An unusual power source

Powering automata with wind-up gramophone motors

by Chris Hughes • Owen Sound, Ontario, Canada • Photos by the author

1. The *David Byrne—Big Suit* automaton stands three feet (91cm) tall.

This is a discussion of my first attempt at using a wind-up gramophone motor to drive an automaton. It is by no means a definitive exploration of the subject. I used one to power an automaton depicting David Byrne, of Talking Heads, dancing while wearing the iconic Big Suit (**photo 1**). I would also like to direct the reader to the inspirational work of Daniel Bennan, who uses a gramophone motor to drive a brilliant Beatles automaton (see *Automata Magazine*, July-August, 2022, as well as the video link at end of this article).

Motorizing an automaton allows the viewer to set the piece in motion, then stand back and enjoy the show without actually being a part of the show. I have previously written about my experience bringing motion to existing automata using 12-volt motors (*AM*, May-June, 2024).

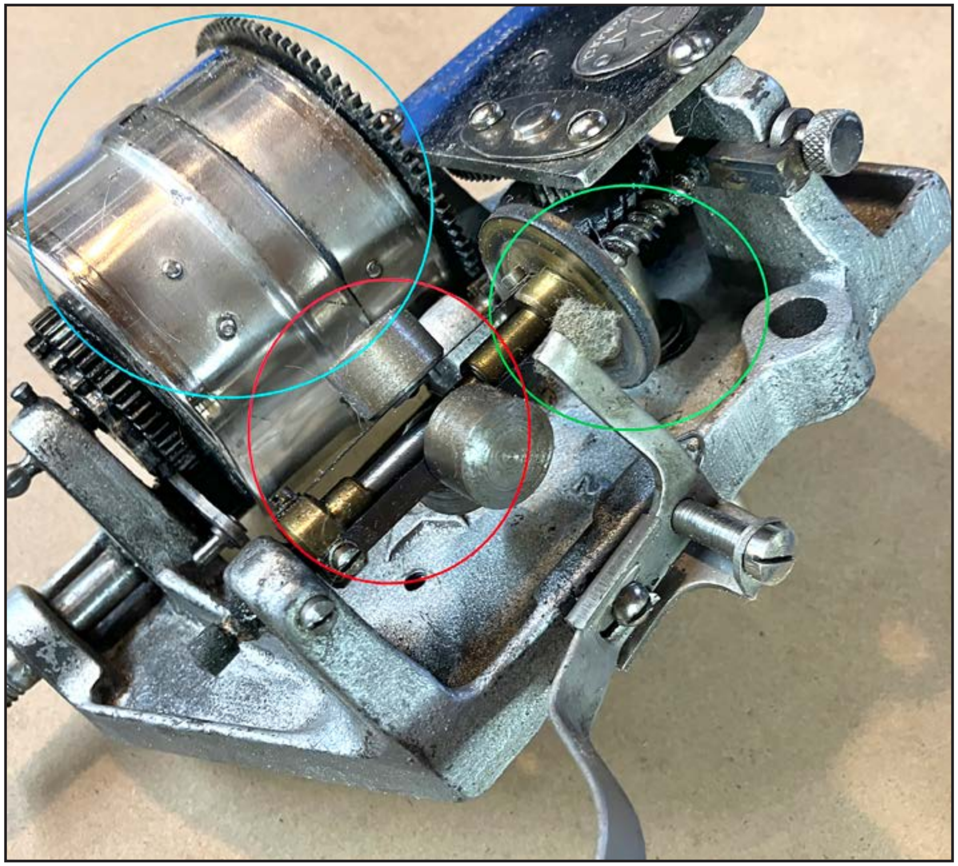
Using a wind-up gramophone motor frees the piece from the constraints of a plug and electrical cord and is more in keeping with the history of the craft. There is no reason why an old gramophone motor shouldn't last another hundred years. My *David Byrne—Big Suit* automaton will run for five and a half minutes on 30 turns of the gramophone-motor crank.

