

High Noon

True solar time, wherever and whenever you are

James Gurney

 Arnold & Son's new True North Perpetual is a paragon of clever thinking: unlike any other 'equation of time' watch, it can indicate the true solar time for any given location, allow for daylight-saving schemes *and* indicate true north once a day. Seemingly determined to live up to the traditions of its name, Arnold & Son has become a hotbed of invention. After all, why use such a name merely as dial decoration?

Eric Loth, CEO of The British Masters has taken the bit between his teeth when it comes to ensuring that his present-day Arnold & Son brand is a worthy successor to the original London clockmakers. Working closely with movement makers La Joux Perret (see 'Venus', p.82), Loth's team took as a starting point the

challenge that originally made John Arnold's reputation. As Dava Sobel's excellent *Longitude* made clear, the competition to discover a reliable means of finding longitude was eventually won by John Harrison and his series of marine chronometers. It was however, Arnold & Son that successfully rose to the

challenge of commercialising production of marine chronometers and who became the main supplier to the Royal Navy.

While the basic theory that midday differences between a ship's position and a reference time are sufficient to give longitude, performing the same operation



White-gold variant of Arnold & Son's True North Perpetual (£27,200).

at other times of the day is open to error, due to the periodic difference between mean time and solar time. A function of the Earth's polar axis being tilted in relation to the sun, this difference gave rise to the inclusion of the 'solar equation' watch, programmed to highlight the fluctuating difference between the two measures of time.

While solar equation watches (also known as 'equation of time' watches) have proved enduringly popular among collectors, there has always been one fundamental error that makes their practical use virtually impossible. Because our time is set by the time-zone we live in, rather than by the apparent midday of our latitude, solar equation watches start by including an error equal to the longitude difference between where we live and the reference point for our time-zone. A second, more glaring error is that very few solar equation watches allow for the solar indicator to account for the hours gained and lost through daylight-saving schemes.

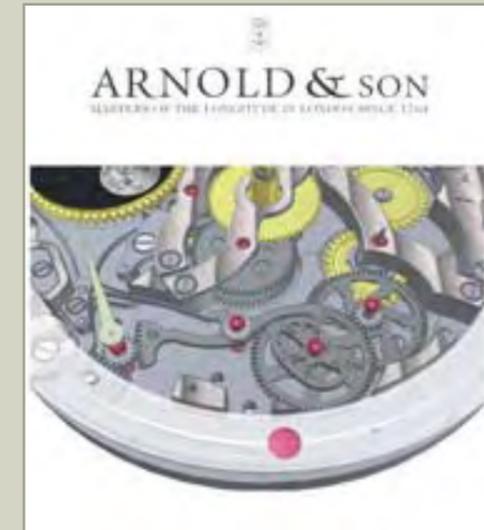
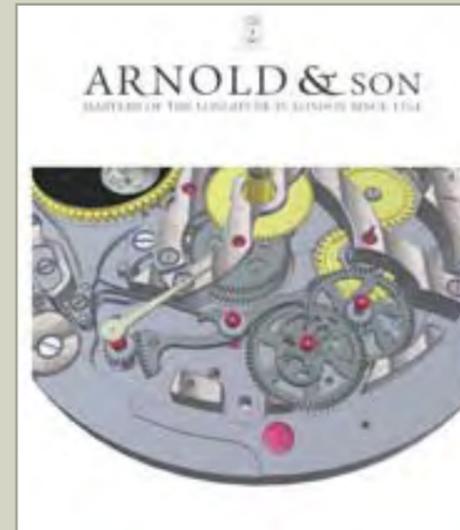
In practice

Arnold & Son's solution to all this is to make its system flexible and comparatively simple to operate. Seeing the system in action at the hands Loth makes it seem deceptively simple. The idea is that the watch can be corrected by push buttons, both for degrees longitude away from meridian and for changes in civil time. The key is knowing where you are, relative to the nearest meridian, which in turn means turning to the directory supplied with the watch.

First, set your watch to standard or winter time for your zone. By pulling out and rotating the crown located at 8 o'clock, you then rotate the outer dial ring towards the value indicated in the directory. A marker on the inner dial ring shows the values in degrees. Geneva is one hour ahead of London time, or 15°, but in distance east of London, Geneva is only 6°. The appropriate correction is then 9°. Once the adjustments are made, solar time is read off the 24-hour outer dial ring as well as the equation of time (mean time - solar time) being indicated

(Above) The finely decorated movement of the True North includes the secret signature '1764' engraved in skeleton form on one of the wheel bridges.

(Right) Platinum-cased (£39,300) and rose-gold variant of Arnold & Son's True North (£27,200).



(Left) This CAD diagram shows the equation cam at a position that indicates the maximum equation of time (a solar time approximately +14 mins, relative to mean time).

(Right) Here, the equation cam indicates the minimum equation of time (a solar time approximately -16 mins, relative to mean time).

