THEODOLITE: AN INTRODUCTION

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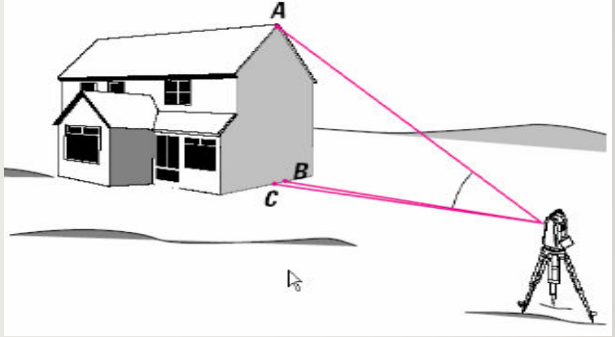
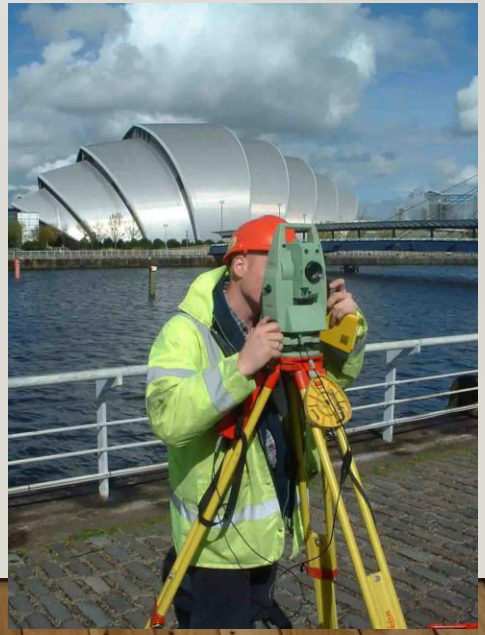
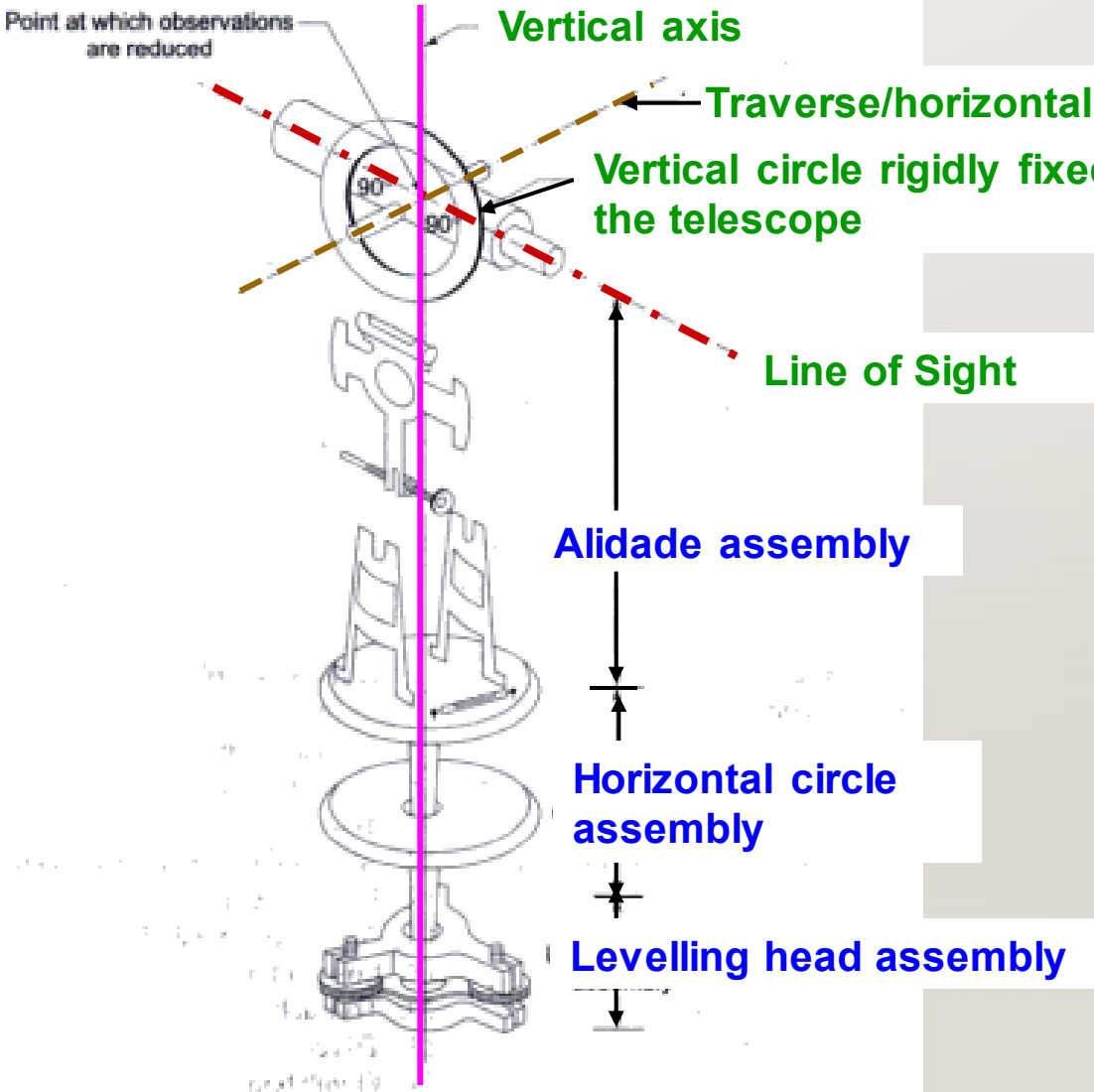
INTRODUCTION



