Note: The following transcripts and videos are from the October 15, 2015 Speakers Series lecture, presented by Jim Surkamp and Dan Tokar.

Transcript

Dan Tokar Explains The 1842 Graham Deadbeat Escapement Clock, Shepherdstown, WV
by Jim Surkamp, October 30, 2015, McMurran Hall, Shepherdstown, WV

1. How to Make "Raw Gravity" Tell the Time
What we have is the trackway which guides the driving weight for the mechanism of the clock. And it goes all the way up there and it has a pulley and that steel cable that comes down winds around this drum. OK. On the other end of that steel cable after it goes around the pulley is about a two hundred pound weight that runs up and down in this track and once a week the clock is wound so that the steel cable winds around that drum and it raises that weight all the way up to where that white mark is on the trackway, and that is the maximum height you should have it wound to so that you don't bind up the pulley at the top of the trackway. OK. So this weight is what provides the power to run the movement of the clock.

The drum has the steel cable wound around it and that gravity power is transferred to this big, bull wheel which goes to this little pinion wheel. This is the little pinion wheel, so that you're basically taking one rotation of the bull gear and making multiple rotations of the small wheel. It speeds up – say for every foot of this cable being played out – you'll probably get one rotation of that wheel, and one rotation of that wheel will give you multiple rotations of this little wheel. So it's a way of speeding up the RPM's from gravity (power) to a useful speed. So that little wheel speeds it up and then you have another big wheel going to another pinion – and there's the second pinion gear – and you'll notice you can actually see the shaft moving now. You can't really see the motion of this wheel. This gear IS moving. It's rotating, but so slowly that it's hard to see. By the time it's been sped up by going to this small pinion, this big one, and this second pinion, you can actually see the speed of the rotation of that little pinion. OK. And now you have another bull gear and pinion that speeds it up even faster. You can see how slowly that's moving, but you can see with this little gear, that pinion right there. You can see how much faster that's moving than this pinion gear, because each time it goes up, it's going faster and faster. So this is the pinion that drives the shaft that holds the escapement wheel. – NEXT The escapement wheel the heart of the clock and what goes “tic-tock.”

2. Where the Clock's Power Really Comes From

This wheel is the escapement wheel and this is the verge - OK - and this is a Graham deadbeat escapement. It’s named after the man who invented it in England. But the salient feature - why it’s called the “deadbeat” - is that you’ll notice that the wheel rotates and then stops. There is an actual pause in the motion of the wheel between each tic and tock of the clock. There are some movements where you don’t have a noticeable pause. In this one, each time the escapement (wheel) clicks back and forth, there is a pause where the movement stops. You’ll notice that on both of these escapements, there’s an incline plane, and as the wheel, which is under power from all that weight, goes around, it actually slides along that incline and pushes the escapement and that’s what powers the pendulum. (That’s the true tension or power) Yes (the resistance on that) Yes. The two hundred pounds of weight is geared to run faster and faster through all those bull and pinion gears and that power is then transmitted to the pendulum by that little incline. Otherwise the pendulum would slowly swing shorter and shorter and stop to make up for losses from friction and all of that, the pendulum needs to have energy. Each time the wheel - a tooth on the wheel - hits the incline on either one of these verge arms, it gets a kick. You can see it slides along there and it pushes it out of the way and that’s transmitted up the verge to the shaft here (to the shaft where?) this shaft right here; and this shaft comes through this little bearing over here.

