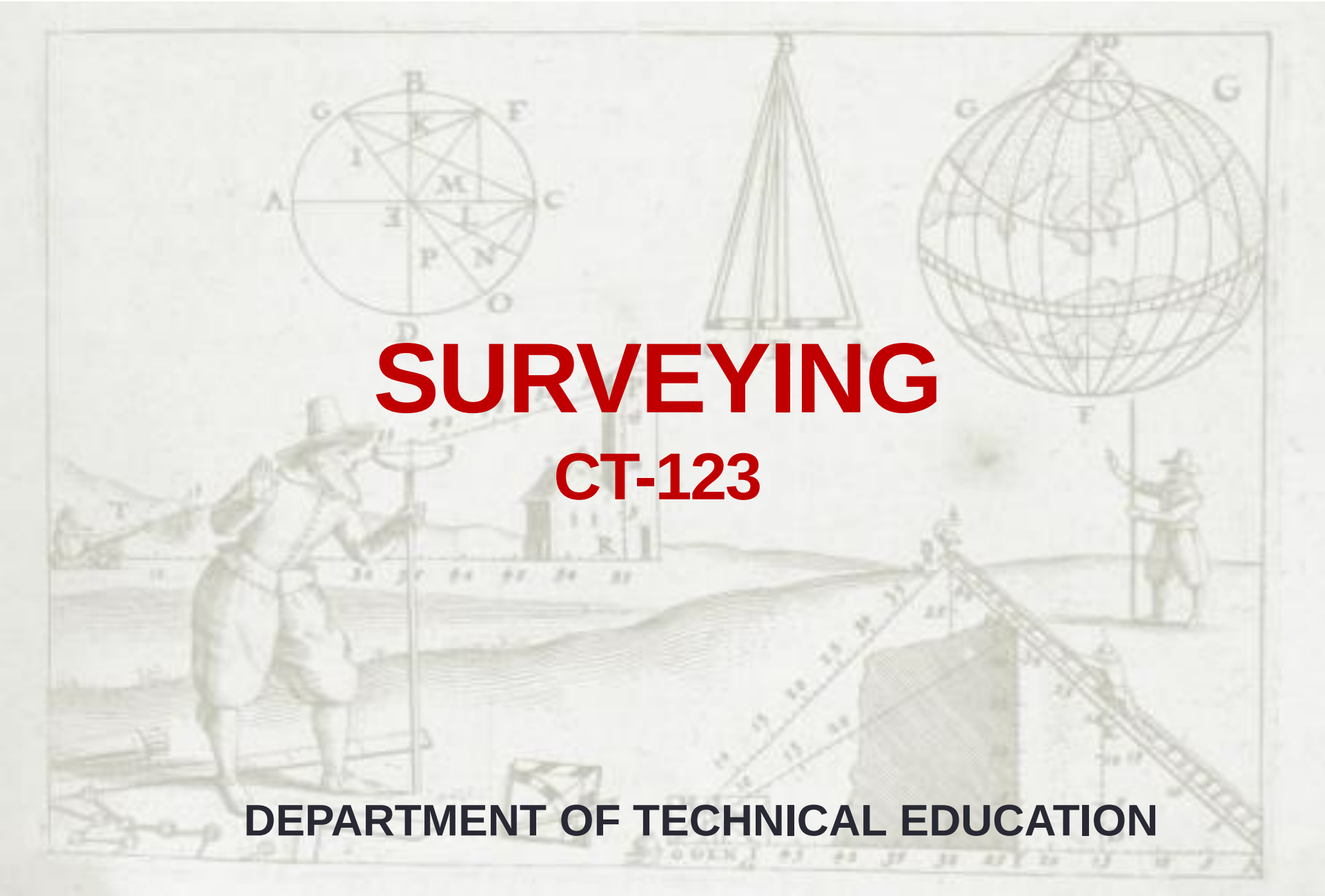

SURVEYING

CT-123

DEPARTMENT OF TECHNICAL EDUCATION

- **Course Instructor**

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Objectives

- To impart basic surveying knowledge to the students of Civil Engineering to give them an understanding of this subject so that they must be able to develop an ability to translate survey information for design and construction purposes.

- To develop skills for practical handling of survey instruments like Theodolite, Total Stations, Electronic Levels, staff rod etc.

Course Outlines

1. Study and use of conventional surveying instruments and EDM devices.
2. Triangulation.
3. Traversing.
4. Introduction and use of Total station.
5. Introduction to GPS.
6. Leveling.
7. Contouring.
8. Techeometry.
9. Setting out curves (horizontal and vertical).
10. Hydrographic Surveying.
11. Introduction to true north, latitude, longitude and time.

Recommended Books

1. Handouts by Instructor
2. SURVEYING Principles & Applications by Barry F. Kavanagh
3. SURVEYING AND LEVELLING by T.P Kanetkar & S.V Kulkarni

Marks Distribution

- Sessional - 20%
  - Assignments – 10%
  - Quiz – 10 %
- Mid Term - 30%
- Final Exam - 50%

Study and use of conventional surveying instruments

LECTURE-1

Survey Instruments

- Surveying is defined as the science of determining the dimensions and contour of the earth's surface by the measurements of distance, directions and elevations

- Surveying has three different components, measuring distance, angles and elevation.

- Listed are the various types of surveying equipment and their uses.

Chains

- Chains are used to measure distances on the field.

- **Different types of Chains:**

1. Gunter’s chain
2. Engineer’s chain
3. Revenue chain
4. Metric chain

GUNTER'S CHAIN

- Gunter's chain, named after its inventor, is 66 ft. long and it is divided into 100 links; each of 0.66 ft. long. It is very convenient for measuring distance in miles, furlong and for measuring land when the unit of the area is an acre on account of its simple relation to the mile and acre.
  - 10 Gunter's chains = 1 furlong
  - 80 Gunter's chains = 1 mile
  - 10 Square Gunter's chain = 1 Acre
- Distance measured with the Gunter's chain is recorded in chains and decimals e.g., 9.37 chains/chain and links. i.e.,9 chains & 37 links.

REVINUE CHAIN

- It is 33 ft long and divided into 16 links each 2 $^{1/16}$ or 2.0625 ft long

ENGINEER'S CHAIN

- It is 100 ft long and divided into 100 links; each link equals to 1 ft. It is used in all engineering surveys when long lines are to be measured.
- It is most accurate than the Gunter's chain because of the greater length.
- The distance measured with engineer's chain is recorded in feet & decimals.

METERIC CHAIN

- It consists of 20 meter or 30 meter length divided into 100 or 150 links respectively. Length of each link is 20 cm.

Tapes

- Tapes are also used to measure distances.
- Tapes come in a variety of lengths and materials. For engineering work the lengths are generally 10m, 30m, 50m and 100m.
- Various materials of tapes includes linen, steel, cloth, invar (35% Nickel and 65% Steel).

Arrows

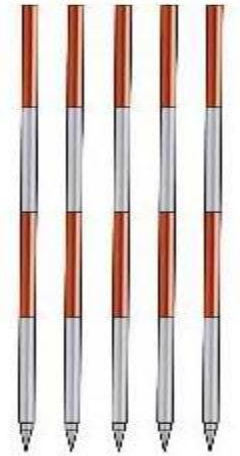
- Arrows are made of good quality hardened steel wire of 4 mm diameter. The arrows are made 400 mm in length, are pointed at one and the other end is bent into a loop or circle

- They are also called as marking or chaining pins and are used to mark the end of chain during the process of chaining.