- Theodolite is used to measure the horizontal and vertical angles.
- Theodolite is more precise than magnetic compass.
- Magnetic compass measures the angle up to as accuracy of 30'. However a vernier theodolite measures the angles up to and accuracy of 10",20".
- There are variety of theodolite vernier, optic, electronic etc.

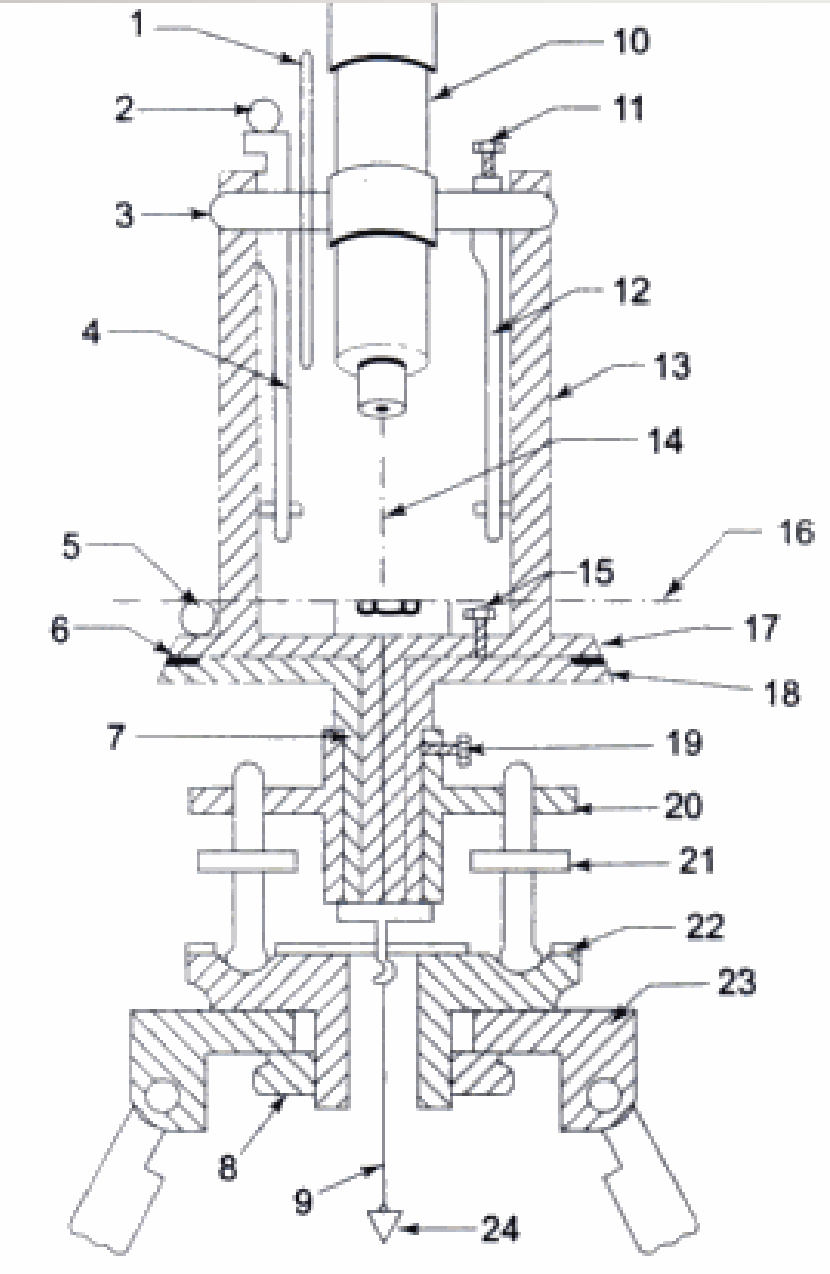
TYPE OF THEODOLITE





Three assemblies of Theodolite

- Vernier theodolite is also known and transit.
- A transit theodolite is one in which the telescope can be rotated in a vertical plane.

