H	Torso & Head	¼" (6mm) plywood	2	7" x 8 ⅝" (178mm x 219mm)	Pattern	Torso black; edges‡
J	Face - Full	¼" (6mm) plywood	2	3 ½" x 4" (89mm x 102mm)	Pattern	1 bright green; 1 face‡
K	Mouth	¼" (6mm) plywood	1	1" x 2 ½" (25mm x 64mm)	Pattern	Dark green
L	Head Top - Half	⅜" (10mm) plywood	1	1 ½" (38mm) square	Pattern	Edges only†
M	Head Top - Full	⅜" (10mm) plywood	4	1 ½" x 3 ¼" (38mm x 83mm)	Pattern	2 edges only; 2 head‡
N	Head Hinge	⅝" (16mm) round dowel	2	13mm/16" (20.6mm) long	Dimensions	Gray
Q	Drive Gear – Small Spur	¼" (6mm) plywood	2	1 ½" (38mm) round	Pattern	Clear polyurethane
R	Drive Gear – Large Spur	¼" (6mm) plywood	1	2 ¾" (70mm) round	Pattern	Clear polyurethane
S	Rotor Disc	¼" (6mm) plywood	1	3" (76mm) round	Pattern	
T	Rotor Rod	⅜" (3mm) o.d. brass rod	2	2 ½" (64mm) long	Dimensions	
U	Large Gear Washer	⅜" (3mm) plywood	2	2" (51mm) round	Pattern	
V	Light Bulb	¼" (6mm) plywood	1	1 ½" x 2 ¼" (38mm x 57mm)	Pattern	Yellow & gray
W	Question Mark	¼" (6mm) plywood	1	1 ½" x 2 ¼" (38mm x 57mm)	Pattern	Black
X	Geneva Drive – Drive Wheel	¼" (6mm) plywood	1	3 ⅝" (84mm) round	Pattern	
Y	Geneva Drive – Blocking Disc	¼" (6mm) plywood	1	2 ¾" (60mm) round	Pattern	
Z	Geneva Drive – Pin	⅜" (3mm) brass rod	1	½" (13mm)	Dimensions	
AA	Geneva Drive – Driven Wheel	¼" (6mm) plywood	1	2-9⁄16" (68mm) square	Pattern	
BB	Geneva Drive – Washer	⅜" (10mm) plywood	1	¾" (19mm) square	Pattern	
CC	Music Gear – Large Spur	¼" (6mm) plywood	1	3 ½" (89mm) round	Pattern	Clear polyurethane
DD	Music Gear – Small Bead	¼" (6mm) plywood	1	1 ⅝" (33mm) round	Pattern	Clear polyurethane
EE	Music Gear – Beads	Plastic	8	17⁄64" (6.75mm) o.d.		
FF	Music Gear Mount – Large	⅜" (10mm) plywood	1	2 ¾" x 2 7⁄16" (61mm x 62mm)	Pattern	Gray
GG	Music Gear Mount – Small	⅜" (10mm) plywood	1	2" x 2 ¾" (51mm x 61mm)	Pattern	Gray
HH	Music Crank Pusher	⅜" (10mm) plywood	1	1 ½" (38mm) round	Pattern	
JJ	Washer – Connection	⅜" (10mm) plywood	4	1" (25mm) round	Pattern	
KK	Washer – Wall Extension	⅜" (10mm) plywood	1	1" (25mm) round	Pattern	
LL	Washer	Metal	2	⅝" (8mm) dia.	N/A	
MM1	Geneva Drive shaft	⅝" (8mm) round dowel	1	3 ½" (89mm) long; trim to fit	Dimensions	
MM2	Crank driveshaft	⅝" (8mm) round dowel	1	4 ½" (114mm) long; trim to fit	Dimensions	
NN	Driveshaft Extension	⅜" (3mm) o.d. brass rod	1	1 ½" (38mm) long	Dimensions	
PP	Toy Axle	⅝" (8mm)-dia. hardwood	3	Trim to length		
QQ	Toy Axle Cap (cut off ⅝", or 8mm, axle)	Hardwood	1	N/A	N/A	
RR	Crank Disc	⅜" (10mm) plywood	1	3 ⅝" (84mm) round	Pattern	White
SS	Crank Knob	Hardwood bead	1	¾" (19mm) dia.	N/A	
TT	Crank Toy Axle	Hardwood	1	7⁄32" (5.5mm) dia.; trim to length	N/A	
UU	Musical Movement Riser	½" (13mm) plywood	1	Fit per movement	Dimensions	Gray
VV	Musical Movement	Metal	1	N/A	N/A	
WW	Neck Bolts	Metal	2	⅝" (8mm) dia. x ¾" (19mm) long	N/A	

