

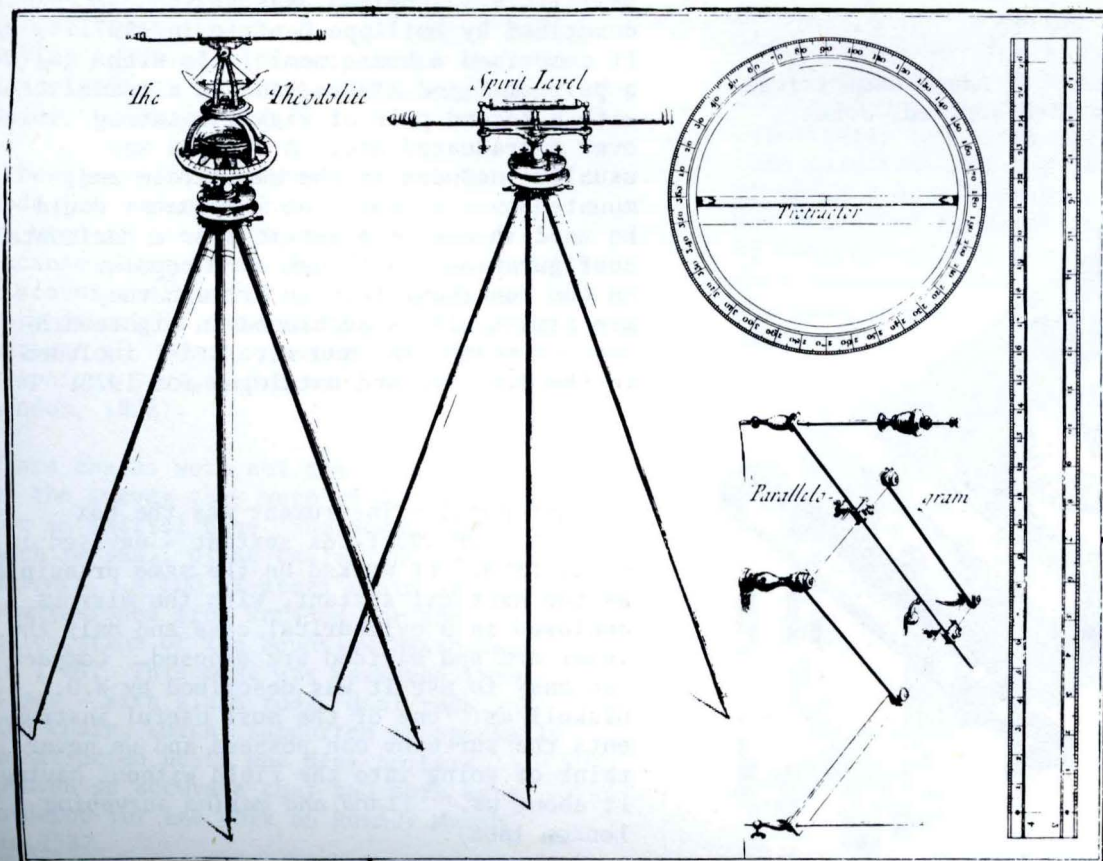
The Improved Theodolite and Level

By the early eighteenth century the standard surveying instruments in England were the chain (most commonly Gunter's), the simple theodolite, the plane table and the circumferentor. The cross-head and the graphometer or semi-circle were also used and this whole group of instruments remained the most commonly described throughout the century. However there were important introductions. The seventeenth century had seen two inventions important for surveying - telescopic sights and vernier scales - and these were first commonly applied in the eighteenth.

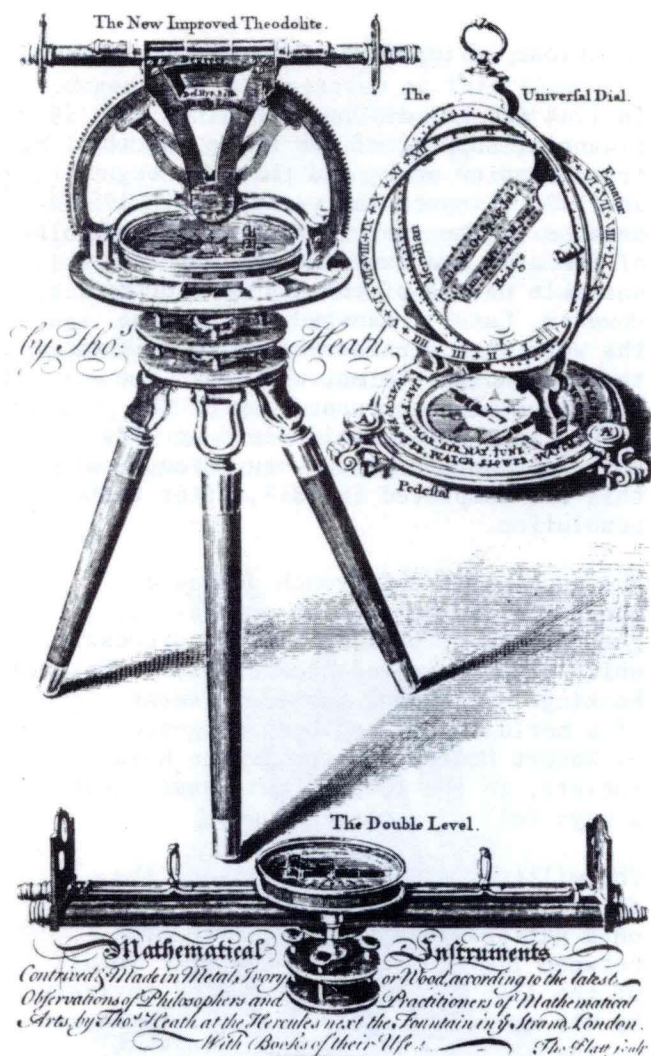
In 1725 a textbook by Samuel Wyld called *The practical surveyor* was first published, with an engraved frontispiece showing an altazimuth theodolite with a telescopic sight by Jonathan Sisson and also a Sisson level with a telescopic sight. The book was partly sponsored by Sisson and although Wyld deals first with the standard instruments - chain, plane table, simple theodolite and circumferentor - he also describes Sisson's 'new Theodolite, which hath met with a general Applause from all Mathematicians that have seen it, and far exceeds any other Instrument that hath yet been invented' (*ibid.*, p. 35). He deals also with Sisson's level and its use with a divided staff to find differences in height.