- They are pointed at one end of inserting in to the ground. The other end is in to a ring.

Ranging rods

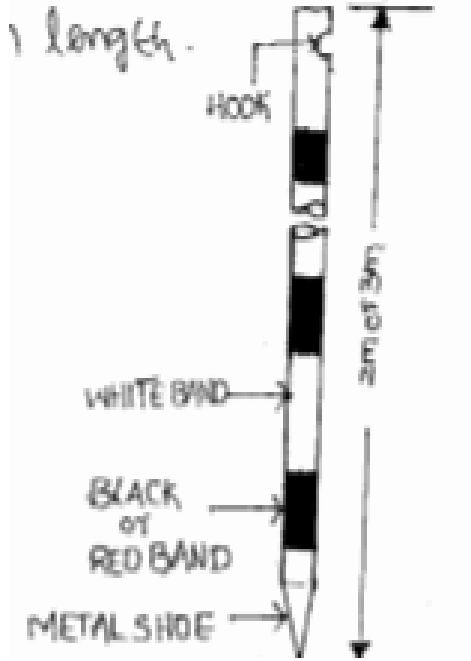
- Ranging rods are used to range some intermediate points in the survey line The length of the ranging rod is either 2m or 3m.
- Ranging rods are divided into equal parts 0.2m long and they are painted alternately black and white or red and white or red, white and black.
- When they are at considerable distance, red and white or white and yellow flags about 25 cm square should be fastened at the top.



Offset rod

- The offset rod is used for measuring the off set of short lengths. It is similar to a ranging rod and is usually of 3m lengths

- Top is an provided with an open ring for puling or pushing the chain through a hedge



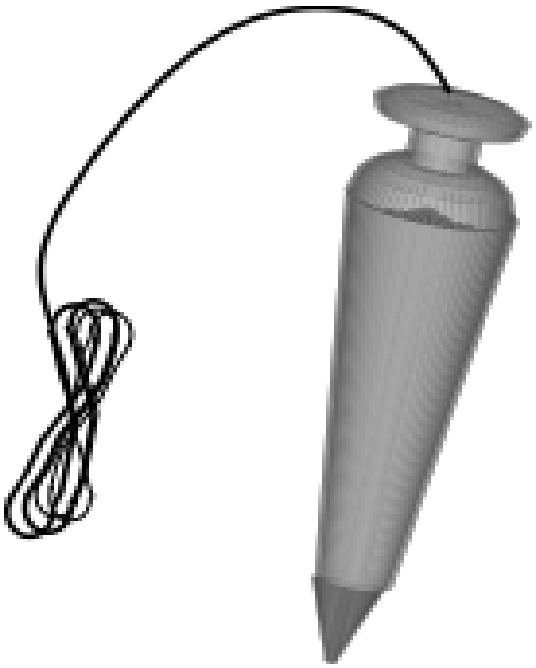
Pegs

- These are used to mark the positions.
- They are made of hard timber and tapered at one end.
- They are usually, 2.5 cm square and 15 cm long. But in soft ground 40 to 60 cm long and 4 to 5 cm square is suitable.
- They should be driven in the ground with about 4 cm lengths, projecting above the ground

Plumb bob

- The plumb bob is required when measuring the distance along slopes in order to transfer points to the ground.

- It is also used for testing the verticality of ranging poles.



The Compass

- A surveyor uses a compass to determine the direction of a line.
- The compass needle points to the magnetic north pole and by turning the compass in the direction of the line being surveyed, the direction of the line can be observed.

- There are two types of compasses:-
- 1) prismatic compass
- 2) surveyor’s compass.

Prismatic compass

- Prismatic compass is very valuable instrument. It is usually used for rough survey for measuring bearing and survey lines.
- The prismatic compass is a magnetic compass which consists of the following parts.

- **Cylindrical Metal Box**
- Cylindrical metal box is having diameter of 8 to 12 cm. It protects the compass and forms entire casing or body of the compass.
- It protects compass from dust, rain etc.
- **The Prismatic Compass Pivot**
- Pivot is provided at the center of the compass and supports freely suspended magnetic needle over it.

- **Magnetic Needle**
- Magnetic needle is the heart of the instrument. This needle measures angles of a line from magnetic meridian a the needle always remains pointed towards north and south pole at the two ends of the needle when freely suspended on any support.

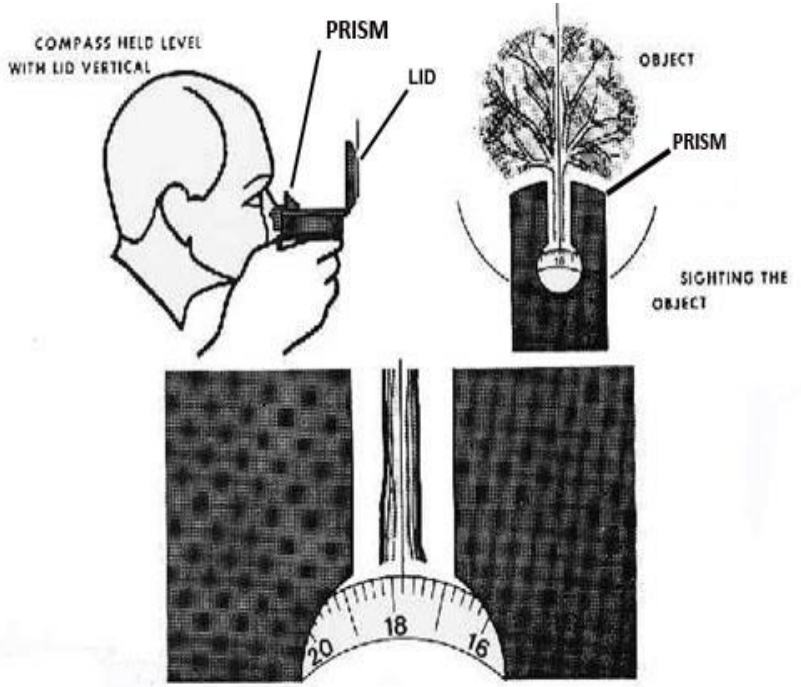
- **Graduated Circle or Ring**
- This is an aluminum graduated ring marked with 0^{0} to 360^{0} to measure all possible bearings of lines, and attached with the magnetic needle.

- The ring is graduated to half a degree.

- **Prism**
- Prism is used to read graduations on ring and to take exact reading by compass.
- It is placed exactly opposite to object vane. The prism hole is protected by prism cap to protect it from dust and moisture.

- **Object Vane**
- Object Vane is diametrically

opposite to the prism and eye vane. The object vane is carrying a horse hair or black thin wire to sight object in line with eye sight.



- **Glass Cover**
- It covers the instrument box from the top such that needle and graduated ring is seen from the top.

- **Reflecting Mirror**
- It is used to get image of an object located above or below the instrument level while bisection. It is placed on the object vane.

Working of the Prismatic Compass

- When the needle of the compass is suspended freely. It always points towards the north.

- Therefore, all the angles measured with prismatic compass are with respect to north (magnetic meridian).