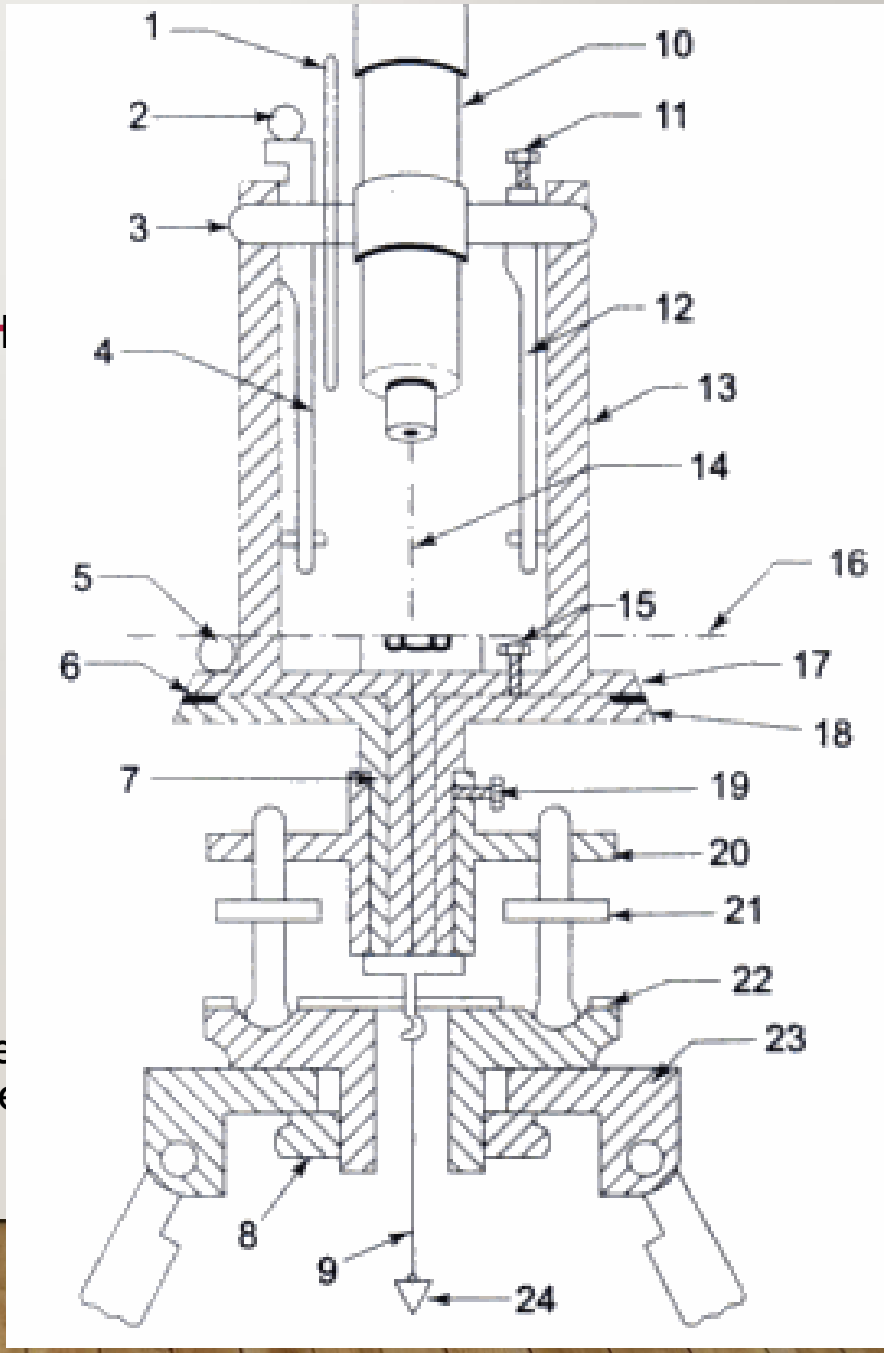


- **Main parts of a theodolite**
  - **Levelling head (7):** Levelling head is used to attach the instrument to tripod and attach the plumb bob along the vertical axis of the instrument.

1. Vertical circle
2. Altitude bubble
3. Horizontal axes
4. Vernier arm
5. Plate bubble
6. Graduated arc
7. Levelling head
8. Clamping nut
9. Vertical axis
10. Telescope
11. Vertical circle clamping screw
12. Arm of the vertical circle clamp
13. Standard
14. Line of sight
15. Upper plate clamping screw
16. Axis of plate bubble
17. Upper plate
18. Lower plate
19. Lower plate clamping screw
20. Tribrach
21. Foot screw
22. Trivet
23. Tripod top
24. Plumb bob

