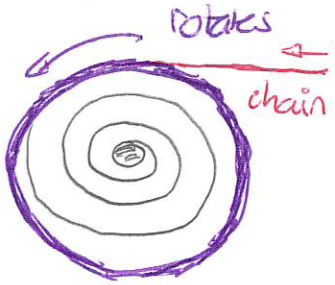
Essl 290 2021

Lecture 19

Weds: Mondsch 78 – 91
Barnett Ch 9

Mainspring clocks

In a mainspring clock the energy source is a coiled metal spring, usually housed inside a "barrel". As the spring unwinds, the barrel rotates and can pull a chain or cable that subsequently drives the clock mechanism (the "going train")



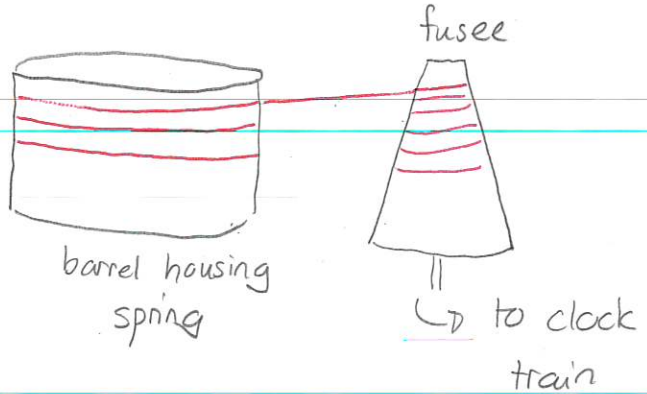
The fundamental issue with this is that as the spring unwinds it generates a force that weakens.

One can compensate for this by connecting the chain or cable to a fusee, which is a tapered drum that is then connected to the clock.

Demo: Show Henlein clock

(apparently ~~1530~~ 1530–1580)
some components 19th century

Demo: Show first Henlein



↳ Note controversy about the origin of this clock.

Early development of small clocks

Smaller versions of verge and foliot clocks seem to have appeared within 100 years of the arrival of the verge and foliot mechanism.

Rossum pg 119

Demo Miniature with a wall clock. - Marsel (~1406)

Initially such clocks could have been driven by suspended masses.

Other early mentions of portable clocks were

1) portable clocks - 1365 Pope Urban V (Avignon)
   - 1377 French king
   - 1385 Duke of Burgundy
2) use of a "clock carrier" - 1387 French king

As with the verge-and-foliot mechanism the development of the mainspring and fusee is unclear. The date and inventor of the first such mechanism are still unknown.

It appears that the mainspring and fusee mechanism appeared around 1400. Apparently the first mention of a spring in conjunction with a clock was by Brunelleschi (1377-1446).

Rossum 120

Rossum 121
Landes 90

The earliest definitive evidence for such a construction is the "Burgundy clock" of 1430.

↳ Wikimedia: Burgundy Clock

This belong to "Philip the Good"

Early examples of such clocks continued to appear in the 1400s and are variously called

- table clocks — Suzo picture
- chamber clocks.

Landes pg 91 This process of miniaturization led to the appearance of the first watches in the 1500s

Accuracy issues

The timing in mainspring driven clocks was initially regulated by verge-and-foliot mechanisms and the inherent inaccuracies of these still limited the accuracy of the clocks.

Q What determined the accuracy of the early mainspring clocks?

The fundamental issue here is that although the verge and foliot mechanism oscillates, it is not naturally an oscillator. Left to itself it will never display a repeated motion and it has to be driven (by the crown wheel and going train).

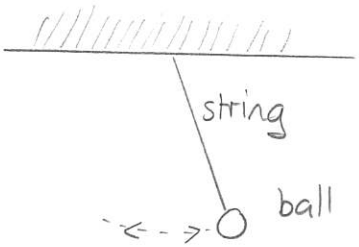
Thus such clocks would have needed to be checked as they lost around 15 min per day.

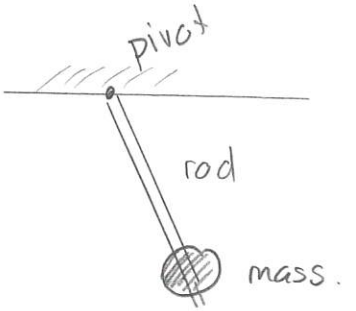
Q How might one have checked such clocks?

Pendulums

The first step in improving clock accuracy come from a fundamental improvement in the regulating mechanism - replacing the verge and foliot with a natural oscillator, in this case a pendulum.

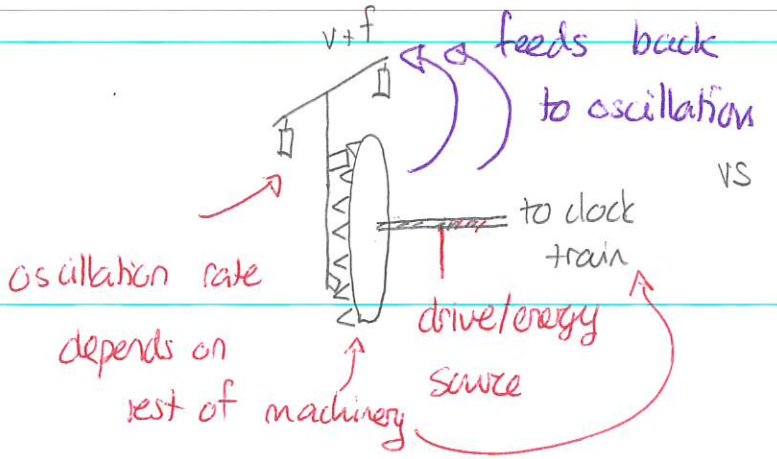
A pendulum is an object which swings back + forth under the influence of Earth's gravity. Some examples:

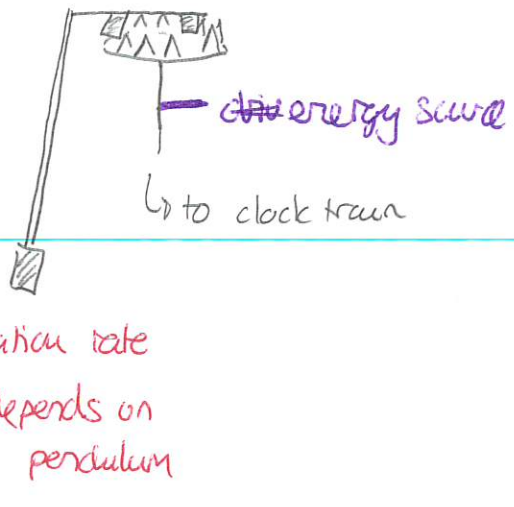




A crucial feature of a pendulum is that the motion is oscillatory and the rate at which it moves back + forth is somehow inherent to the pendulum itself.

We will see that the rate of oscillation can be adjusted. Then if the verge + foliot could be replaced by a pendulum oscillating at the correct rate, the natural oscillation of the pendulum could enhance accuracy





The remaining mechanism of the clock is fundamentally the same but needs to be rearranged to accommodate the pendulum's motion

Demo: Christian Huygen's clock video