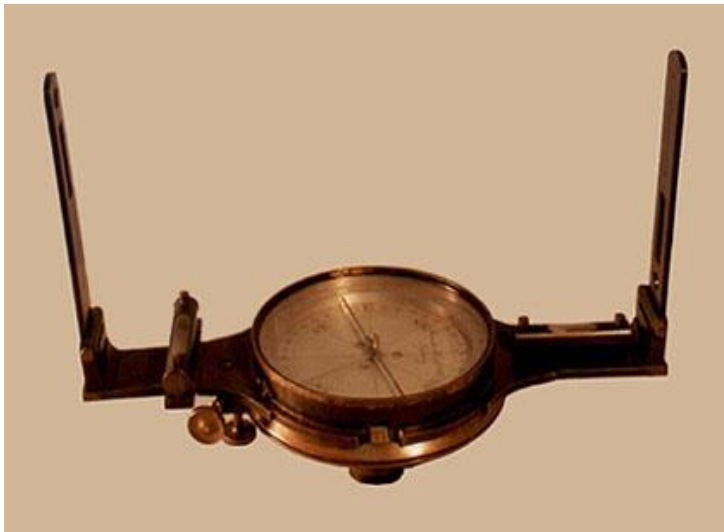
“The horizontal angle made by a survey line with reference to magnetic meridian in clockwise direction is called the bearing of a line.’

- While using the compass, it is usually mounted on a light tripod which is having vertical spindle in the ball and socket arrangement to which the compass is screwed.

Surveyor’s compass.

- The surveyors compass is similar to a prismatic compass except it has another plain sight having a narrow vertical slit in place of prism and eye hole.

- This compass is having pointed magnetic needle in place of broad form needle as in case of prismatic compass.



Differences between prismatic and surveyors compass.

	Prismatic compass	*Surveyor's compass*
1.	Graduation circle is fixed to broad needle type needle. Hence, it will not rotate with the line of sight.	Graduation circle is fixed to the box. Hence, it rotates with the line of sight.
2.	There is a prism at viewing end.	At viewing end there is no prism. There is only a slit.
3.	Sighting and reading can be done simultaneously.	Sighting and viewing cannot be done simultaneously.
4.	The graduations are in whole circle bearing.	The graduations are in quadrantal system.
5.	Graduations are marked inverted since its reflection is read through prism.	Graduations are marked directly. They are not inverted.
6.	The reading is taken through a prism.	The reading is taken by directly viewing from top glass.
7.	Tripod may or may not be used. It can be held on a stretched hand also.	Tripod is essential for using it.

Leveling instruments

- The instrument which are directly used for leveling operation are:-

  - Level
  - Levelling staff

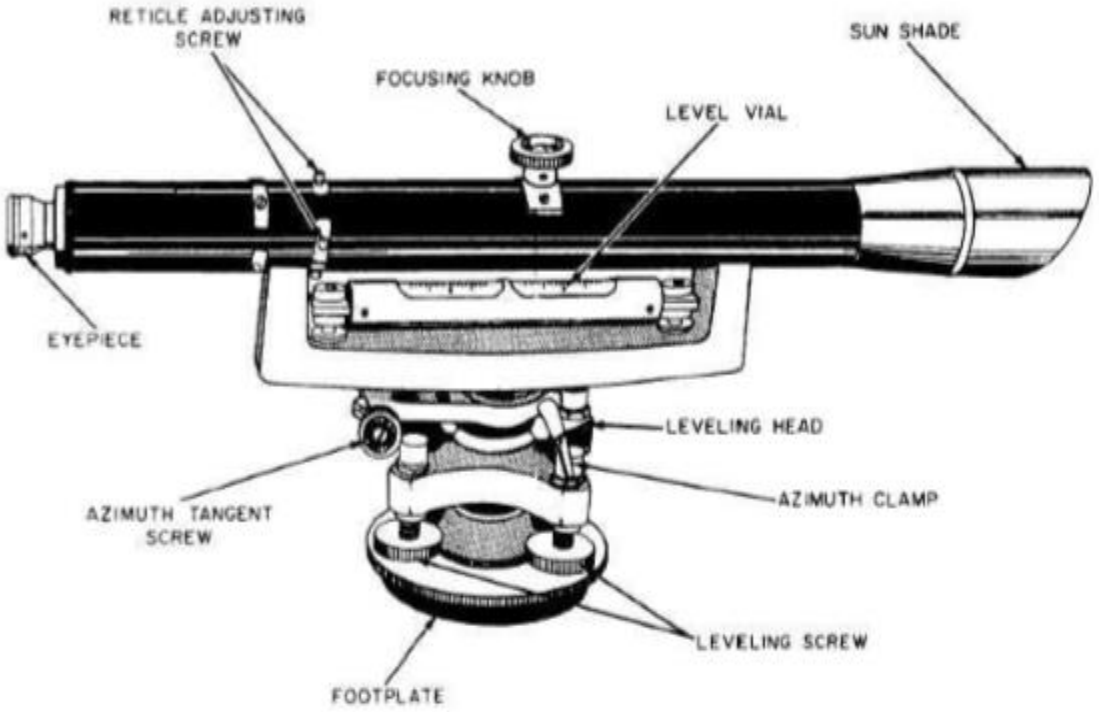
- **Level**
- An instrument which is used for observing staff reading on leveling staff kept over different points after creating a line of sight is called a level.

Types of Level

1. Dumpy level
2. The wye or Y level
3. The tilting level
4. The automatic level

Dumpy level

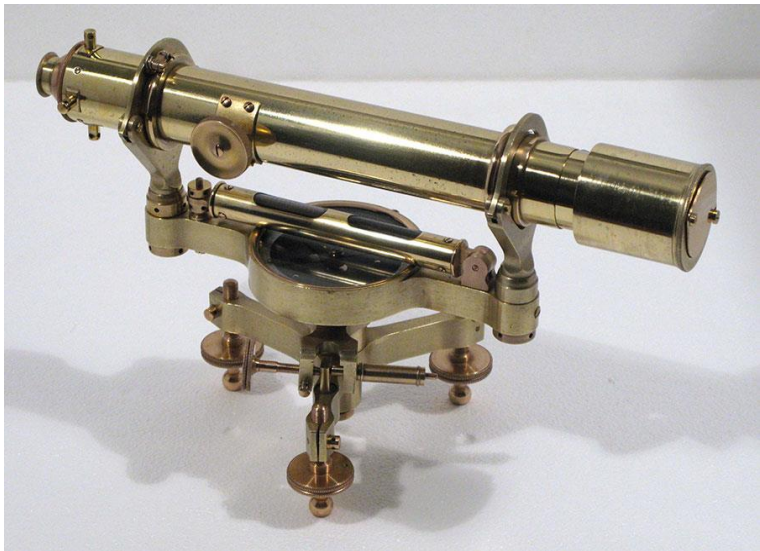
- The dumpy level is simple compact and stable .the telescope is rigidly fixed to its supports and therefore can neither be rotated about its longitudinal axis nor can it be removed from supports.it has greater stability of adjustments than the Y level.



Dumpy Level

The Wye or Y level

- The wye level is so named because the telescope is held in Y-shaped supports which are attached to the ends of a horizontal bar.
- The instrument is so constructed that the telescope may be changed end-for-end in the Y's and thus be readily reversed for adjusting.
- Attached and parallel to the telescope is a sensitive spirit level for leveling the instrument.