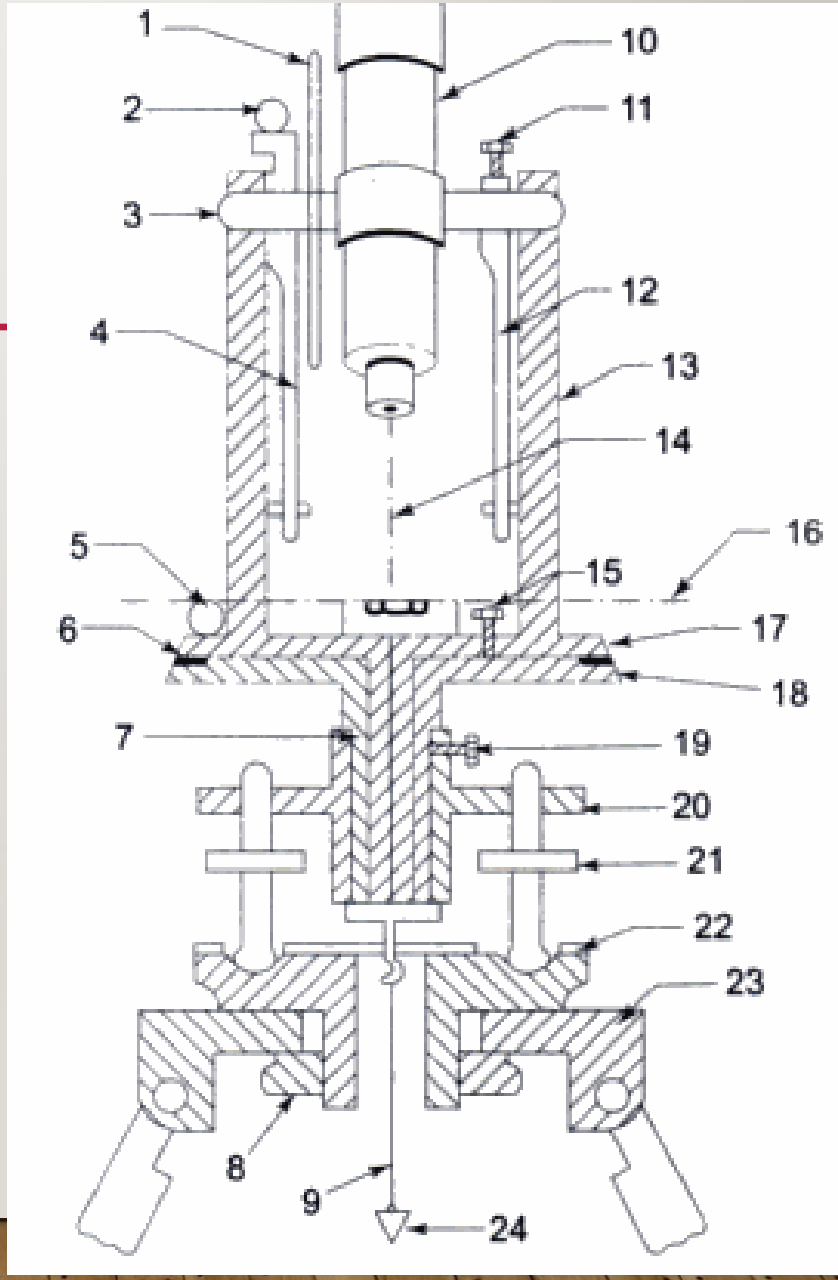
MAIN PARTS-2

- **Lower plate/circle plate (18):** an annular horizontal plate with the graduations provided all around, from 0 to 360°, in a clockwise direction. Th graduations are in degree divided in to 3 parts so that each division equals to 20 min.
- Horizontal angles are measured with this plate.
- The size of the theodolite is defined by the diameter of horizontal circle.
- **Upper plate (17):** Horizontal plate of smaller diameter provided with two verniers. on diametrically opposite parts of its circumference. These verniers are designated as A and B. They are used to read fractions of the horizontal circle plate graduations. The verniers are graduated in 20 min and each minute is divided in 3 to 5 parts making least count 20" or 10".