That power kicks the pendulum coming along this shaft here. That power comes down along here to this adjustable contact with the pendulum arm. This slot and this pin are what join the energy coming from the verge and transmits it to the pendulum. And the reason this is adjustable is because with expansion and contraction, with temperature and other factors - how well we lubricated the clock - the clock runs faster - or slower - and how you regulate how fast or slow it’s moving is by how long the swing of the pendulum is. And that’s partly regulated by this adjustment screw which raises and lowers this block that has the little spring - the flexible metal part that attaches the pendulum all the way down (to the pendulum ball). And when you raise this up and down, this little hand wheel up here has a screw thread - it’s a nut and block kind of thing - so that when you turn it one way, it raises this block, which raises the pendulum - that’s why we have a slot here for adjustment - an up-and-down adjustment. It changes the length of the pendulum arm to allow the clock to run faster or slower, because the length of the pendulum regulates the time it takes for the pendulum to swing. So in the summer or winter you may have to raise or lower this to adjust for the changes that happen with temperature and the lubricant getting thicker, oil gets more viscous when it gets cold - all of those numerous things. This is the only real adjustment you have for how fast the clock is running. This is a slowbeat clock. If you listen to how fast the escape wheel makes that ticking - that tic and tock - of the clock, that's happening very slowly. If you've ever heard a mechanical wrist watch, it ticks very quickly. That's a fast beat movement. This is a very slow beat movement. The pendulum does only forty-five swings for each minute. So it's actually longer than a second for each swing of the clock.

3. Sending the Power to the Face of the Clock and its "Hands"

The same bull gear and pinion and shaft - which is (are) providing power to run the escape wheel (which is powering the pendulum). The pendulum is, in turn, regulating how fast this escapement is turning, and that, in turn, regulates how fast the power is being fed from this gear, which regulates how fast the power is going to this differential, which powers the shafts that go out to each of the clock faces. OK? So, anyway, the shaft from the differential gear powers this gear - which goes to this gear and this pinion - and this gear is the hour hand of the clock. It has a shaft inside of a shaft. (The shaft) is hollow. The minute hand is run directly off of this. The minute hand is run by the main shaft that goes through the hollow shaft. So this little tab here and these numbers, that corresponds to the location of the minute hand on the clock. And this tab shows you the hour, and, the minute hand shaft is actually going through the shaft for the hour hand. So this (the main shaft) is being driven directly to the minute hand (outside), and the hollow shaft that goes around the outside of (that shaft) for the hours is being powered by this set of gears going to this little pinion and the big gear so that it (the hour hand drive) moves sixty times slower than the direct drive of the minute hand. These little openings - these ports here - are so that you can actually get your hands out to adjust the hands of the clock, if they aren't in sync with the gearing. It's possible, for all sorts of reasons, for the hands of the clock to slip a little bit and not be in sync with the gearing. So you can have one face of the clock say that it's two o'clock and a different face will say that it's two-fifteen, that the minute hand has slipped in location. But you should be able to tell the time (that the clock is showing) by looking at these tabs and this little clock face here. And, of course, because we're inside the clock, it's (the numbers are) running counter-clockwise. It's only clockwise when seen from the outside. But there are four shafts and each of the faces of the clock has its own set of gearing to run the hour and the minute hands.

4. Dan Striking the Bell
The big bell is almost struck “on time” almost automatically, and with out computers or electricity! Dan Tokar explains. Gravity’s power is channeled to ring the clock bell.

There it is! (Clock bell striking eleven) And that’s striking the hour.

What makes the clock strikes so slow and “stately” sounding? A “governor” is a “speed-limiter”

A fly governor that runs on a pinion shaft below here. That’s what this thing is. See this thing that moves? That provides wind resistance. That’s what regulates how fast the striking happens. Because if there wasn’t some resistance, it (the bell) would go boing-boing-boing-boing instead of the stately boing . . . boing. So the amount of drag by this governor is what regulates how fast the striking happens. That’s one of the parts that I had to remake because the original governor had come apart.

What keeps the governor from breaking while it works to hold down the speed of the striking?

Youll notice what stops it is that this arm comes back in. You’ll want a view of that when it stops striking. You’ll see that little spring touch that pin again. and that little spring - a shock absorber.

The governor will freewheel because of that ratchet, so the striking doesn’t transfer all the energy to the governor and hurt the gears.