

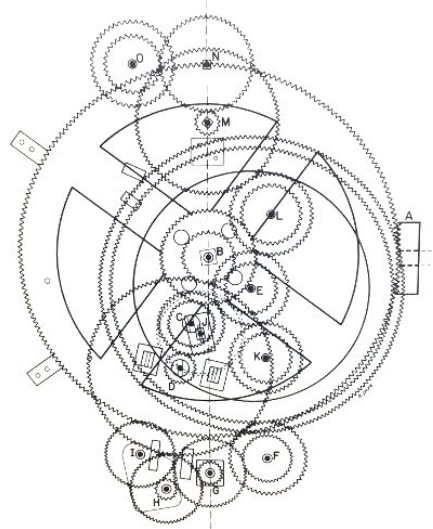


Like historians when I started this corner I thought that hindsight was a many splendid thing because I arrogantly thought that our hindsight was pretty complete. I never expected one piece of machinery to ever question that hindsight. Back in 2017 we looked at the Harmonic Analyser Mechanism because I thought it 'historic'. However in this special we are going to look at a mechanism that has over-turned so much history that not only do the books need re-writing but our modern day assumptions about antiquity have had to be completely re-assessed. I thought of history as linear: one discovery leads to another. Scientists modestly confess that they have stood on the shoulders of giants. Yet for 2000 years modern pride has actually been in catch up and we didn't know it. This lost mechanism proves modern technology is not as modern as it thinks it is. Sadly it is in an exceedingly fragile state.

Fragile Fragment The Antikythera Mechanism is so called because we have no idea who made it. The name comes from the Greek island where a modest lump of corroded copper was lifted from a Roman shipwreck in 1901 and left in a box until nearly a year later when archaeologist Valerios Stais noticed the outline of a gear wheel on it. Of course Archimedes made some form of geared and chain water clock in third century BC but gears per se were first seen only on south facing chariots in China in the third century after Christ. The Chinese attempted counting mechanisms in the eighth century and the first astrolabe came along perhaps in the thirteenth century. As the Antikythera gear looked relatively modern the whole lump was left until 1951 ! After X-ray investigation in 1971 diagrams were published in 1974. Research was picked up again in 2008 and origins were postulated as recently as 2017 ! Whilst this seems like grotesque scientific over-sight remember that they were dealing with crumbling mass that very few were allowed to probe by non-physical means.



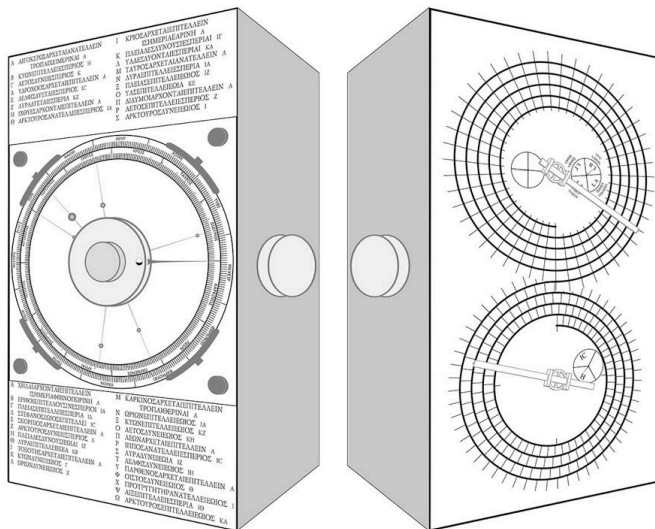
Of course Archimedes made some form of geared and chain water clock in third century BC but gears per se were first seen only on south facing chariots in China in the third century after Christ. The Chinese attempted counting mechanisms in the eighth century and the first astrolabe came along perhaps in the thirteenth century. As the Antikythera gear looked relatively modern the whole lump was left until 1951 ! After X-ray investigation in 1971 diagrams were published in 1974. Research was picked up again in 2008 and origins were postulated as recently as 2017 ! Whilst this seems like grotesque scientific over-sight remember that they were dealing with crumbling mass that very few were allowed to probe by non-physical means.



relatively modern the whole lump was left until 1951 ! After X-ray investigation in 1971 diagrams were published in 1974. Research was picked up again in 2008 and origins were postulated as recently as 2017 ! Whilst this seems like grotesque scientific over-sight remember that they were dealing with crumbling mass that very few were allowed to probe by non-physical means.

Getting Their Teeth Into The Gears Their investigations revealed quite some complexity (see above) and not all gears meshed in the conventional sense. We'll see more of this later.

Boxing Clever The entire machine must have been in some sort of box which had disappeared long ago. However X-ray tomography and gamma ray mapping have revealed writing on opposite layers of the remaining 'cake'. These may have been written on 'front' and 'rear' panels but, having read the descriptions and viewed numerous YouTube videos, which while erudite, all have got to be no more than guesswork.



