CHAPTER 7

Ratchets

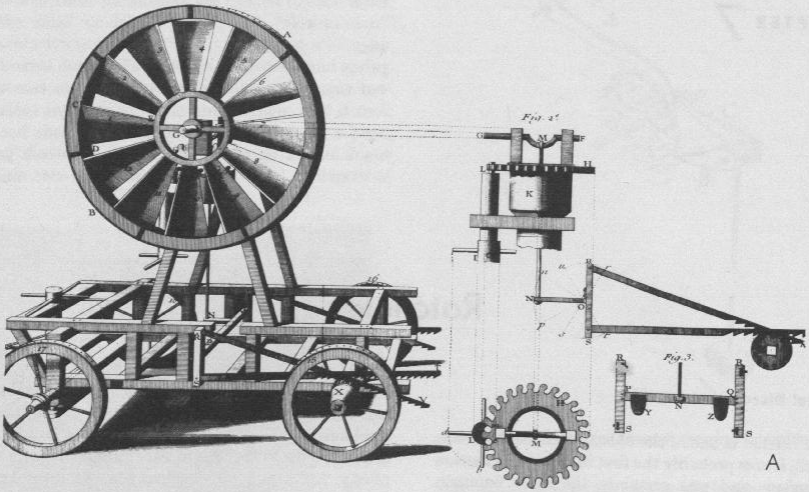
General Discussion

The ratchet is one of the oldest of all mechanisms. As such, it was probably the first intermittent motion mechanism, and was certainly the most common during the first century of the industrial revolution. Leonardo Da Vinci's notebooks are full of ratchet applications, and they were probably in use centuries before he came along. Most of these early applications, however, seem to have used the ratchet for mechanical advantage rather than to produce intermittent motion, the latter really being a product or need of the industrial revolution. Leonardo's ratchets, for example, are usually used to control engines of war; a man winds a catapult or crossbow, and the ratchet allows him to do this in short, easy steps, resting (dwell!) between exertions (index!). The drawing of the early machine (Fig. 7–1A), shows ratchets used to convert the continuous, relatively high-speed rotation of windmill sails into the slower, nearly continuous rotation of the rear wheels of a vehicle. I am sure the designer (who was not Leonardo, in this case) would prefer both input and output to be continuous here, but he settled for the wind and the ratchet. Figures 7–1B and 7–2A and B, showing some of the demonstration models built about 1876 by The Science Museum in London, give some indication of the number and variety of ratchets which were known a long time ago. It is interesting to note that such things as Genevas, star wheels, and escapements are also included in these photographs of "ratchet trains."

In any event, the ratchet is a logical place to start a discussion of different types of intermittent motion mechanisms. Another thing that makes it a logical candidate for first place in this discussion is its simplicity. A toothed wheel, a pawl, and a lever are all that is required to make a simple ratchet, as shown in Figs. 7–3 and 7–4. The first of these illustrations, Fig. 7–3, also shows that a ratchet can be built with (A) compression pawls, or (B) tension pawls. Figure 7–4 shows that the input can be through the pawl or through the wheel; and that internal as well as external ratchet wheels are possible.

Simplicity is one of the big advantages of the ratchet. Other related advantages include low cost and reliability. The ratchet is also noted for its ability to carry a large load in relation to its size. It is also a versatile device and is used in an amazing number of applications ranging from moderately heavy-duty machinery to high-speed instruments.

Disadvantages of the ratchet include the fact that it is an impacting mechanism, as seen in Chapter 5. There are ways to reduce the impacts in certain versions, but impact will almost always be present to some extent, and can lead to wear, control, and stability problems unless the rest of the system is properly designed. The basic problem, of course, is that impacts produce forces throughout the mechanism that are well in excess of the subsequent drive forces, as shown in Fig. 7–5, A and B. Impact also results in noise, which is very undesirable in most applications, and "noise pollution" should soon get a lot more attention from machine and instrument



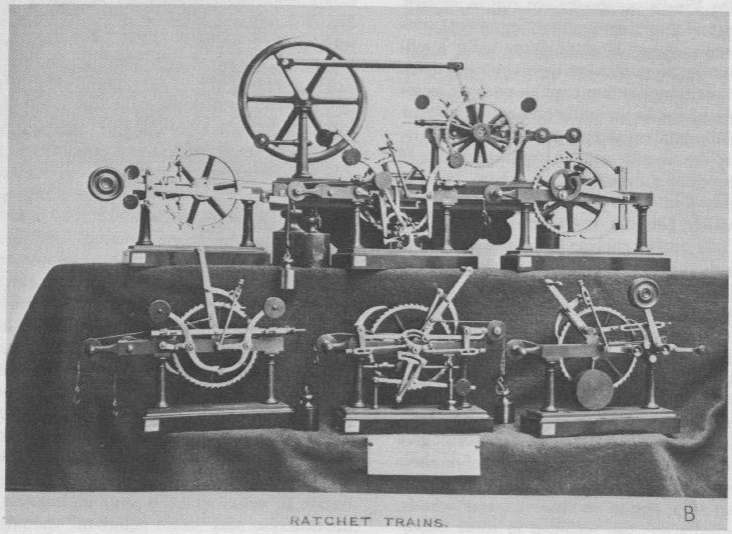


Photo. Science Museum, London

Fig. 7-1. A. Drawing of a ratchet-driven horseless carriage that was built (or proposed) about 1713. B. Display of ratchet trains in The Science Museum, London.