The Tilting Level

- In case of this instrument the telescope has a small motion about a horizontal axis.
- It is there fore known as tilting level. It is mainly designed for precise leveling work.

The Automatic level

- The automatic level is designated as self aligning level is a recent development.
- An "automatic" level is basically a dumpy level, but it has a built in compensator that automatically adjusts for minor errors in the set up of the instrument.

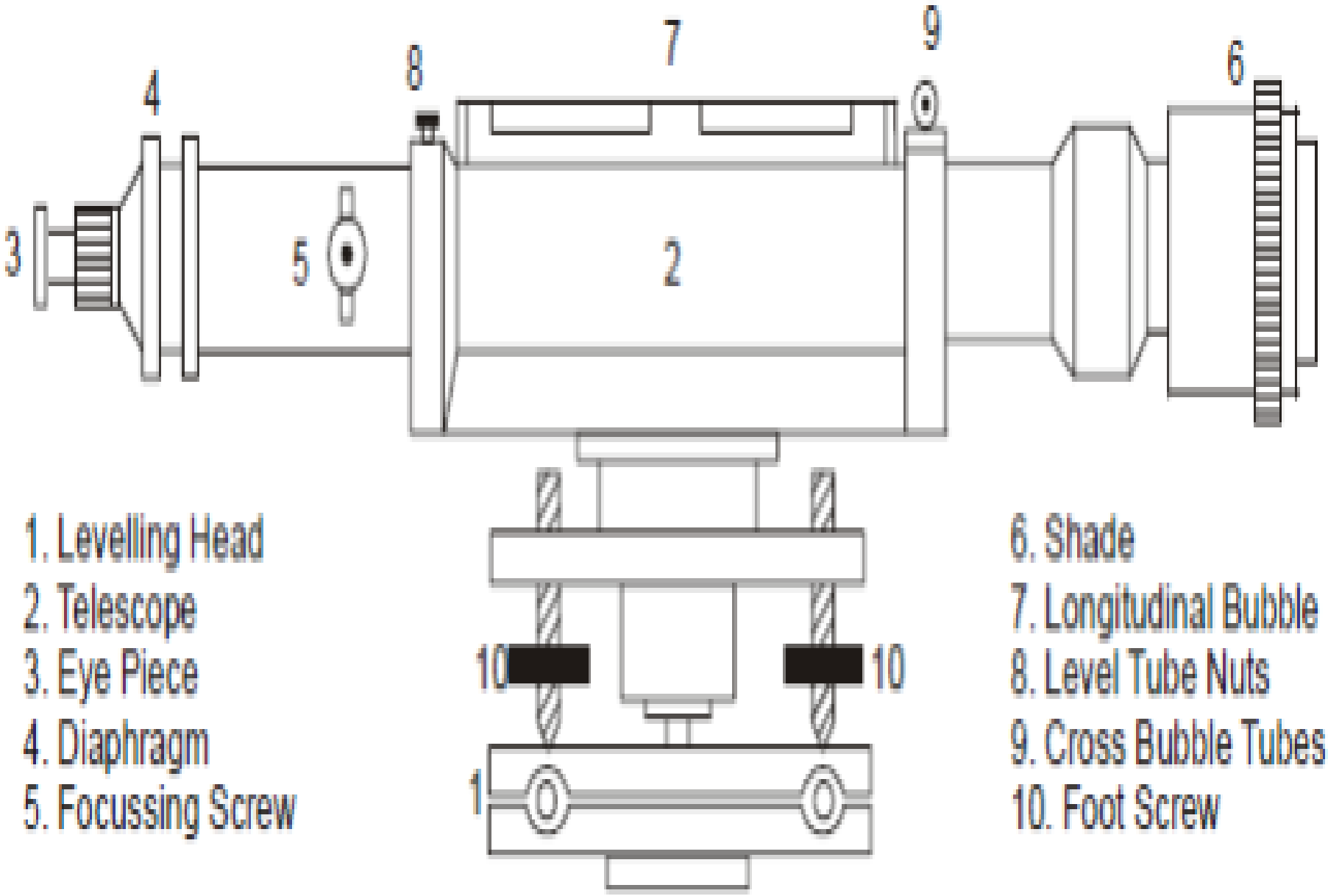
The Major Components Of A Dumpy Level

- **TELESCOPE:**
- It contains of two metal tubes, one of which slides within the other one tube carries the object glass and the second one carries eyepiece and diaphragm.
- **FOCUSSING SCREW:**
- The telescope is focused by turning the focusing screw either forward or backward.
- **BUBBLE TUBES:**
- The telescope is attached with two bubble tubes. One is longitudinal and the other is cross bubble tube. These two are placed at right angles to each other.
- **DIAPHRAGM:**
- It carries cross hairs.

The Major Components Of A Dumpy Level

- **TRIBRACH & TRIVET**
- The telescope with vertical spindle is supported by two parallel triangular plates. The upper plate is called tribrach and the lower plate is called trivet

- **FOOT SCREWS**
- By turning the foot screws, the tribrach can be raised or lowered to bring the bubble to the center of its run.



1. Levelling Head
2. Telescope
3. Eye Piece
4. Diaphragm
5. Focussing Screw
6. Shade
7. Longitudinal Bubble
8. Level Tube Nuts
9. Cross Bubble Tubes
10. Foot Screw

Level staff

- A **level staff**, also called **leveling rod**, is a graduated wooden or aluminum rod, the use of which permits the determination of differences in elevation.