2. A nice example of a 44"-tall (112cm) gramophone cabinet with an internal horn.

Availability of old gramophones

Old gramophones are plentiful on Kijiji (*https://www.kijiji.ca/*) and Facebook Marketplace in my area. Prices vary, but you aren't looking for aesthetics—just a motor with a spring that works and a decent hand crank. I purchased three of them—one in a small tin case and two large cabinet-style gramophones—at a local auction house for $90 Canadian, including taxes and buyer's premium.

A friend of mine was aghast (partly for comedic effect, I believe) that I would dismantle a hundred-year-old artifact to power an automaton. My defence is that the gramophone I sacrificed was in poor condition and missing parts (hence the low price) and unlikely to ever be restored to its former glory. There seems to be a far greater supply of old gramophones than there is demand, and 78 RPM gramophone records that are in decent condition are difficult to come by. I do have a nicely restored gramophone that graces my living room, so I feel I'm still making some small contribution to their preservation.



3. A representative motor showing the speed control (green circle), the centrifugal speed governor (red circle), and the spring casing (blue circle).

What to look for when purchasing a gramophone

Gramophones come in a variety of styles and cabinets. Large, vertical cabinets, approximately 44" (1.12m— **photo 2**) tall; smaller table-top cabinets; and small portable units made from tin, all with internal horns. Some also have an external horn, in the style of the old RCA "His Master's Voice" logo, but these seem to be considerably more collectible and I would be less inclined to repurpose one of them.

4. The output shaft (upper left), tapered sleeve (removed, left) and hand crank of a motor.

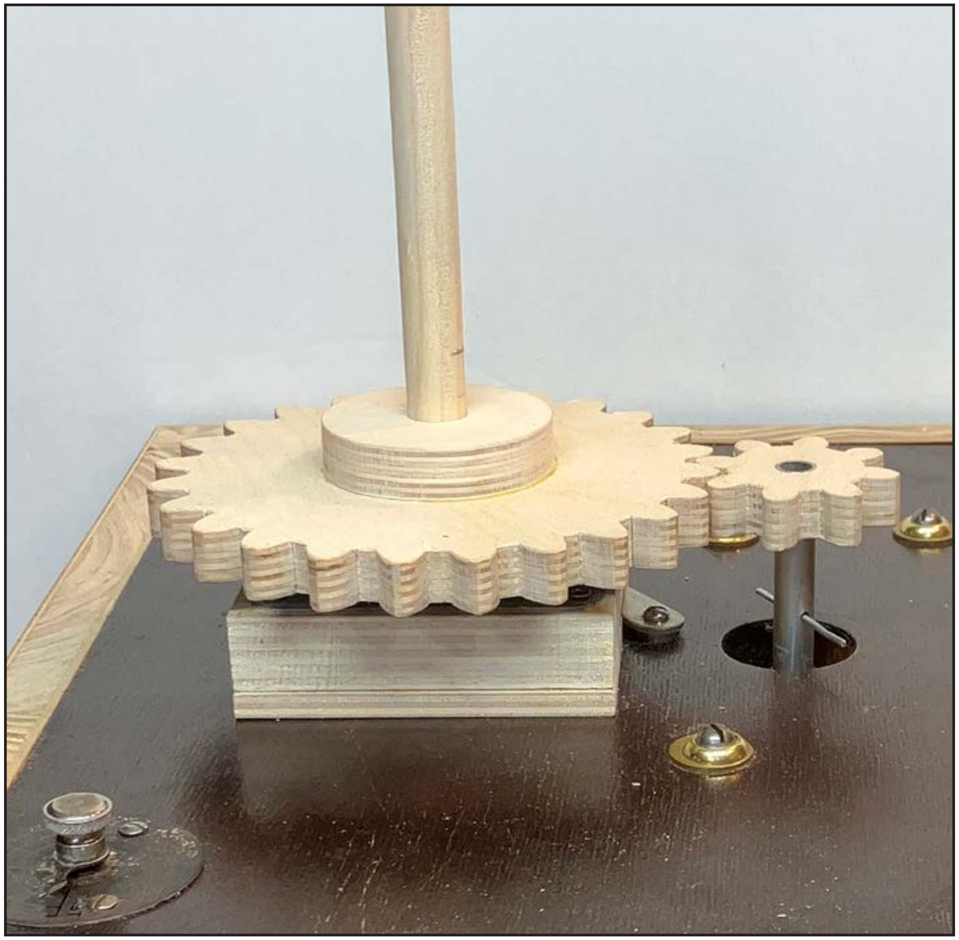
Gramophones were made by large companies like Victrola and Columbia, as well as local cabinetry shops and casket makers who wanted to get in on an emerging market. The mechanisms are quite robust, as evidenced by the fact that many still work after a hundred years.