MAIN PARTS-3

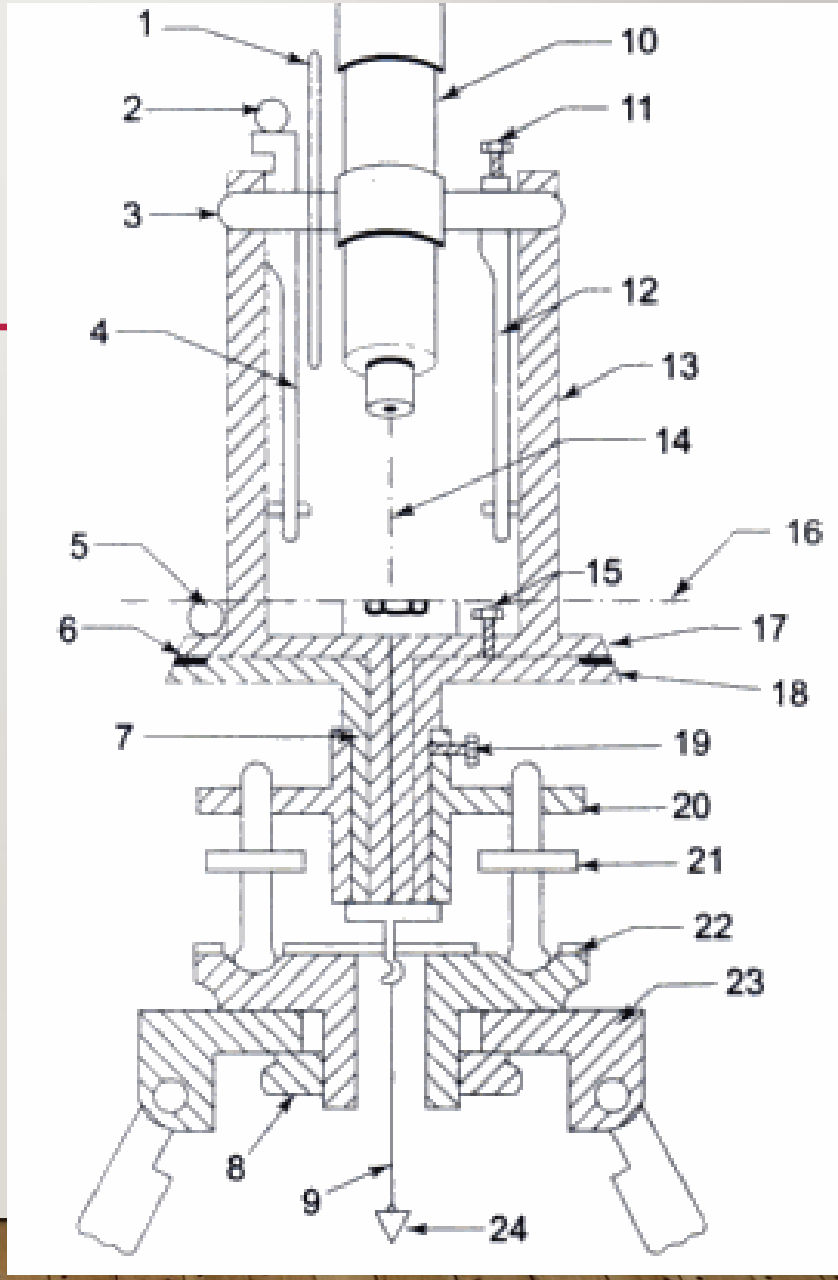
- **Clamps and tangent screws (15, 19):**
  - There are two clamps and associated tangent screws with the plate. These screws facilitate the motion of the instruments in horizontal plane.
  - Lower clamp screw locks or releases the lower plate. When this screw is unlocked both upper and lower plates move together. The associated lower tangent screw allows small motion of the plate in locked position.
  - The upper clamp screw locks or releases the upper vernier plate. When this clamp is released the lower plate does not move but the upper vernier plate moves with the instrument. This causes the change in the reading. The upper tangent screw allows the fine adjustment.



MAIN PARTS-4

- **Plate level (5):**
  - Spirit level with the bubble and graduation on glass cover.
  - A single level or two levels fixed in perpendicular direction may be provided.
  - The spirit level can be adjusted with the foot screw **(21)** of the levelling head **(7)**.

- **Telescope (10):** The essential parts of the telescopes are eye-piece, diaphragm with cross hairs, object lens and arrangements to focus the telescope.