Tripod

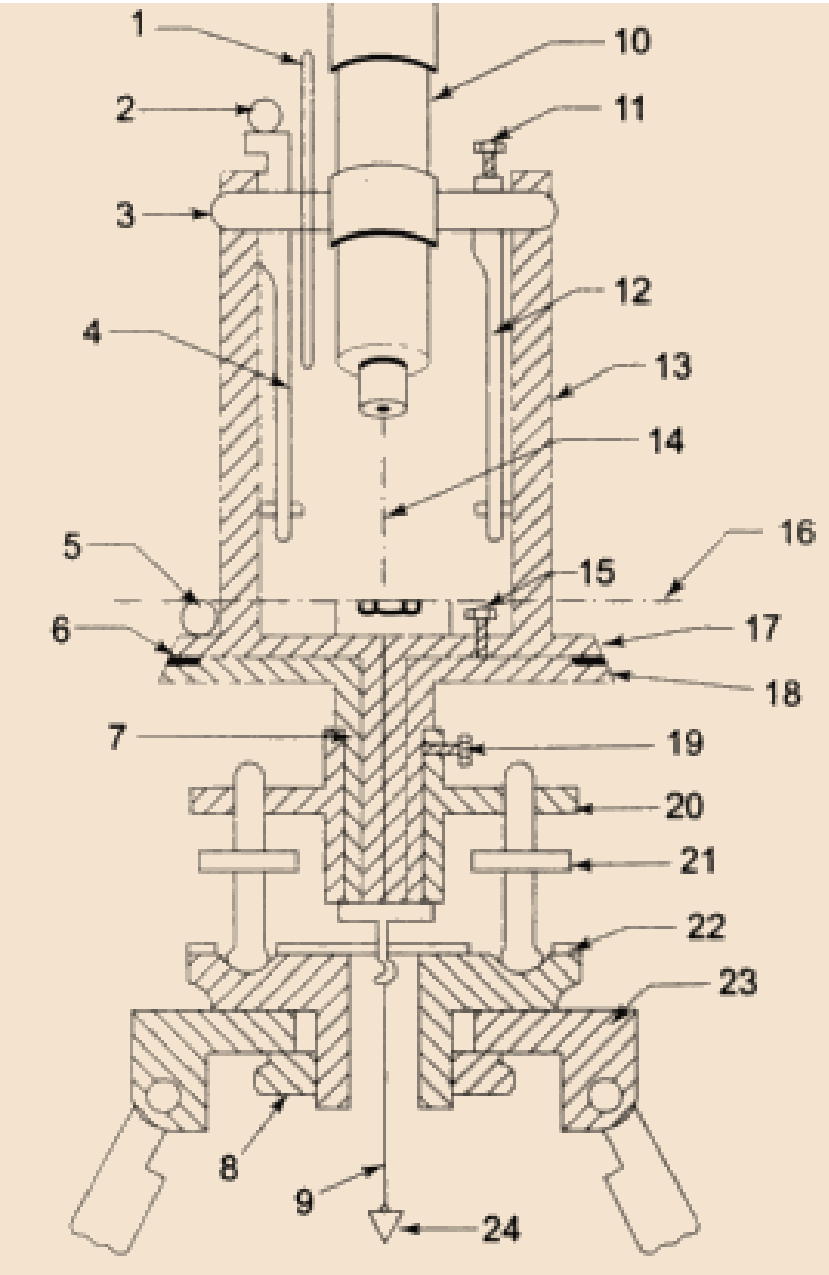
- A surveyor's tripod is a device used to support any one of a number of surveying instruments, such as theodolite, total stations ,levels or transits.

Theodolite

- Theodolite is an instrument designed for the measurement of horizontal and vertical angle.
- It is most precise method it is also used for laying of horizontal angles
- Locating points on line prolonging the survey line establishing the gradient, determination of difference in the elevation setting out curve .
- Theodolite are of two types transit and non transit. Transit theodolite is commonly used now a days .
- in transit theodolite telescope can be revolved a complete revolution about its horizontal axis in a vertical plane.

Digital Theodolite

- This type of theodolite provides the value of observation directly in viewing panel. The precision of this type of instrument varies in the order of **1" to 10".**



