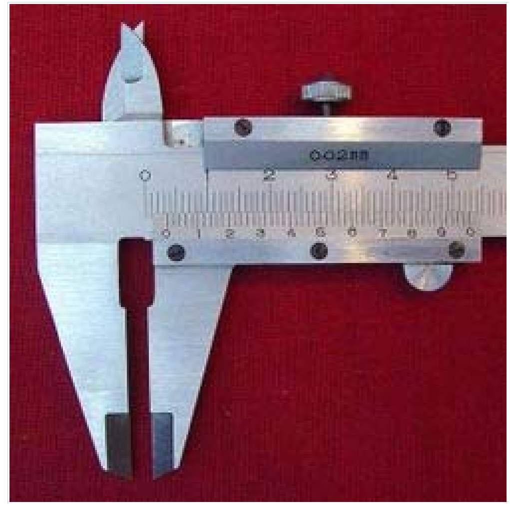
Vernier scale

From Wikipedia, the free encyclopedia
(Redirected from Vernier)

For the spacecraft component, see Vernier thruster.



A set of vernier calipers.

A **vernier scale** lets one read more precisely from an evenly divided straight or circular measurement scale. It is fitted with a sliding secondary scale that is used to indicate where the measurement lies when it is in-between two of the marks on the main scale.

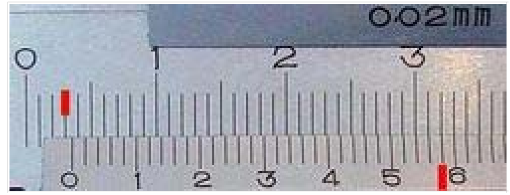
It was invented in its modern form in 1631 by the French mathematician Augustus Vernier (1580–1637). In some languages, this device is called a **nonius**, which is the Latin name of the Portuguese astronomer and mathematician Pedro Nunes (1492–1578) who invented the principle. Another theory is that this name is from the Latin "nona" meaning "9" and therefore "nonius" means a "ninth" of the main scale.

(Note - Wiki contains an entry for Pierre Vernier, but not Augustus Vernier - also, many sources list his birth and death dates as 1584 and 1638 - There may be an error in the current entry).

Verniers are common on sextants used in navigation, scientific instruments and machinists' measuring tools (all sorts, but especially calipers and micrometers) and on theodolites used in surveying.

When a measurement is taken by mechanical means using one of the above mentioned instruments, the measure is read off a finely marked data scale (the "fixed" scale, in the diagram). The measure taken will usually be between two of the smallest gradations on this scale. The indicating scale ("vernier" in the diagram) is used to provide an even finer additional level of precision without resorting to estimation.

Contents

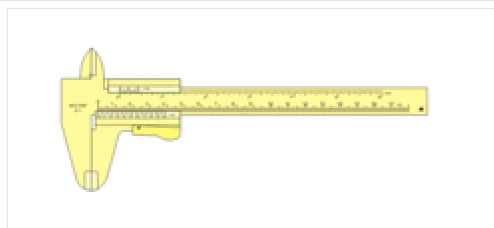


An enlarged view of the above calipers shows they have a resolution or precision of 0.02 mm. The reading is 3.58 mm. The 3 mm is read off from the upper (fixed) data scale. The 0.58 mm is obtained from the lower (sliding) indicating scale at the point of closest alignment between the two scales. The superimposed red markings show where the readings are taken. **Note** In this photograph, parallax error makes it unclear whether the right value is 0.58 mm or 0.60 mm

Construction

The indicating scale is constructed so that when its zero point is coincident with the start of the data scale, its gradations are at a slightly smaller spacing than those on the data scale and so do not coincide with any on the data scale. N gradations of the indicating scale would cover N-1 gradations of the data scale (where N is the number of divisions the maker wishes to show at the finer level).

