2.2 VERNIER INSTRUMENTS

The instruments discussed in this chapter until now can be branded 'non-precision' instruments, not for their lack of precision but for their lack of amplification. A steel rule can measure accurately up to 1 mm or at best up to 0.5 mm. It is not sensitive to variations in dimensions at much finer levels because of the inherent limitation in its design. On the other hand, vernier instruments based on the vernier scale principle can measure up to a much finer degree of accuracy.

Vernier instruments have two scales of different sizes which are used to measure the dimension in high accuracy. Various types of vernier instruments are as follows: -

2.2.1 Vernier Calliper

A vernier calliper consists of two main parts: the main scale engraved on a solid L-shaped frame and the vernier scale that can slide along the main scale. The sliding nature of the vernier has given it another name—sliding calliper. The main scale is graduated in millimetres, up to a least count of 1 mm. The vernier also has engraved graduations, which is either a forward vernier or a backward vernier. The vernier calliper is made of either stainless steel or tool steel, depending on the nature and severity of application.

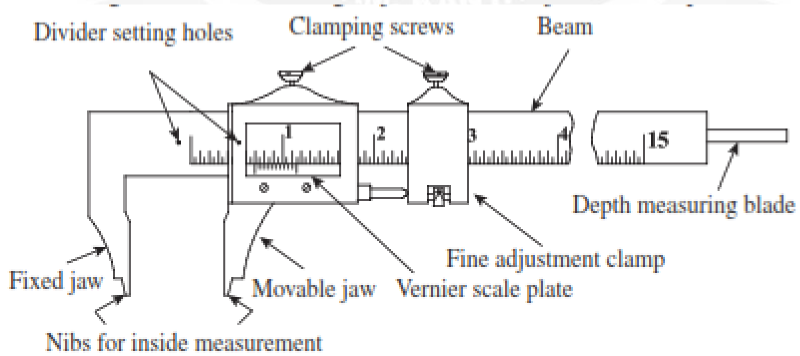

Fig. 2.12 Main parts of a vernier calliper

[source: "Engineering Metrology & Measurements", N.V. Raghavendra., page-95]

The L-shaped main frame also serves as the fixed jaw at its end. The movable jaw, which also has a vernier scale plate, can slide over the entire length of the main scale, which is engraved on the main frame or the beam. A clamping screw enables clamping of the movable jaw in a particular position after the jaws have been set accurately over the job being measured. This arrest further motion of the movable jaw, so that the operator can note down the reading in a convenient position. In order to capture a dimension, the operator has to open out the two jaws, hold the instrument over the job, and slide the movable jaw inwards, until the two jaws are in firm contact with the job.

A fine adjustment screw enables the operator to accurately enclose the portion of the job where measurement is required by applying optimum clamping pressure. In the absence of the fine adjustment screw, the operator has to rely on his careful judgement to apply the minimum force that is required to close the two jaws firmly over the job. This is easier said than done, since any excessive application of pressure increases wear and tear of the instrument and may also cause damage to delicate or fragile jobs. The two jaws are shaped in such a manner that they can be used to measure both inside and outside dimensions. Notice the nibs, which can be used to measure inside dimension. Figure illustrates the method of measuring inside and outside dimensions using a vernier calliper. Whenever the vernier slides over the main frame, a depth-measuring blade also slides in and out of the beam of the calliper. This is a useful attachment for measuring depths to a high degree of accuracy. Divider setting holes are provided, which enable the use of a divider to aid the measurement process.

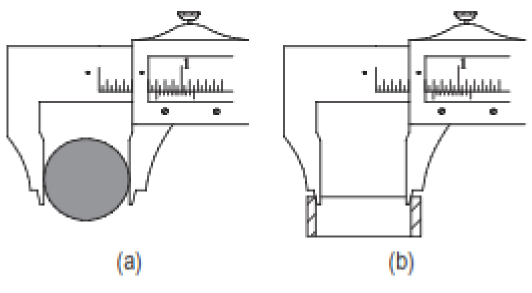

Fig. 2.13 Measurement of dimensions (a) Outside dimension (b) Inside dimension

[source: "Engineering Metrology & Measurements", N.V. Raghavendra., page-96]

Measuring a diameter is easier than measuring between flat surfaces, because the diameter is the greatest distance separating the reference and the measured points. Compared to the measurement between flat surfaces, the area of contact between the calliper and the job is much lesser in diameter measurement. Therefore, the resultant force acting either on the job or on the jaws of the calliper is lesser, with the result that there is no deformation or buckling of the jaws. This not only improves the accuracy of measurement, but also reduces the wear and tear of the instrument. Whether the measurement is done for the inside diameter or outside diameter, the operator has to rely on his/her feel to judge if proper contact is made between the measured surfaces and also that excessive force is not exerted on the instrument or the job. Continued closing of the calliper will increase the springing. High gauging pressure causes rapid wear of the jaws, burnishes the part (localized hardening of metal), and may cause damage to the calliper.

The following guidelines are useful for the proper use of a vernier calliper:

1. Clean the vernier calliper and the job being measured thoroughly. Ensure that there are no burrs attached to the job, which could have resulted from a previous machining operation.