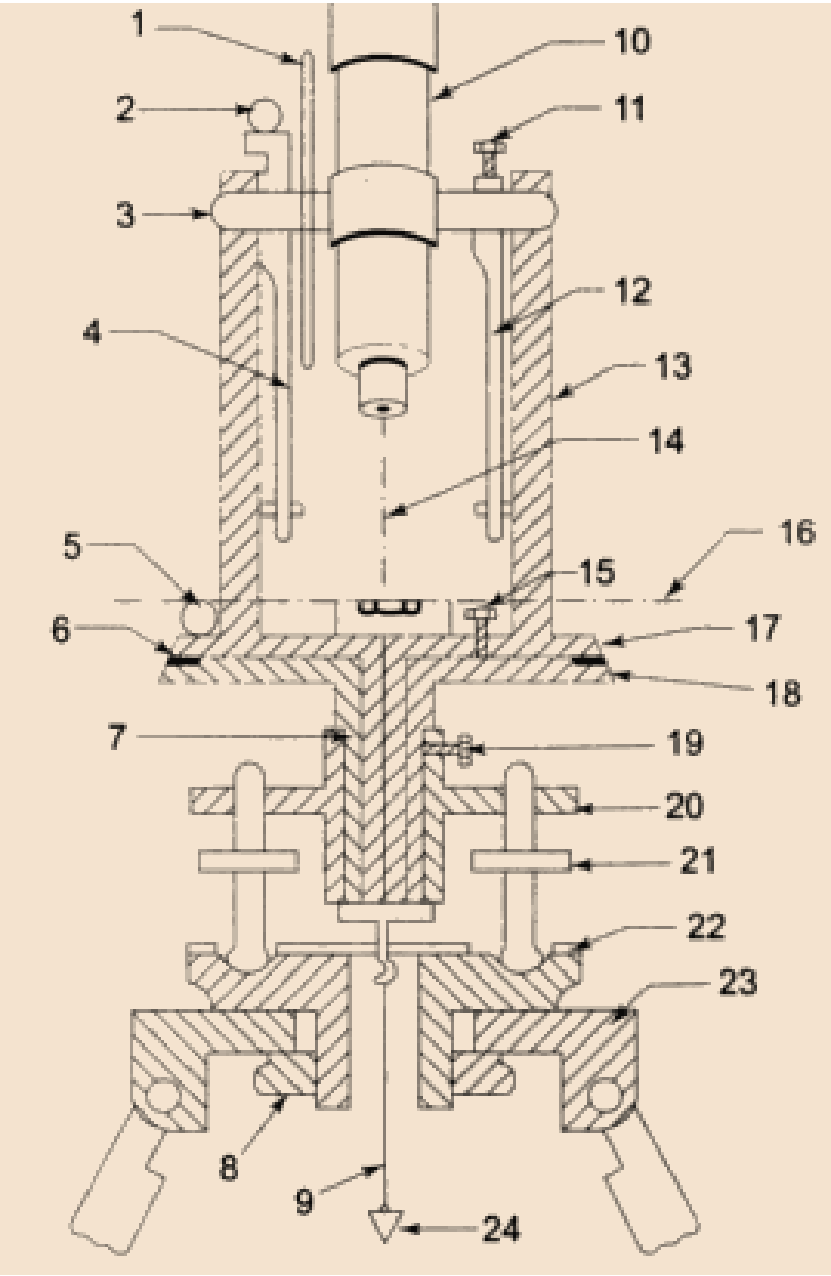
MAIN PARTS

- **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

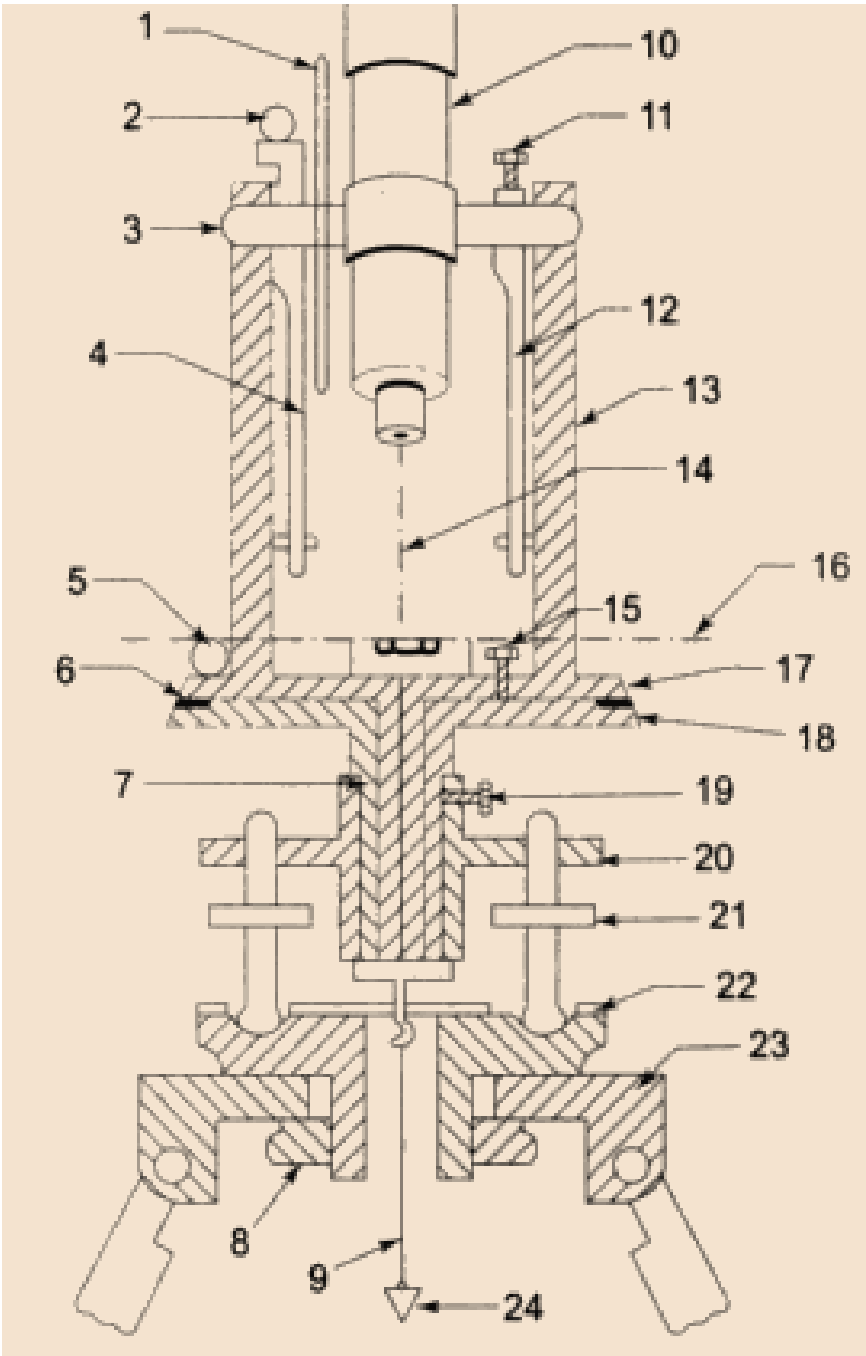
MAIN PARTS

- **Lower plate/circle plate (18):** an annular horizontal plate with the graduations provided all around, from 0 to 360°, in a clockwise direction. The graduations are in degree divided in to 3 parts so that each division equals to 20 minutes.
- 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

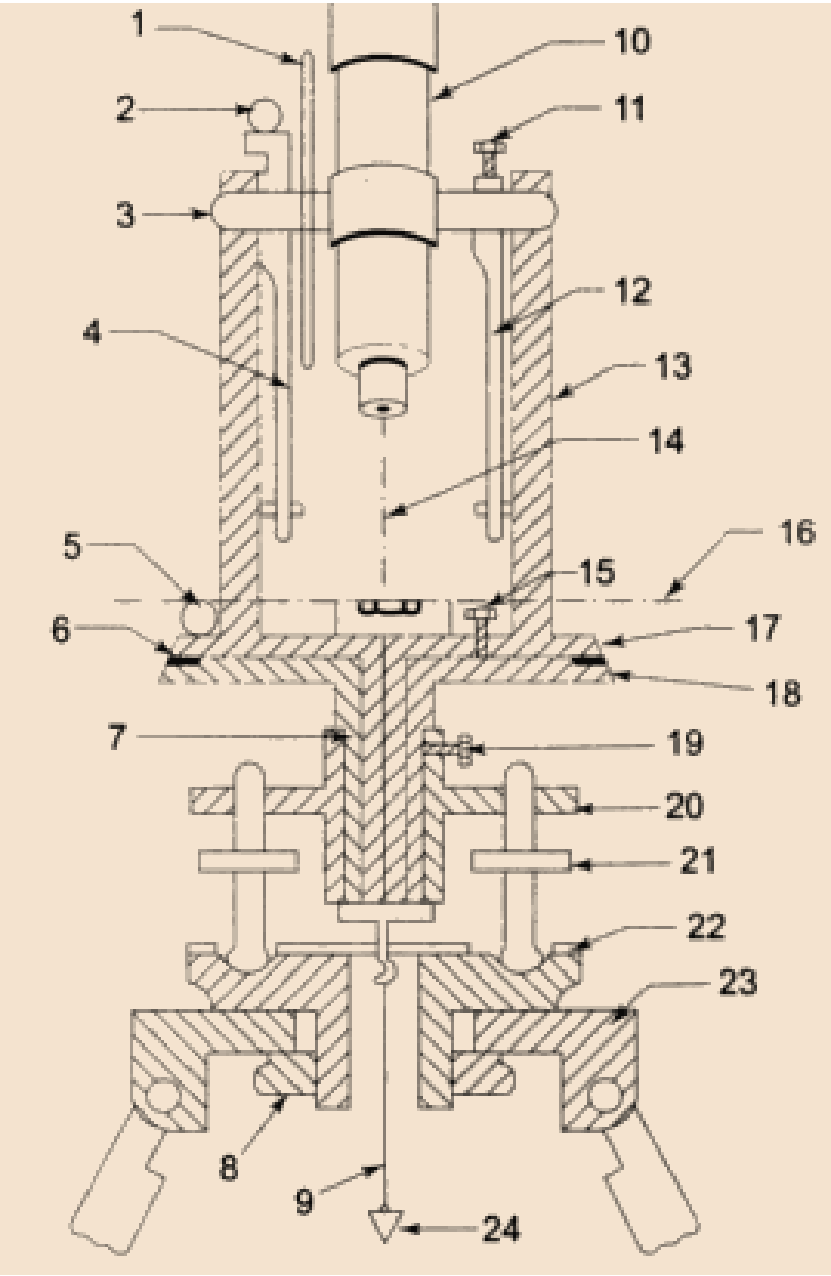
- **Clamps and Tangent Screws/ Slow Motion (15, 19):**
  - There are two clamps and associated tangent screws (Slow Motion) with the plate. These screws facilitate the motion of the instruments in horizontal plane.
  - Lower clamp screw locks or releases the lower plate. When this screw is unlocked both 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

- **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, cross hairs, object lens and arrangements to focus the telescope.