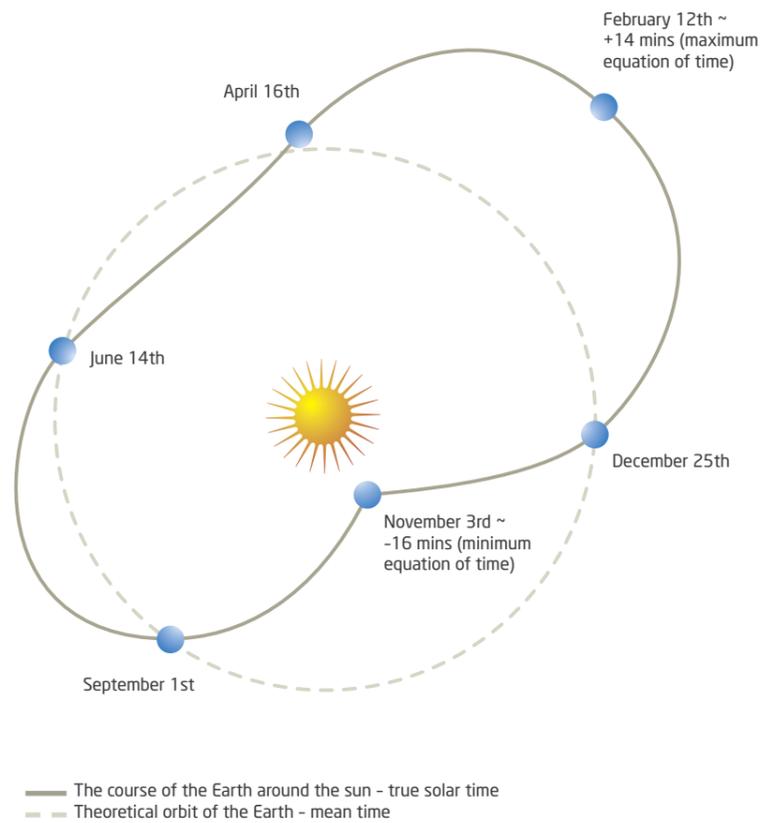
To make solar indication as accurate as feasible, a unique gearing system with elastic teeth was developed - each tooth is under tension, ensuring more precise contact.



The Master

London watchmaker John Arnold (1736-1799) was one of the true master clockmakers from what was unarguably England's golden age of horology. He was one of the four laureates of the famous Longitude Act prize. Crucially though, in contrast to John Harrison, Arnold was blessed with the business and social acumen to ensure that his abilities were appreciated. He is credited with several patents regarding escapement and balance spring designs and was the first to use the word 'Chronometer' in the modern sense.

In 1787, he set up Arnold & Son with John Roger Arnold who served an apprenticeship with A-L Breguet. The company, though young, became the only one capable of manufacturing timekeepers in sufficient quantity, and it quickly became the main supplier to the Royal Navy and the great British explorers of the time. John Roger continued the business after his father's death with John Dent. He also went on to become Master of the Clockmaker's Company in London in 1817.



Solar time versus mean time

The rotation of the Earth makes a good clock for most purposes. Unfortunately, the apparent position of the Sun is determined not just by the rotation of the Earth about its axis, but also by the orbit of the Earth around the Sun, hence the complicated nature of what follows:

The plane of the Earth's equator is inclined to the plane of the Earth's orbit around the Sun ('angle of obliquity'). The orbit of the earth is elliptical. Solar time is measured as a projection of the Sun's motion onto the equator, which of course changes through the year as the Sun moves above and below the equator due to the tilt in the Earth's axis. The apparent motion of the sun across the Earth's skies varies, and will therefore vary in speed as the Sun moves to and from the equator - speeding up as it moves to the equinoxes and slowing towards the solstices.

The distance between the Earth and the Sun is at its minimum on its elliptic orbit near December 31st and is at its maximum near July 1st ('perihelion' and 'aphelion' respectively). Between these two dates, the Sun's apparent longitude accelerates and decelerates so that between perihelion and aphelion the Sun will be slow relative to mean time, reaching its slowest at around the 31st March. From aphelion to perihelion the Sun moves fast relative to mean time with the maximum gain reached around the 30th September. The equation of time is the difference between mean time and solar time, indicated on equation of time watches by means of the 'equation cam', shaped similarly to the Earth's true orbit, as pictured here.

And as if this were not complicated enough, there are observable year to year differences on observed Solar Time that can amount to as much as twenty seconds per year.

in a separate subdial. Perhaps more usefully, if less complicatedly, the solar hand can also be used as a second time-zone indicator.

Incorporating the equation of time into the outer ring may seem a sensible idea from the design point of view as it makes indication of the time fairly clear. Putting this idea into practice however was a very different proposition and necessitated the use of outside help; in this case, the highly respected Jean-Marc Wiederrecht, of Agenhor SA in Geneva.

One of the challenges was to make solar indication as accurate as feasible and, to this end, a unique system of elastic gearing, or rather gearing with elastic teeth, was developed. Didier Othenin Girard, watchmaker at The British Masters, explains: "Normal train wheels need an element of play between the teeth so that they do not

stick. Unfortunately this play can lead to an error of five minutes or even more on 24-hour indicators. While this is acceptable for a GMT hand, such an error would make the equation function meaningless. The elastic system, where each tooth is under tension ensures more precise contact and more accurate indication.

While GPS is the instrument of choice for navigation, we wanted to make a mechanical instrument that could rival GPS for accuracy and for ease of use."

The name 'True North' however comes from an even more esoteric ability of the watch. Once set up, the solar hand will indicate true north at midday simply by being aligned with the Sun. After such a technical marvel, the presence of a moonphase and perpetual calendar seems almost mundane. ○

Further information: William and Son, 10 Mount Street, London W1K 2TY. Tel: 020 7493 8385, Email: info@williamandson.com, www.williamandson.com, www.arnoldandson.com