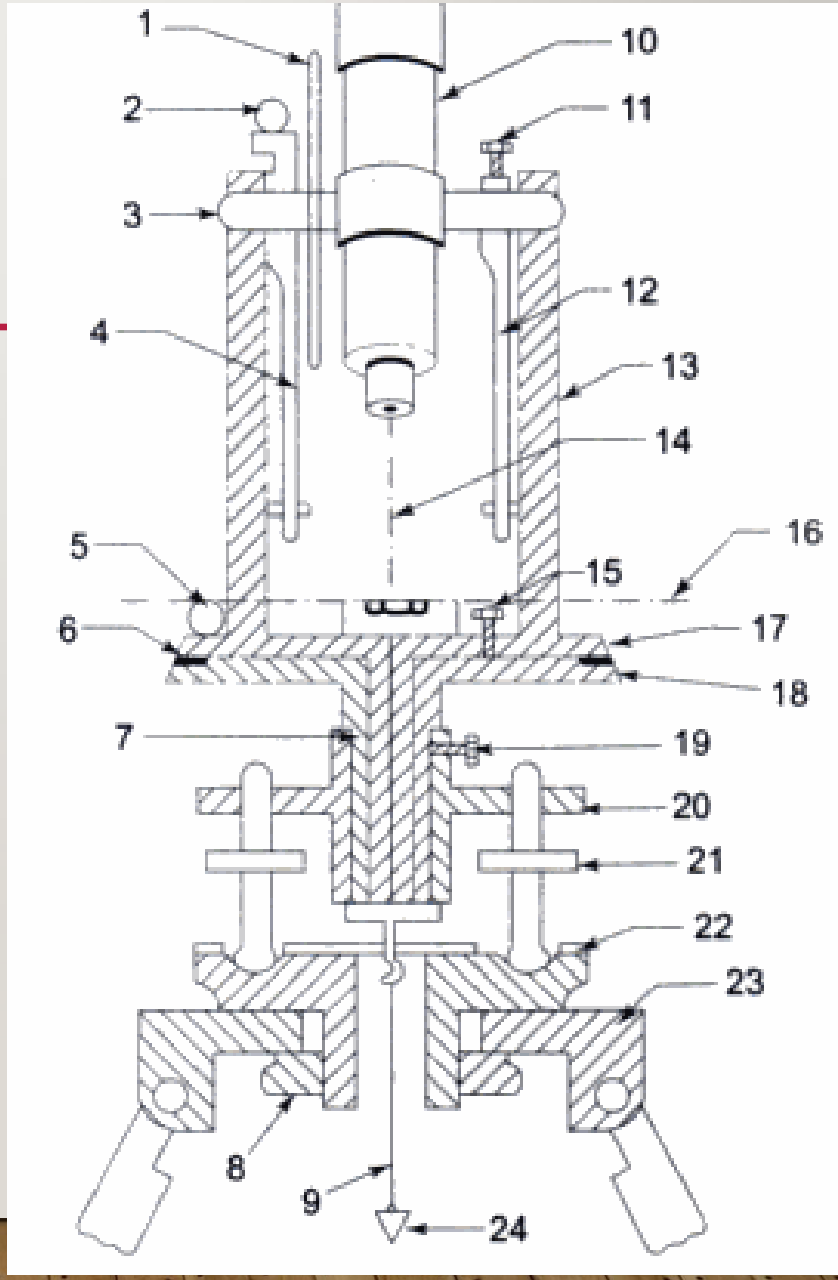


MAIN PARTS-5

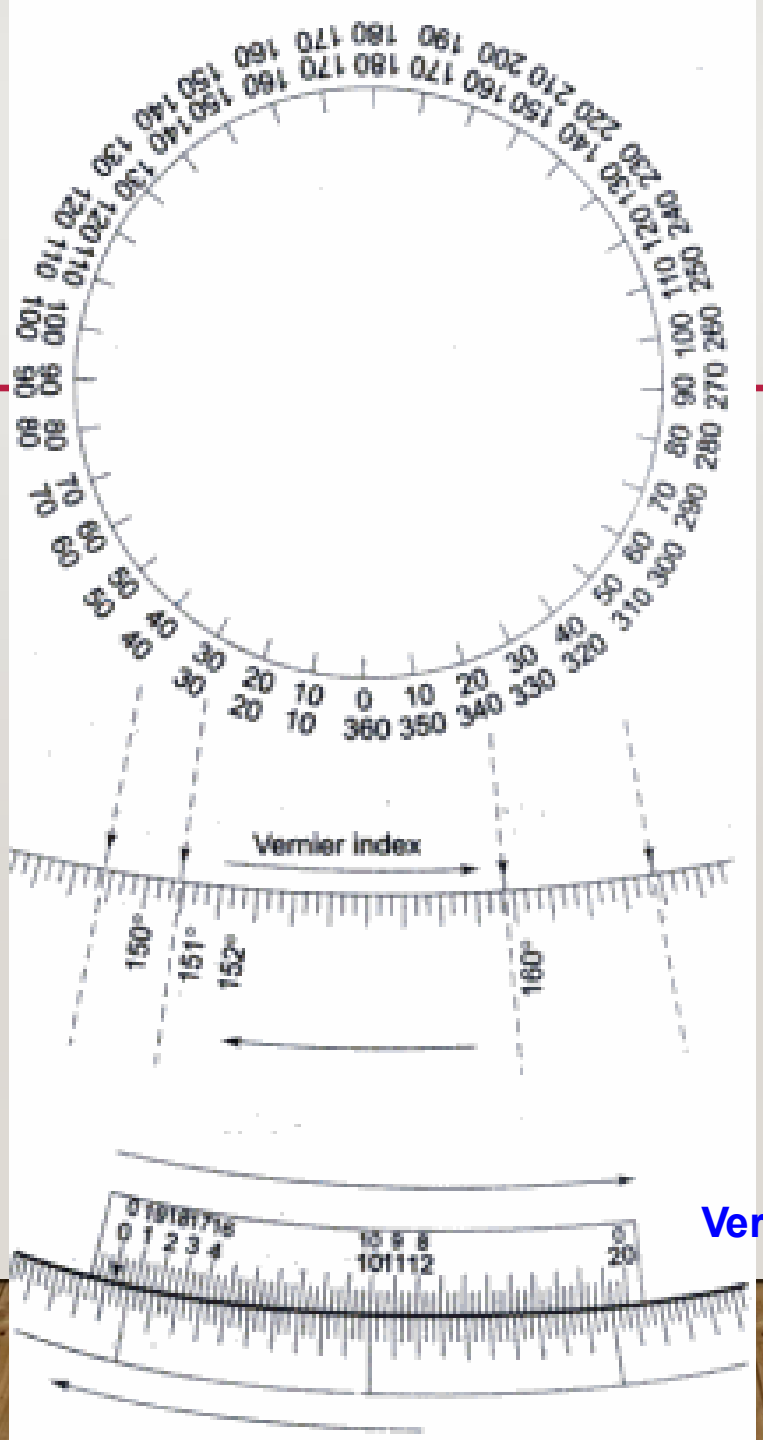
- **Vertical circle (1):** circular plate supported on horizontal axis of the instrument between the A-frames. Vertical circle has graduation 0-90 in four quadrants. Vertical circle moves with the telescope when it is rotated in the vertical plane.