*Note: Many of these measurements are exact pattern sizes. Add gluing and cutting allowances to your blanks as desired. † Refer to photo. ‡ See Paint Guide.

Materials & Tools

Materials:

• Baltic birch plywood: *Note: Multiple layers can be laminated to achieve the required thickness. See Parts List for cutting dimensions of individual pieces. Keep the scraps; you'll need them for jigs and shims.*

- > ⅛" (3mm) thick: 4" x 11" (102mm x 279mm)
- > ¼" (6mm) thick: 18" x 26" (457mm x 660mm)
- > ⅜" (10mm) thick: 10" x 18" (254mm x 457mm)
- > ½" (13mm) thick: 6" (152mm) square
- Dowel, ⅝" (8mm) round: 8" (203mm) plus scraps
- Dowel, ⅝" (16mm) round: 2" (51mm)
- Dowel, 1" (25mm) round: 2" (51mm)
- Dowel, ⅜" (10mm) square: 11" (279mm)
- Brass rod, ⅜" (3mm) o.d.: 7" (178mm)

- Glue: wood, such as Gorilla PVA Wood Glue; gel cyanoacrylate (CA), such as Gorilla Gel Super Glue; white, such as Elmer's School Glue; 2-part epoxy, such as Gorilla brand
- Tape: blue painter's; double-sided
- Acrylic paint: black, white, bright green, dark green, red, light blue, gray, yellow
- Nails, 10d bright finish: approx. 20
- Hardwood bead, ¾" (19mm): 1 each
- Toy axles: 1 each 7⁄32" (5.5mm); 6 each ⅝" (8mm) dia.
- Plastic beads: 10 each 17⁄64" (6.75mm) o.d. (I used Bead Landing Crafting Beads, Michaels SKU 260414)
- Brass escutcheon pins: 8 each #18 x ¾" (19mm)
- Sandpaper: 80, 120, 220 grits
- Water-based polyurethane

- Musical movement: "If I Only Had A Brain" (Available from www.kikkerland.com.)
- Screws and brads: as necessary to reinforce glue joints
- Metal washers, ⅝" (8mm): 2 each
- Screws, #4 wood: as needed to fill registration holes
- Bolts, steel: 2 each ⅝" dia. x ¾" (8mm dia. x 19mm)

- Clamps
- Steel putty knife

Step 4 Jig:

- Plywood, ¼" (6mm) thick: 4" x 6" (102mm x 152mm)
- Crosshairs pattern
- Nylon spacer: ¼" (6mm) o.d. x ¾" (3.5mm) i.d. x 1" (25mm) long
- Toy axle, ⅝" (8mm) dia.