2. When a calliper's jaws are fully closed, it should indicate zero. If it does not, it must be recalibrated or repaired.

3. Loosen the clamping screw and slide the movable jaw until the opening between the jaws is slightly more than the feature to be measured.

4. Place the fixed jaw in contact with the reference point of the feature being measured and align the beam of the calliper approximately with the line of measurement.

5. Slide the movable jaw closer to the feature and operate the fine adjustment screw to establish a light contact between the jaws and the job.

6. Tighten the clamp screw on the movable jaw without disturbing the light contact between the calliper and the job.

7. Remove the calliper and note down the reading in a comfortable position, holding the graduations on the scale perpendicular to the line of sight.

8. Repeat the measurement a couple of times to ensure an accurate measurement.

9. After completing the reading, loosen the clamping screw, open out the jaws, and clean and lubricate them.

10. Always store the calliper in the instrument box provided by the supplier. Avoid keeping the vernier calliper in the open for long durations, since it may get damaged by other objects or contaminants.

11. Strictly adhere to the schedule of periodic calibration of the vernier calliper.

2.2.2 Types of Vernier Calipers

According to Indian Standard IS: 3651-1974, three types of Vernier calipers have been specified to make external and internal measurements and are shown in figures respectively. All the three types are made with one scale on the front of the beam for direct reading.

2.2.2.1 Type A: Vernier has jaws on both sides for external and internal measurements and a blade for depth measurement.

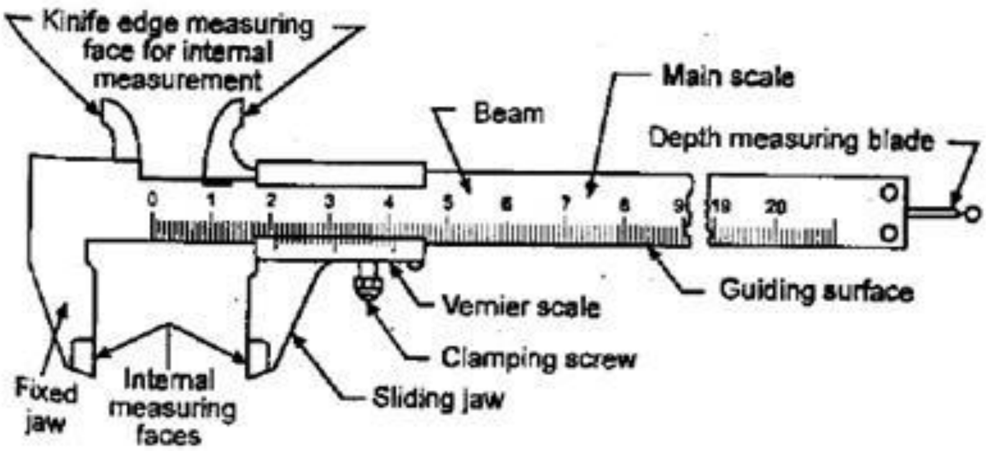

Fig 2.14 Type A Vernier Calipers

[source: https://www.brainkart.com/article/Vernier-Calipers_5819/]

2.2.2.2 Type B: It is provided with jaws on one side for external and internal measurements.

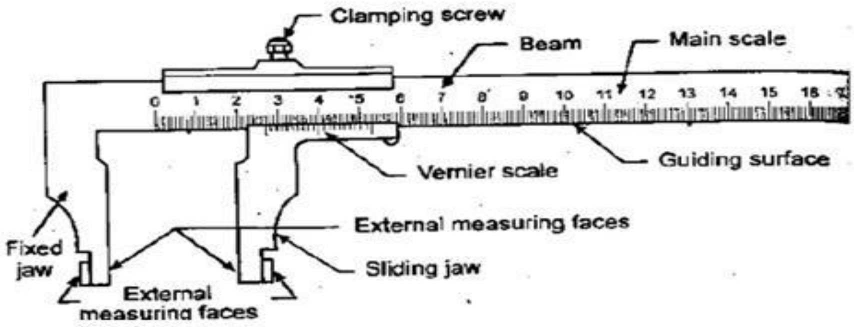

Fig 2.15 Type B Vernier Calipers

[source: https://www.brainkart.com/article/Vernier-Calipers_5819/]