REWINDING THE CLOCK

Leaps Of Years To you and I, and the sponge divers that found it, a lump of corrosion doesn't inspire factual deduction. However archaeologists looked at the location, the pottery and coins nearby and deduced several likely times when the ship went down which was about 80BC. Obviously that was not the year of manufacture. It's style and inscriptions give rise to a guess of just after 200BC. But *hang-on-a-minute* the technology the X-ray people are talking about came at least 1,300 years later so they must be wrong or had to explain more !

Guessing The Game It's no understatement to say everything in this article, especially from here on, has got to be a complete guess and raises controversy for all who investigate so I'm going to pick a few examples but these are pure pontification ! Some Meccano people I know are good at that (shhh down the back there. I know what you're thinking).

In 1974 the incredible scientific historian Dr Derek Price (Cambridge Uni, Yale and many other institutions) was the first to attempt a model of the machine. However Prof Michael Wright (Imperial College London) and others including Meccanoman Dr Alan Partridge (who I knew well at the Midlands Meccano Guild) were the first to spend years afterwards making a fully working example. A fair few have followed but none, to my knowledge, in Meccano. Given the



concentric axles, through the middle, the front panel may have looked like this (left). Notable are the five dials representing the known visible planets at the time plus us and our central rotating moon showing its distinctive phases and one showing the true position of the sun. Further, given the need for accurate setting of the internal gearing inscriptions imply a rear panel that may have looked like this (right).



So what should you and I also note as complete amateurs ? The fact that the earth is in the middle ! In fact the geocentric view

of our solar system (accurately and beautifully mis-described by Ptolemy in 150AD) wasn't replaced until those magnificent Copernicus and Kepler men put forward the heliocentric view of our green and pleasant watery flying machine (first secretly described in 1510 but then published in 1543 and improved upon by Kepler much later in 1602).

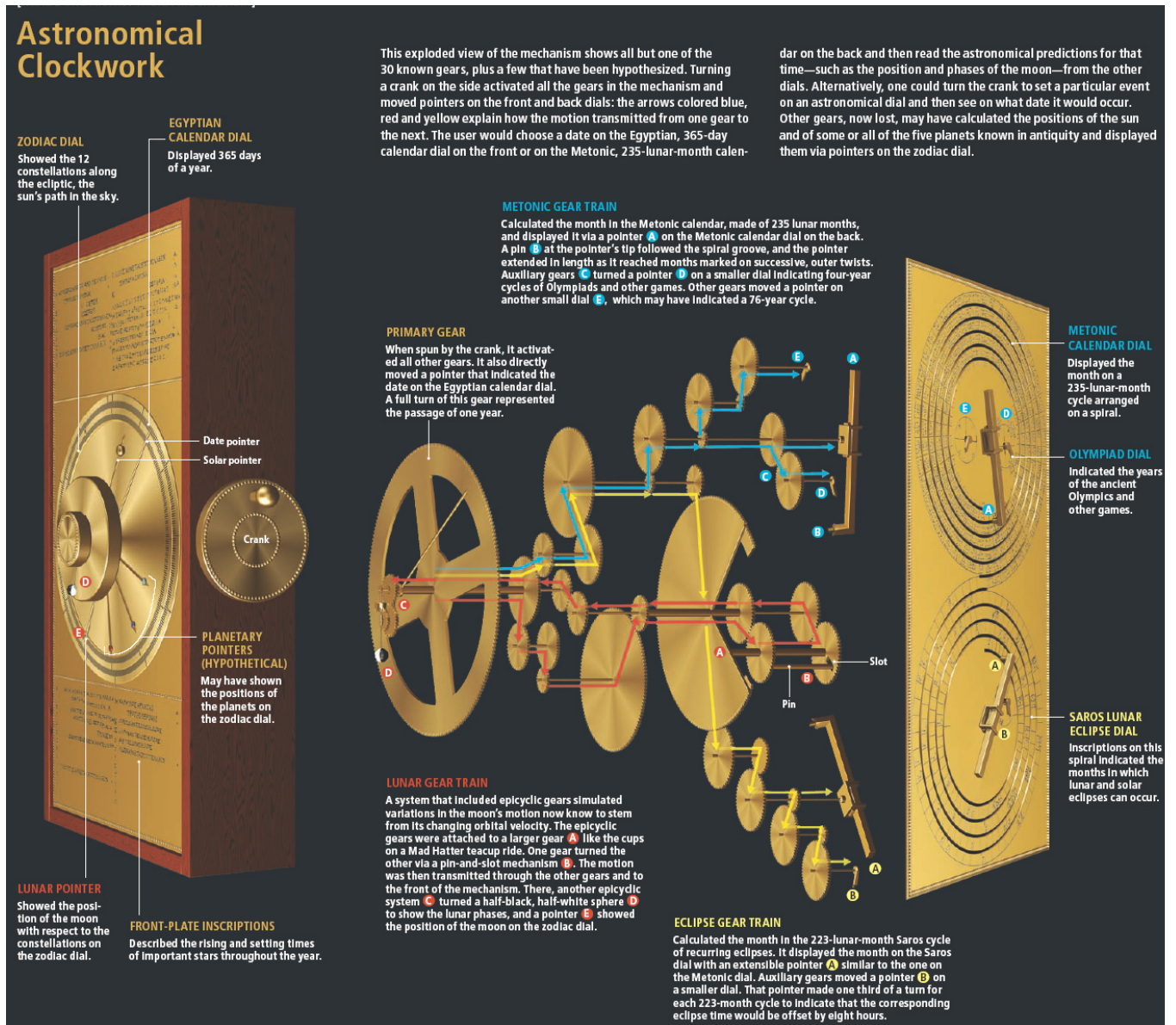
As I write I now hit several other *hang-on-a-minute* moments and I reckon anyone having a look at this machine would think the same. **Firstly** if you muck up the view of the solar system you cannot possibly make a machine to model a muck up -yet this maker has ! **Secondly** no craftman before Christ, let alone before the Chinese of all damn clever people many centuries later, could cut fine gears in rubbish metal with rubbish tools to rubbish plans to describe orbits of planets they couldn't see until telescopes were perfected by Galileo in 1609. **Thirdly** the machine is tiny. It is obviously portable and probably many were produced. **Fourthly** this tiny machine imparted so little friction within its rubbish little cogs that it could simply be turned, by a small knob on the side, and not by a weight of fourteen tons of Egyptian granite. **Fifthly** the accuracy for several of the outputs is calculated to be several parts per million by modern standards. What is going on ? No, no, no way !