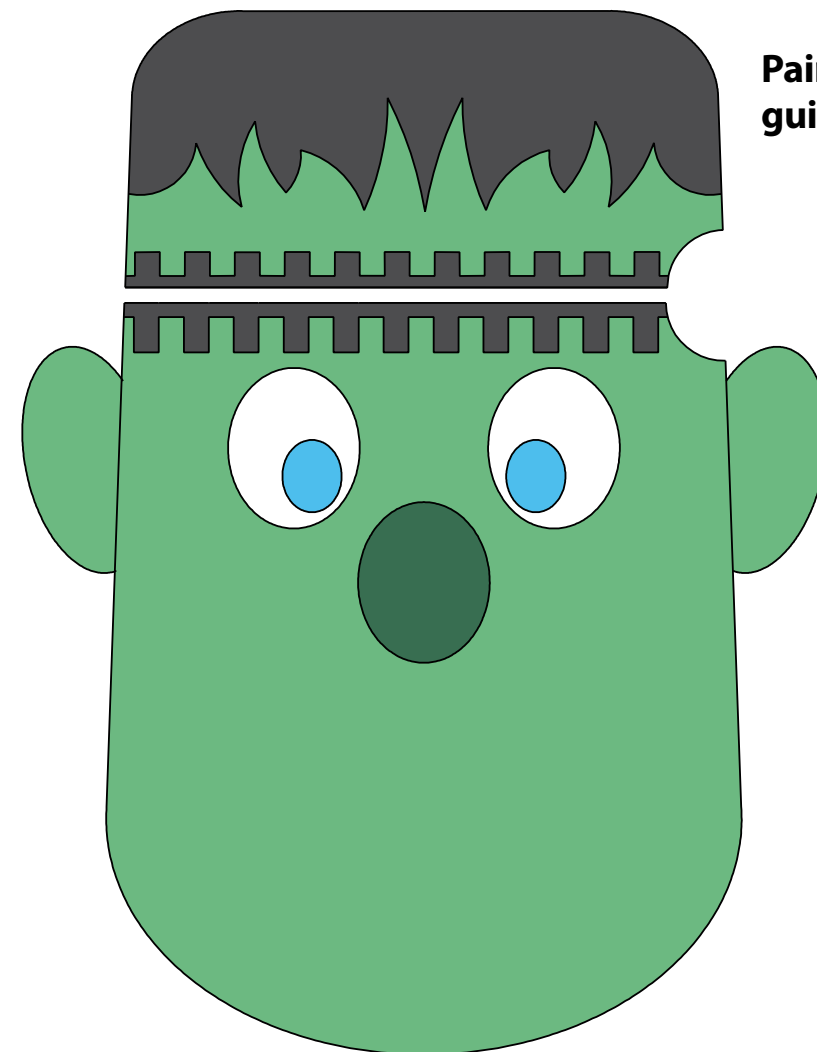
Tools:

- Scroll saw and blades: pin end: 10, 18.5, 20 TPI; or reverse-tooth blades: #1, #3, #5
- Hand drill, drill press, and bits: ⅛" (2mm), ⅜" (3mm), ⅝" (3.5mm), 7⁄32" (5.5mm), 11⁄32" (8.7mm); ½" (13mm), 1" (25mm); brad point bits: ⅝" (8mm), 21⁄64" (8.3mm), 23⁄64" (9mm)
- Paintbrushes

Step 9 Bead Jig:

- Plywood, ¼" (6mm) thick: 3" (76mm) square
- Pattern DD copy
- Plastic beads (see above)
- Toy axle, ⅝" (8mm) dia.
- Cyanoacrylate (CA) glue
- Drill bits: ⅛" (2mm), 21⁄64" (8.3mm)

The author used these products for the project. Substitute your choice of brands, tools, and materials as desired.



Paint guide

Patterns for *IF I ONLY HAD A BRAIN* are in the pattern pullout section.



When not woodtinkering, John Hutchinson finds a few spare moments for his multiple professions of architect, illustrator, and writer. His work has appeared in *Fine Woodworking*, *Woodworker's Journal*, *Popular Woodworking*, *American Woodworker*, and *Woodcraft Magazine*, as well as three books by *Popular*

Woodworking Books. Questions and comments? Contact John at jhutchi2@columbus.rr.com.