2.2.2.3 Type C: It has jaws on both sides for making the measurement and for marking operations.

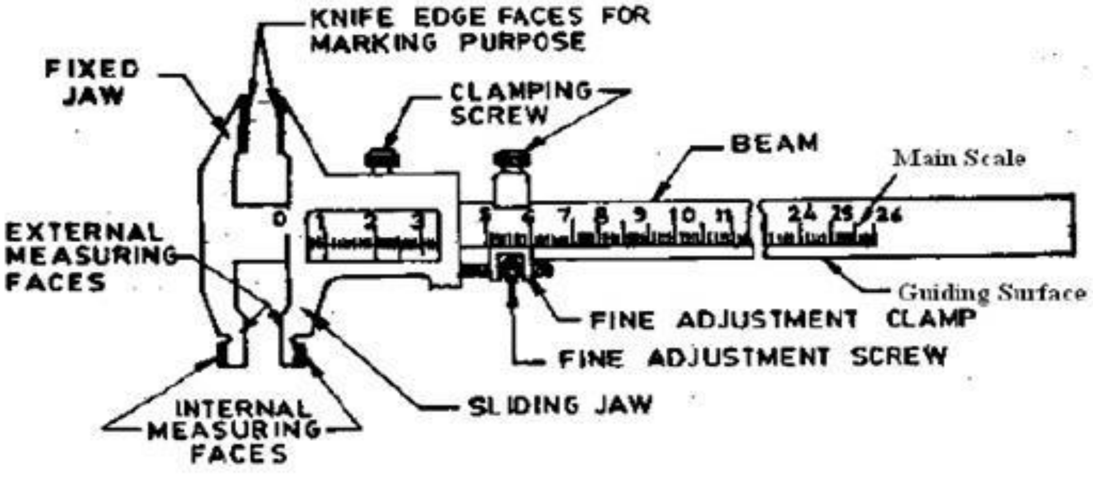

Fig 2.16 Type B Vernier Calipers

[source: https://www.brainkart.com/article/Vernier-Calipers_5819/]

2.2.3 Errors in Calipers

The degree of accuracy obtained in measurement greatly depends upon the condition of the jaws of the Calipers and a special attention is needed before proceeding for the measurement. The accuracy and natural wear, and warping of Vernier caliper jaws should be tested frequently by closing them together tightly and setting them to 0-0 point of the main and Vernier scales

2.2.4 Vernier Depth Gauge

A vernier depth gauge is a more versatile instrument, which can measure up to 0.01 mm or even finer accuracy. Figure 4.29 illustrates the constructional features of a vernier depth gauge. The lower surface of the base has to butt firmly against the upper surface of the hole or recess whose depth is to be measured. The vernier scale is stationary and screwed onto the slide, whereas the main scale can slide up and down. The nut on the slide has to be loosened to move the main scale. The main scale is lowered into the hole or recess, which is being measured.

One should avoid exerting force while pushing the scale against the surface of the job being measured, because this will not only result in the deformation of the scale resulting in erroneous measurements, but also accelerate the wear and tear of the instrument. This problem is eliminated thanks to the fine adjustment clamp provided with the instrument. A fine adjustment wheel will rotate the fine adjustment screw, which in turn will cause finer movement of the slide. This ensures firm but delicate contact with the surface of the job. Vernier depth gauges can have an accuracy of up to 0.01 mm. Periodic cleaning and lubrication are mandatory, as the main scale and fine adjustment mechanism are always in motion in the process of taking measurements.

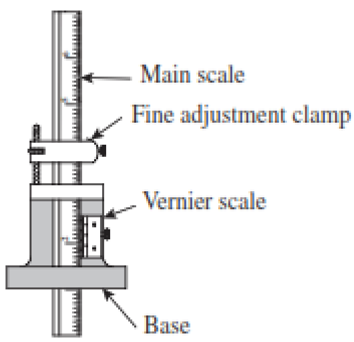

Fig. 2.17 Vernier depth gauge

[source: "Engineering Metrology & Measurements", N.V. Raghavendra., page-99]

2.2.5 Vernier Height Gauge

The graduated scale or bar is held in a vertical position by a finely ground and lapped base. A precision ground surface plate is mandatory while using a height gauge. The feature of the job to be measured is held between the base and the measuring jaw. The measuring jaw is mounted on a slider that moves up and down, but can be held in place by tightening of a nut. A fine adjustment clamp is provided to ensure very fine movement of the slide in order to make a delicate contact with the job. Unlike in-depth gauge, the main scale in a height gauge is stationary while the slider moves up and down. The vernier scale mounted on the slider gives readings up to an accuracy of 0.01 mm.

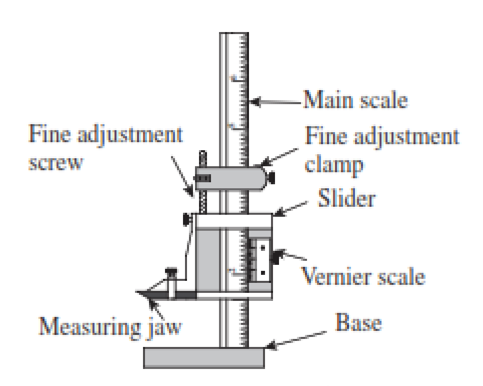

Fig. 2.18 Vernier height gauge

[source: "Engineering Metrology & Measurements", N.V. Raghavendra., page-99]

Vernier height gauges are available in sizes ranging from 150 to 500 mm for precision tool room applications. Some models have quick adjustment screw release on the movable jaw, making it possible to directly move to any point within the approximate range, which can then be properly set using the fine adjustment mechanism. Vernier height gauges find applications in tool rooms and inspection departments. Modern variants of height gauges such as optical and electronic height gauges are also becoming increasingly popular.