My criteria for inspection at the auction house was basically, "Can the spring be wound and does the platter turn?" Missing or broken parts for the needle arm or sound box are not a concern. I would pass on an old gramophone if the hand crank is jammed, if it turns without resistance, or if the platter does not spin on its own when the brake is released. These symptoms probably indicate a broken spring or otherwise damaged mechanism.

From my reading, a common issue affecting gramophone motors is that the old grease in the cylinder that contains the spring dries out, causing the cylinder to hesitate as the spring unwinds. This is more of a problem where very smooth operation is necessary to play a record but less of an issue for powering an automaton.

Disassembling the spring is a messy and potentially dangerous process, especially if the proper procedures are not followed. Happily, the motor I used in my project ran smoothly enough that a little 3-in-1 oil was all it needed. I do however plan to disassemble, clean, and repack one of these springs this summer.

This type of motor features a centrifugal speed governor with three weights that limits the output speed, much like spinning skaters extending their arms to slow down. This allows the automaton to run at a steady speed until the spring runs out.



5. The gramophone output shaft and wooden reduction gears (these are the original 8-tooth and 24-tooth gears).

The gramophone motors I have inspected all have speed controls that push a felt pad against the face of a rotating disk within the gramophone mechanism (**photo 3**). The control looks like a little dial beside the record platter.

They also have a brake for stopping and starting the mechanism. I have seen two variations of the brake: one that pushes a felt pad against the inside or outside rim of the record platter itself, and the second, which pushes a felt pad against the edge of the same internal disk used in the speed control. As you will, in all likelihood, be discarding the record platter, the second type of brake is preferred if you can find it. The only way to tell the difference is to pull the record platter off, as both types have a brake lever that disappears under the platter. The platters are held in place by gravity, as this is the only way to access the bolts holding the motor.

6. The ½" I.D. and 1⅛" O.D. ball bearing. The smaller parts comprise a three-part thrust bearing with a ½" O.D..

As I used the one gramophone motor with an internal brake on my first build, I will have to figure out how make my own brake for the next project. A friction brake near the beginning of the automaton's drive train would probably work.

I have a few of the tall cabinets now, which make nice stands for my automata as well as a recently purchased antique cash register. I disassembled one stand that was beyond reasonable repair and used it to build the motor box for my *David Byrne—Big Suit* automaton project. I found that oak veneer was applied over solid oak panels, which I guess is what they did in the 1920s! I also reused the original panel to which the spring motor and controls are attached. The dimensions of this panel and the depth of the motor dictated the final size of the motor box, which is 13 x 13" (33 x 33cm) and 6" (15cm) tall.