A rival instrument-maker, Thomas Heath, had designed another altazimuth theodolite and he had his theodolite and his level introduced - by stages - through a surveying textbook which was also called *The practical surveyor*. The first edition appeared also in 1725, with the name of John Hammond on the title-page, though the true author was Samuel Cunn, who had edited the fifth edition of Leybourn's *Compleat surveyor*. References to a theodolite - 'as now improved' - appear on the title-page and occasionally in the text, but there is no detailed description or illustration.

The second edition of 1731, however, while dealing again with the chain, plane table, simple theodolite, etc, has a detailed account of the altazimuth theodolite in a new appendix by Samuel Warner and an engraved frontispiece illustrating both Heath's level (a 'double level' with separate telescopes for sighting backwards and forwards) and the new theodolite. The most obvious difference between the Sisson and Heath theodolites is in the arrangements of the vertical arcs, but it is easy to imagine how each had evolved through the addition of an altitude scale to the simple theodolite. Indeed some early theodolites are so fitted that they can be used in either simple or altazimuth forms.



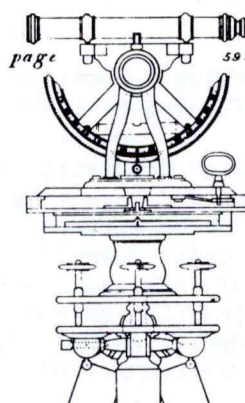
Frontispiece
from S. Wyld, *The
practical surveyor*,
London, 1725.



Frontispiece from J. Hammond, *The practical surveyor*, (London, 1731).

In the 1750 edition of Hammond's *The practical surveyor* the appendix is incorporated into the text and there are accounts of two surveys 'the one performed by the common Theodolite, the other by the new improved Theodolite' (pp. i-ii). Incidentally, the vertical arc on Heath's theodolite was engraved not only in degrees, but also with gradients and a scale of difference between hypotenuse and base (the 'base' being a horizontal line of 100 units). This latter scale gave the number of links to be subtracted from each Gunter's chain laid along a slope to yield the horizontal distance.

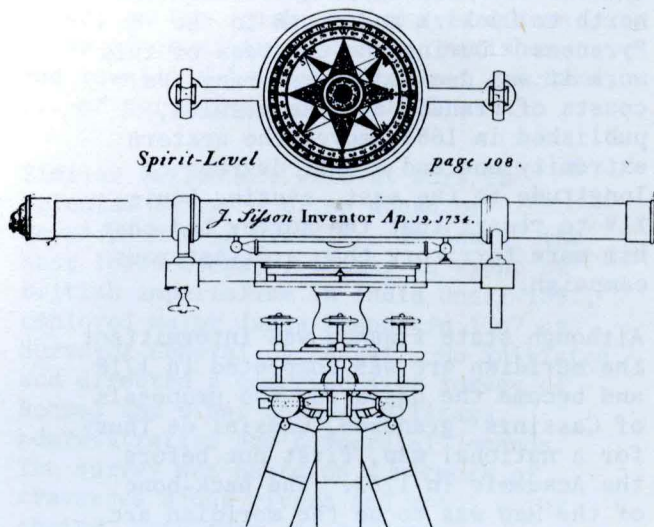
Meanwhile Sisson's rejoinder had taken the form of another surveying textbook - *Practical surveying improved*, written by William Gardiner and first published in 1737. Here again a frontispiece illustrates instruments by Sisson, including an altazimuth theodolite and a level. These are some changes: the vertical arc of the theodolite is mounted differently and is larger than the previous



Sisson's theodolite from W. Gardiner, *Practical surveying improved*, London, 1737.

quadrant; the bubble hangs beneath the telescope of the level. After dealing with the standard collection of instruments, Gardiner moves on to 'Mr Sisson's latest improved Theodolite' (as distinct from the 'common' theodolite) and 'Mr Sisson's New-invented Spirit-Level'.

In spite of these important developments in instrumentation, throughout the eighteenth century the unqualified term 'theodolite' generally refers to the simple theodolite and many newly-published textbooks do not mention the improved instruments. Some, such as *A treatise on mensuration* (Newcastle, 1770) by Charles Hutton, even warn against them: '... but of all the absurd or false methods that by the use of what is called the new-improved theodolite is of the most dangerous consequence; for it is professedly adapted to the diminishing of all land by reducing it to an horizontal plain, even such as is wholly upon a regular declivity; by that means destroying sometimes a third or fourth of the true surface ... In short, let every gentleman, who would not have his real land reduced below its just quantity, beware of those surveyors who use this new-improved instrument' (p. 484).



Sisson's level from *ibid.*