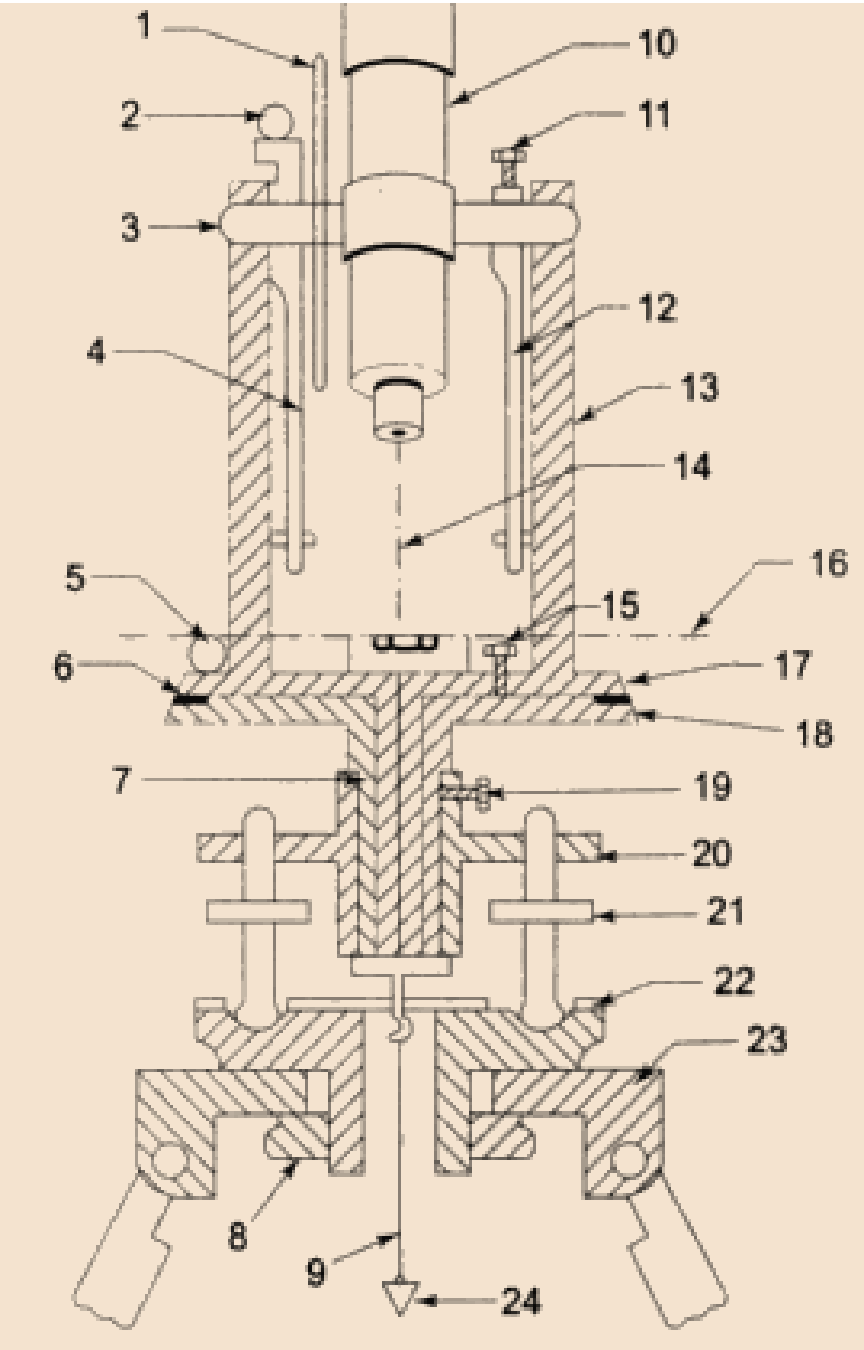


MAIN PARTS

- **Vertical circle (1):** Circular plate supported on horizontal axis of the instrument. 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 leveling particularly when taking the vertical angle observations.



Total Station

- This is an electronic instrument. In this instrument, all the parameters required to be observed during surveying can be obtained. The value of observation gets displayed in a viewing panel. The precision of this type of instrument varies in the order of **0.1" to 10".**

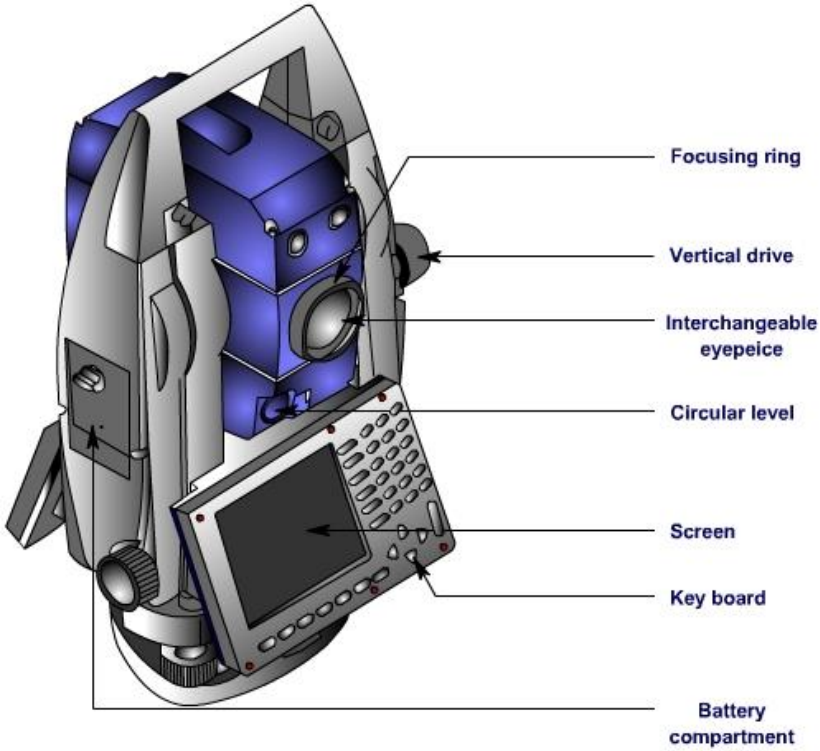


Figure 20.3 Total Station

GPS

- GPS is the shortened form of NAVSTAR GPS. This is an acronym for NAVigation System with Time And Ranging Global Positioning System.
- GPS, which stands for **Global Positioning System,** is one of the satellite systems currently in use. It is able to show you your exact position on the surface of earth anytime, in any weather, anywhere.

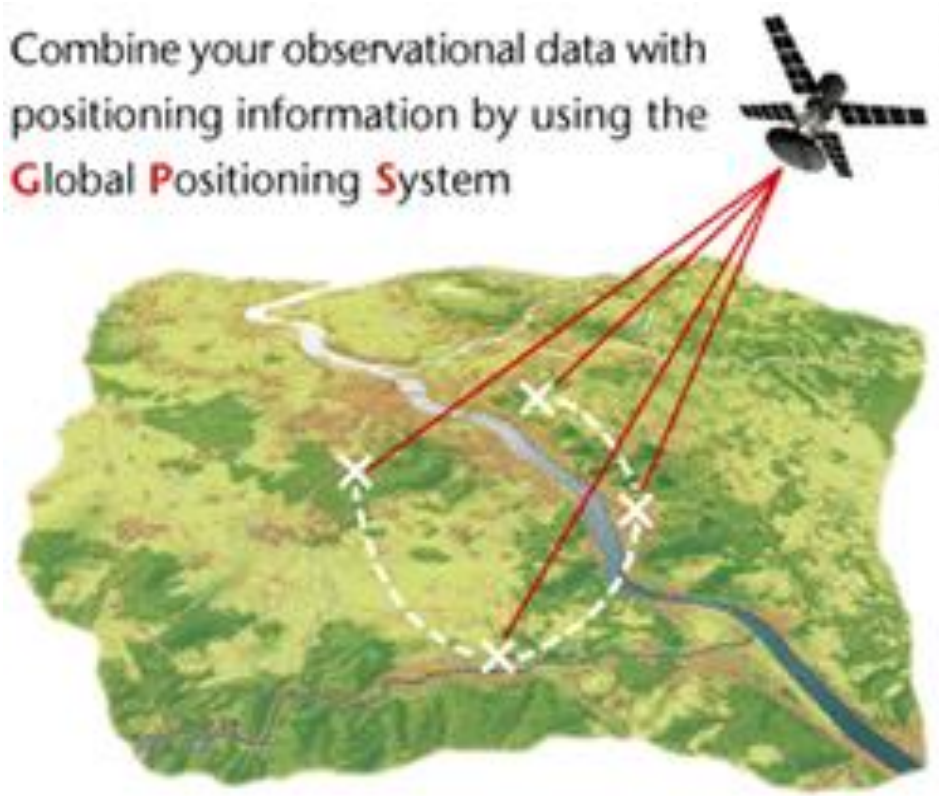
GPS Segments

Basically there are three segments of GPS.