I hereby confess that at first I reckoned Prof Wright was a complete moron ! He'd wasted his life and all the data I'd downloaded watching his YouTube lecture. However he and many others, sceptics or whatever, agree that the dials on the front of this humble lump of barnacles once very accurately predicted the eclipses of each of the visible planets and our moon so Matt you're the moron ! I digress..

HOW IT WORKS

Train Your Eye On The Gear Trains

Given my initial scepticism let's have look at what Meccano people love: the epicyclic guts. The quality of printing here should enable you to read this description so I will add no more.



I do own a telescope I'm not an astronomer. However I will attempt some explanations here remembering that in the real world few things are whole numbers yet gears, with whole teeth, must be used.

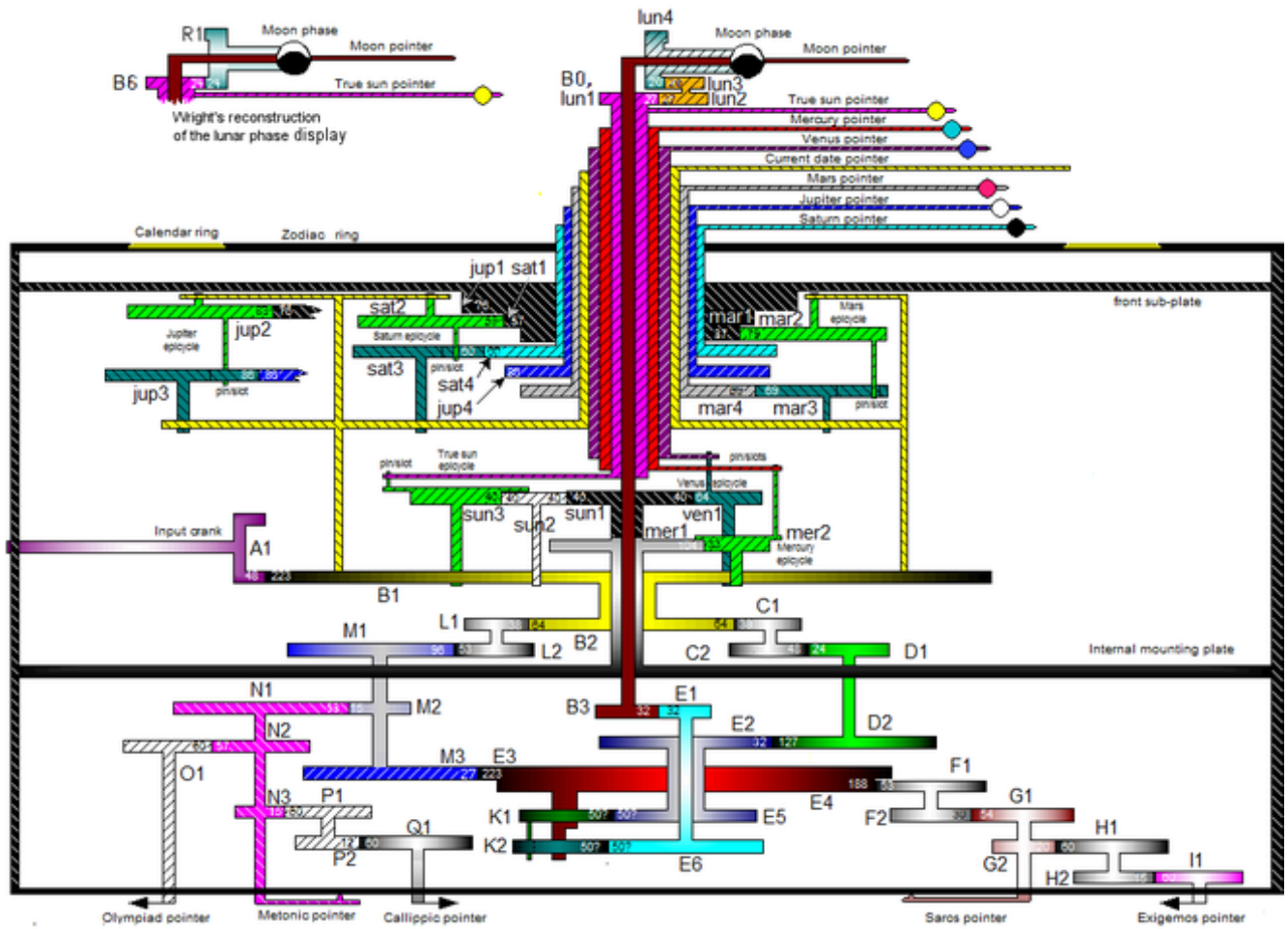
Yearning For A Year Yes a year is one circuit of the earth round the sun. Yes it can be divided, as the Babylonians loved, into 12 months. However $365\frac{1}{4}$ days is not divisible by 12 so each month is given 30 days and 5 are sneakily added. The Julian Calendar had not been devised officially however they knew the $\frac{1}{4}$ had to be compensated for so, on the rear dial, the instructions say an extra day must be manually added every 4 years (they had no knowledge to suppress this every 1000 years as we now do).