- **Vertical circle clamp and tangent screw (11):** Clamping the vertical circle restrict the movement of telescope in vertical plane.

- **Altitude level (2):** A highly sensitive bubble is used for levelling particularly when taking the vertical angle observations.



Reading a theodolite



Vernier scale graduation

Important Definition

Face Right When the vertical circle of a theodolite is on the right of the observer, the position is called *face right* and the observation made is called face right observation.

Face Left When the vertical circle of a theodolite is on the left of the observer, the position is called *face left* and the observation made is called face left observation.

By taking the mean of both face readings, the collimation error is eliminated.

Changing face

- Revolving the telescope by 180° in vertical plane about horizontal axis
- Again revolving the telescope in horizontal plane about vertical axis.

Adjustment of the theodolite

- **Temporary Adjustment**

1. The levelling screws are at the centre of their run.
2. The shifting head of the theodolite is at its centre so that equal movement is possible in all the directions.
3. The wing nuts on the tripod legs are tight enough so that when raised, the tripod legs do not fall under their own weight.

Centring This involves setting the theodolite exactly over the station mark or on the station peg. It is done by the following steps:

1. The plumb bob is suspended from a small hook attached to the vertical axis of the theodolite.
2. The instrument is placed over the station mark with the telescope at a convenient height and with the tripod legs set well apart.
3. Two legs of the tripod are set firmly into the ground and the third leg is moved radially to bring the plumb bob exactly over the station mark. Then the third leg is also pushed into the ground.
4. If the instrument has a shifting head, the instrument is roughly centred over the station mark and then by means of the shifting head, the plumb bob is brought exactly over the station mark.

Approximate levelling This implies levelling the instrument with the legs of the tripod, i.e. by bringing the small circular bubble provided on the tribrach in the centre. To achieve this, two of the tripod legs are pushed firmly into the ground and the third leg of the tripod is moved to the right or to the left, i.e. in the circumferential direction until the bubble is centred. This leg is then pushed into the ground.

4.9.2 Levelling up

This means making the vertical axis truly vertical. This is done with the help of the foot screws. The procedure is as follows:

1. The longer plate level is brought parallel to any two foot screws.

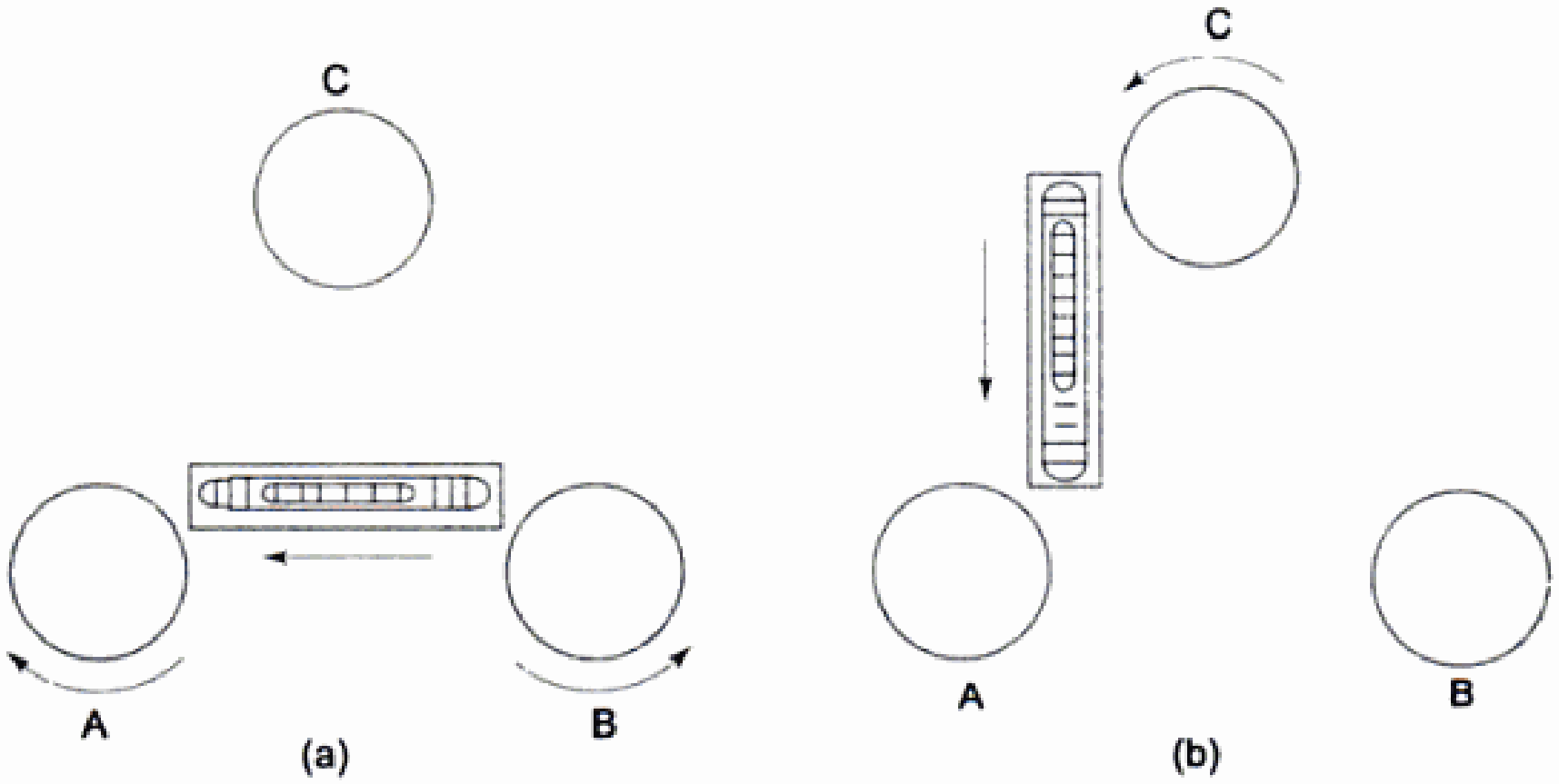


Fig. 4.4 Levelling with three foot screws

In the case of a three screw levelling head, the other plate level will then be parallel to the line joining the third foot screw and the mid-point of the line joining the first two foot screws, as shown in Fig. 4.4.

2. Bring the bubble of the longer plate level to the centre of its run by moving the two foot screws, say A and B, uniformly either inwards or outwards (Fig. 4.4(a)). It may be noted that the bubble always moves in the direction of the left thumb as the surveyor turns the screw.
3. Move the third foot screw C so that the bubble in the other plate level is centred (Fig. 4.4(b)).

4.9.3 Focussing

It consists of focussing the eyepiece and the objective.

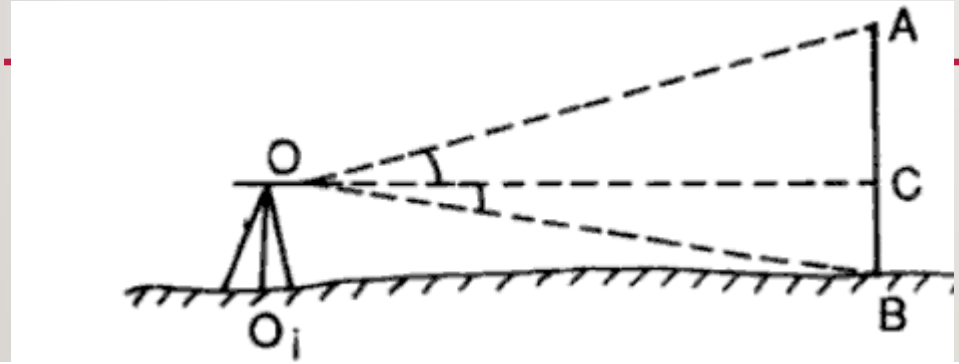
Focussing the eyepiece This operation is done to make the cross-hairs appear clearly visible. The following steps are involved:

1. The telescope is directed towards the sky or a sheet of white paper held in front of the objective.
2. The eyepiece is moved in or out until the cross-hairs appear clear and distinct.

Focussing the objective This operation is done to bring the image of the object in the plane of the cross-hairs. The following steps are involved:

1. The telescope is directed towards the object.
2. The focussing screw is turned until the image appears clear and sharp.

Vertical angle measurement- I



1. The theodolite is set up at O. It is centred and levelled properly. The zeros of the verniers (generally C and D) are set at the 0°–0° mark of the vertical circle (which is fixed to the telescope). The telescope is then clamped.
2. The plate bubble is brought to the centre with the help of foot screws (in the usual manner). Then the altitude bubble is brought to the centre by means of a clip screw. At this position the line of collimation is exactly horizontal.
3. To measure the angle of elevation, the telescope is raised slowly to bisect the point A accurately. The readings on both the verniers are noted, and the angle of elevation recorded.

Vertical angle measurement-2

4. The face of the instrument is changed and the point A is again bisected. The readings on the verniers are noted. The mean of the angles of the observed is assumed to be the correct angle of elevation.
5. To measure the angle of depression, the telescope is lowered slowly and the point B is bisected. The readings on the verniers are noted for the two observations (face left and face right). The mean angle of the observation is taken to be the correct angle of depression. The result is tabulated as shown in Table 9.4.