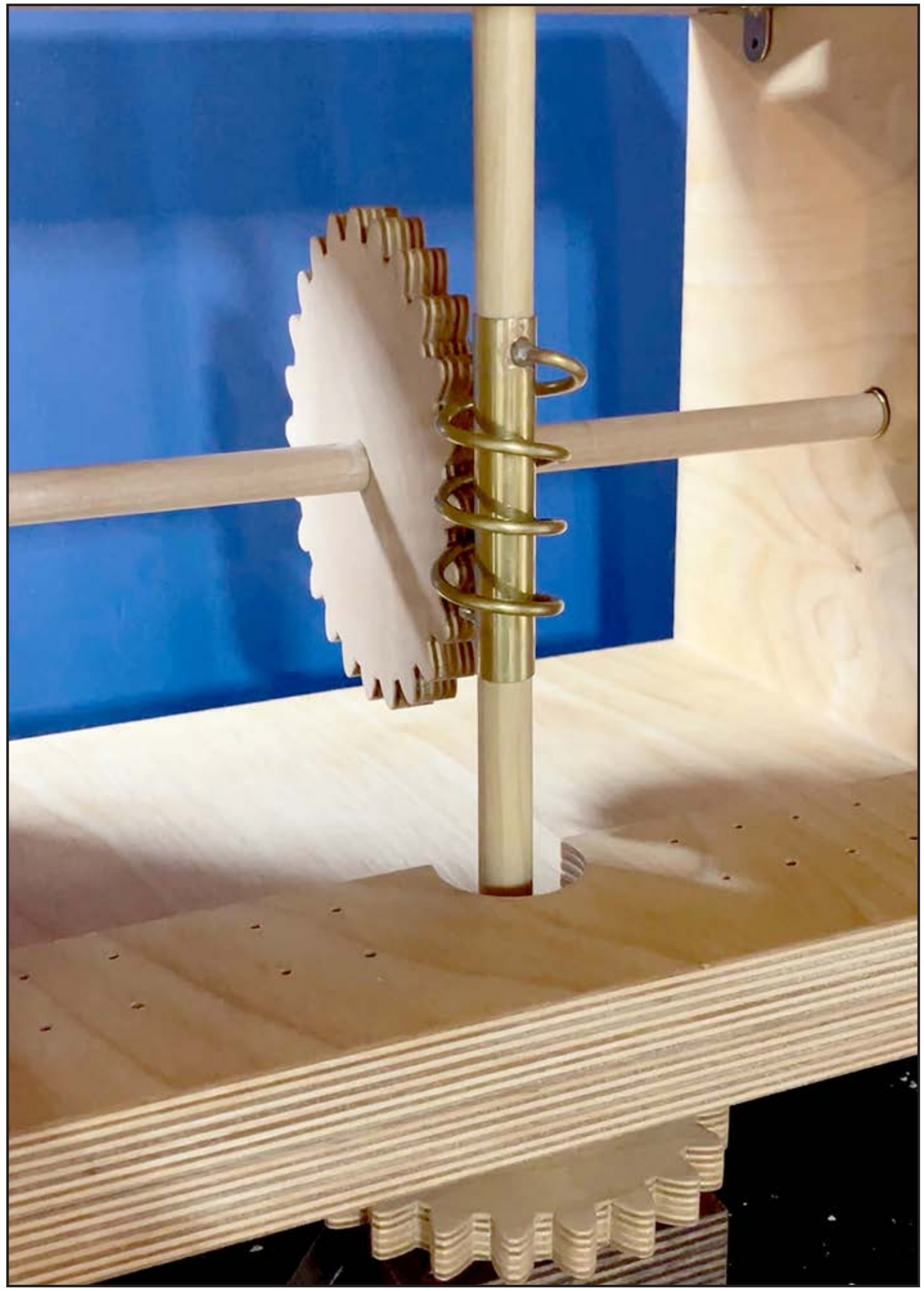
Connecting the gramophone motor to the automaton mechanism

The motor I used for this project had a tapered sleeve that was held onto the record platter spindle with a small machine screw. The platters are quite heavy and the tapered sleeve allows the driveshaft to turn the platter while still enabling the platter to be lifted straight up and off (**photo 4**).