Use



Animation of a caliper measurement using a vernier scale. *Click to enlarge*

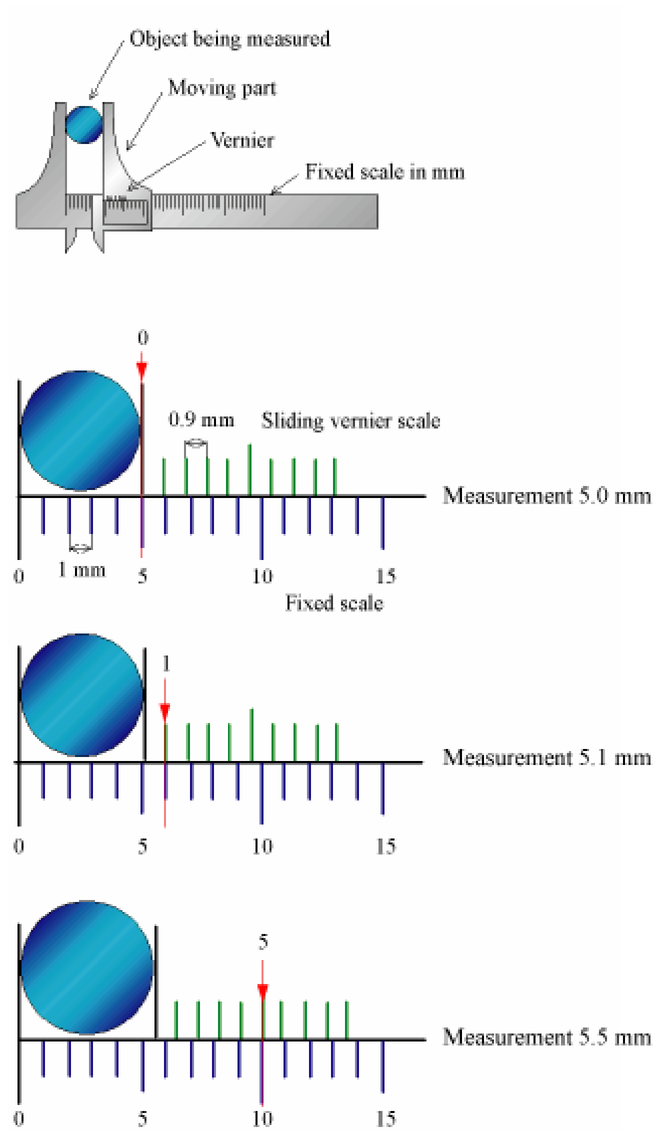
When a length is measured the zero point on the indicating scale is the actual point of measurement, however this is likely to be between two data scale points. The indicator scale measurement which corresponds to the best-aligned pair of indicator and data gradations yields the value of the finer additional precision digit.

Examples

On instruments using decimal measure, as shown in the diagram below, the indicating scale would have 10 gradations covering the same length as 9 on the data scale. Note that the vernier's 10th gradation is omitted.

On an instrument providing angular measure, the data scale could be in half-degrees with an indicator scale providing 30 1-minute gradations (spanning 29 of the half-degree gradations).

Why a vernier scale works



The vernier scale is constructed so that it is spaced at a constant fraction of the fixed main scale. So for a decimal measuring device each mark on the vernier would be spaced nine tenths of those on the main scale. If you put the two scales together with zero points aligned then the first mark on the vernier scale will be one tenth short of the first main scale mark, the second two tenths short and so on up to the ninth mark which would be misaligned by nine tenths. Only when a full ten marks have been counted would there be an alignment because the tenth mark would be ten tenths, that is a whole main scale unit, short and will therefore align with the ninth mark on the main scale.

Now if you move the vernier by a small amount, say, one tenth of its fixed main scale, the only pair of marks which come into alignment will be the first pair since these were the only ones originally misaligned by one tenth. If we had moved it 2 tenths then the second pair and only the second would be in alignment since these are the only ones which were originally misaligned by that amount. If we had moved it 5 tenths then the fifth pair and only the fifth would be in alignment. And so on for any movement, only one pair of marks will be in alignment and that pair will show what is the value of the small displacement.

References

- The VERNIER Scale (http://www.saburchill.com/physics/chapters/0095.html) Open Door Web Site

reference source for both students and teachers.

- How to use the vernier caliper (http://phoenix.phys.clemson.edu/labs/cupol/vernier/index.html) Clemson University Physics On-line Laboratories

See also

- Micrometer (device)

External links

- Animated Vernier calipers (http://members.shaw.ca/ron.blond/Vern.APPLET/)