Relative to the stars astronomers knew the moon goes round the earth roughly every 27.3 days (a sidereal month) but full moon to full moon (with the sun shining on it), where the earth has moved on a bit, gives rise to a 29.5 day cycle (a synodic month). It is this latter that the mechanism calculates.

Eclipses are where the Sun, Moon and Earth line up. The eclipse of the moon by the earth occurs every 223 synodic months (I hope I've not lost you already). This is actually 18 years, 11 days and 8 hours and is called one saros. The master gear correspondingly has 223 teeth on it. The lower large dial on the back allows the setting of where you are in the saros cycle.

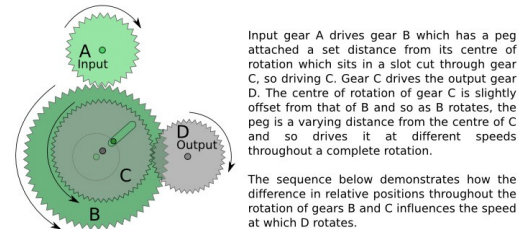
The eclipse of the earth by the moon occurs every 235 synodic months. This is actually defined as 6939 days (almost exactly 19 years) and is called the metatonic cycle. The upper large dial is used to set this. To help decide where you are on these cycles, the symbols of the zodiac, the months of the Egyptian calendar, the names of the Olympic and other games are written there.

Driving The Point Home The diagram below is the Freeth & Jones proposal of 2012 with the Wright theory of 2004. There are others. You'll be relieved to know that I'm not going to describe this in detail.



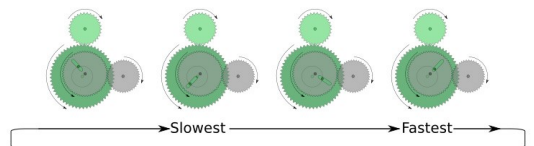
Notable is:

- There are only three fixed bearings: the front panel, the interior mounting plate and the rear panel.
- There are three epicyclic gearboxes. However the front-most one has multiple outputs to cut down on the number of gears needing to be made.
- There are four sliding pivot gears (right). These give rise to variable rate planetary motion which over 1000 years later Kepler would explain as equal swept area ellipses.



Input gear A drives gear B which has a peg attached a set distance from its centre of rotation which sits in a slot cut through gear C, so driving C. Gear C drives the output gear D. The centre of rotation of gear C is slightly offset from that of B and so as B rotates, the peg is a varying distance from the centre of C and so drives it at different speeds throughout a complete rotation.

The sequence below demonstrates how the difference in relative positions throughout the rotation of gears B and C influences the speed at which D rotates.



Models

As eye-candy I'll include some beautiful renditions of what the original may have looked like.