Removing the tapered sleeve left me with a straight shaft pierced by a small hole threaded on one end. I rummaged around my shop until I found some steel tubing that would almost fit snuggly around the driveshaft. The steel tubing had an outside diameter of ⅜" (9.52mm), onto which I originally secured an eight-tooth wooden gear. This was mated with a 24-tooth gear to provide an intermediate drive ratio of 3:1 (**photo 5**). Later in the process I realized that the figure was moving too slowly, so I replaced these with 12-tooth and 21-tooth gears, respectively, for a ratio of 1.75:1. The nominal output of a gramophone spring motor is 78 RPM— far too fast for my use, and without enough torque to drive the mechanism I had in mind. When in use, a gramophone platter can be stopped with just a little pressure to the edge of the platter.

The 21-tooth gear is attached to a ½" (12.7mm) wooden dowel seated in a ball bearing which fits snugly into a hole drilled with a 1⅛" (28.57mm) Forstner bit. The end of the dowel sits on top of a thrust bearing to carry the vertical load (**photo 6**). The top end of the shaft has a 17⁄32" (13.48mm) brass cap and is socketed in a 9⁄16" (14.30mm) hole on the underside of the top deck of the automaton.

A worm gear was made by bending a ⅛" (3.18mm) brass rod into a helix and fitting the ends into holes drilled through a 17⁄32" brass sleeve over a ½" dowel, then soldering them in place. The worm drives a 24-tooth wooden gear attached to the camshaft (**photo 7**). This yields a final drive ratio of 42:1 from the gramophone motor to the camshaft. The automaton completes one cycle every 27 seconds, yielding an actual unbraked output of 93 RPM for the gramophone motor. The significant speed reduction increases the torque and allows the motor to easily handle the load of the automaton mechanism.



7. The worm and 24-tooth drive gear on the camshaft.

8. The worm gear and cam followers in the completed automaton.

Links

Daniel Bennan's *Beatles* automaton:
https://www.youtube.com/watch?v=ZA5wZ3UsFjU
David Byrne—Big Suit: *https://www.youtube.com/watch?v=Mka4a8bKKMQ*
Chris Hughes website: *https://cphughes-art.ca/*
To see all of this issue's videos in one place, *click here.*

The worm is a right-hand helix that translates the counter-clockwise motion of the 21-tooth gear into an upward motion on the 24-tooth gear on the camshaft. This creates a downward pressure on the worm-gear shaft, hence the need for a thrust bearing at the bottom of the shaft. Details on how to make worm gears can be found in the September-October and November-December 2019 issues of *AM*.

Cams are positioned on either side of the 24-tooth gear and all of the cam followers are located on one side of the mechanism box so that the cams rotate upward against the ball bearings on the followers (**photo 8**).

Final thoughts

I felt that the gramophone motor needed to be fully enclosed to keep curious fingers out of the greasy gears and to prevent the accumulation of dirt and dust. I considered cutting plexiglass-covered openings in the sides of the motor box but decided against it. Windows would have required me to pretty up the inside of the box and the interior would be poorly lit in any event.

Gramophone motors are heavy mechanisms, this one being around seven pounds (3.2 kg). Overall, including the lower oak cabinet, the *David Byrne—Big Suit* automaton weighs in at 32 pounds (14.5 kg). The gramophone motor's case also adds to the height of the piece. The automaton is 3 feet (91 cm) tall of which 9 inches (23 cm) is the motor case and side supports.

The use of a gramophone motor also adds to the complexity of the piece. I usually calculate the placement of the drive-train components, starting at the figure and working toward the the hand crank, which can be placed almost anywhere on the end of the mechanism box. However, with this automaton, I started with the box for the gramophone motor and worked toward the figure, having to make adjustments to the mechanism layout to account for the fixed location of the worm drive and the desired motions of the figure. This added significantly to the time it took to design and build the automaton.

Overall, using a gramophone motor to power an automaton was a positive experience. I overcame challenges, learned a lot, improved my craft, and I'm happy with the end result. That said, the automaton I'm currently working on is going to be hand cranked, but I will definitely be making another wind-up-gramophone-motor project in the future.