- **The Space Segment:** Satellites orbiting the earth.
- **The Control Segment:** Stations positioned on the earth's equator to control the satellites.
- **The User Segment:** Anybody that receives and uses the GPS signal.

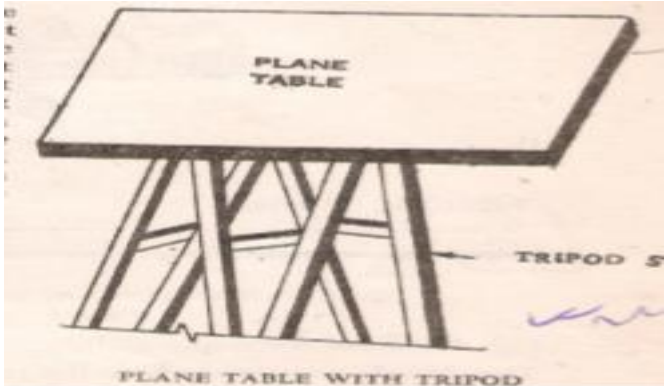
GPS Receivers

- GPS units are made to communicate with GPS satellites (which have a much better view of the Earth) to find out exactly where they are on the global scale of things.



The Plane Table

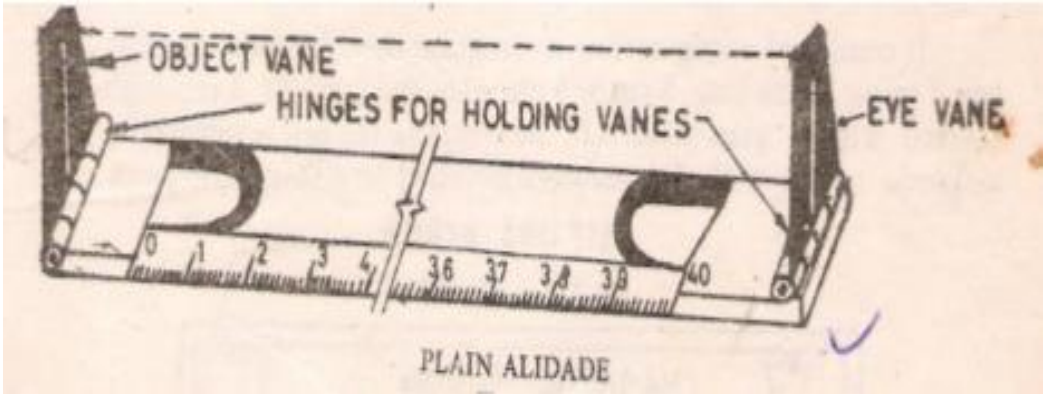
- The drawing board made of well seasoned wood such as teak or pine which is used for the purpose of plotting is called plane table. It is available in sizes 500x400x15mm,600x5000x15mm and 750x600x20mm.
- The top surface of board is perfectly plane and to the underneath it is fitted with a leveling head or ball and socket arrangement.
- The table is mounted on a tripod by means of a central screw with a wing nut or in such a manner so that the board can be revolved, leveled and clamped in any position.



PLANE TABLE WITH TRIPOD

Alidade

- The tool or instrument which consist of metal (usually of brass) or wooden (well seasoned) ruler 40cm to 60cm long, 3cmto5cm wide and fitted with two vanes at the ends is called an alidade.
- The beveled graduated edge is known as the fiducial edge. Such an alidade is known as plain alidade.



PLAIN ALIDADE

Sprit Level

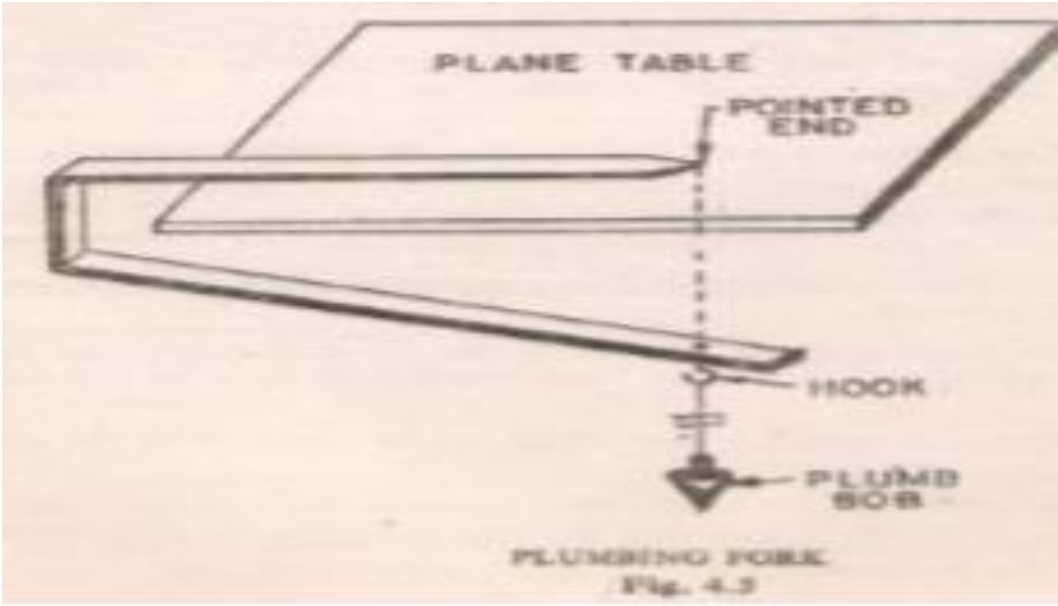
- A small sprit level circular or rectangular is required for seeing if the table is properly level. The level must have flat base so that it can be placed on the table.

Plumbing fork or U-frame

- The plumbing fork to which is attached a plumb bob .
- Used for centering the plane table over the station occupied by the plane table.
- It is also meant for transforming the ground point on to sheet so that both the points should be in the same vertical line
- It consists of two light metal arms as shown in fig. Approximately of equal lengths.
- A hook for suspending a plumb bob is provided at the lower arm immediately below the end point of the upper arm.

Plumbing fork or U-frame

- The upper arm is placed on the plane table while the lower arm with a plumb bob is moved below the table for centering over the ground station mark , thus in the exact position the pointed end of the upper arm will give the corresponding position on the paper



Any Questions?