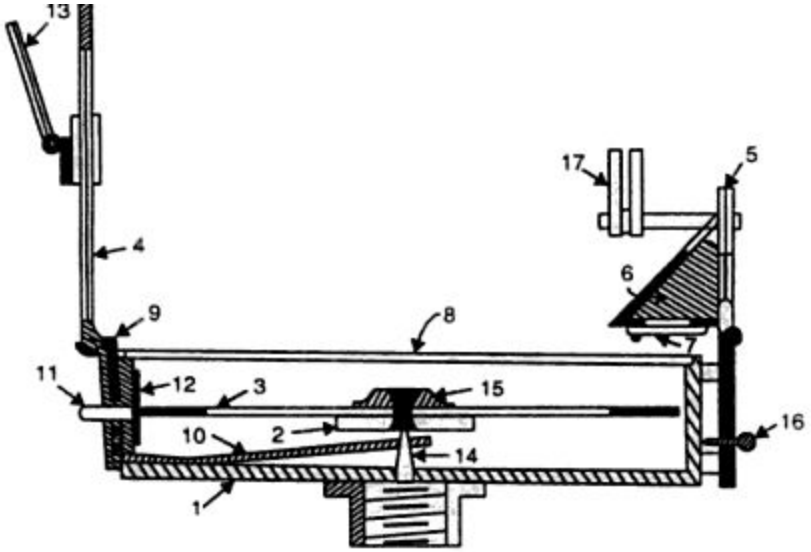
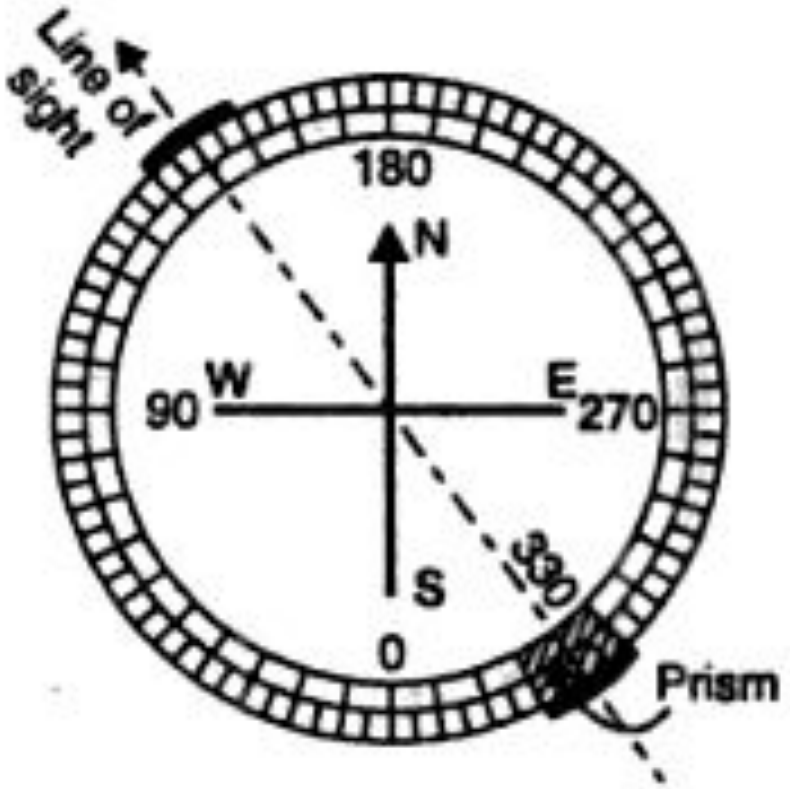
Compass Surveying



1. Box
2. Needle
3. Graduated ring
4. Object vane
5. Eye vane
6. Prism
7. Prism cap
8. Glass cover
9. Lifting pin
10. Lifting lever
11. Brake pin
12. Spring brake
13. Mirror
14. Pivot
15. Agate cap
16. Focusing stud
17. Sun glass

FIG. 5.12. THE PRISMATIC COMPASS.



Compass surveying

The branch of surveying in which direction of survey line are determined by a compass and their lengths by chaining or taping directly on the earth surface is called compass surveying.

Traverse : - a series of connected straight lines each joining two survey stations on the ground is called traverse. Each point is called traverse stations and straight lines between two consecutives are traverse legs.

Theory of magnetism :-

When a magnetic needle is balanced at its centroid on a hard steel pivot it swings freely in a horizontal plane and ultimately rests along N-S direction of the earth magnetic field. The North pole of the earth magnet is assumed to be located near the south geographical pole and south pole of the earth magnet is located near the north geographical pole. Hence lines of force of the earth magnet travel from north magnetic pole to its south magnetic pole.

It is also a well established fact that like poles repels each other, hence the end of magnetic needle pointing towards the geographical north conventionally accepted as north pole of magnetic needle.

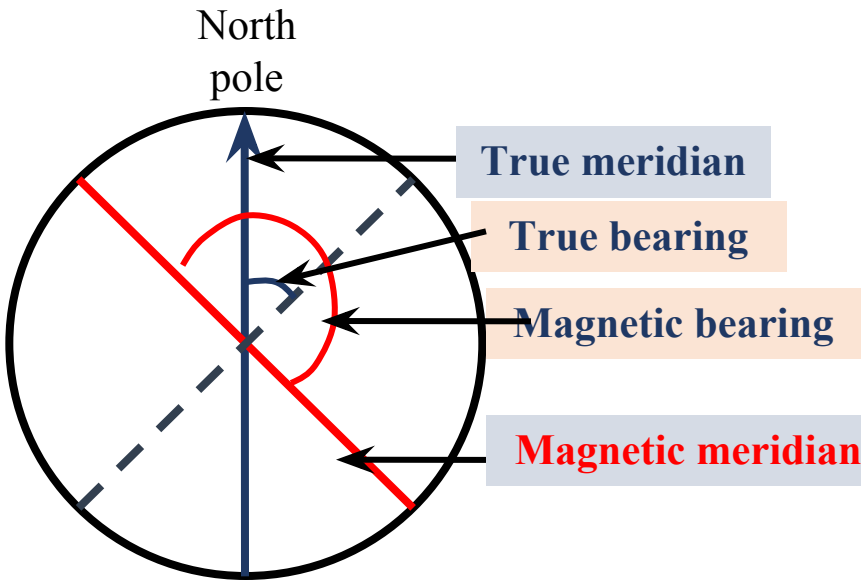
The poles of earth magnet do not coincide with geographical poles and hence magnetic meridian ie. N-S direction at any place is not a true meridian. South pole of earth magnet which is called north magnetic pole, is located near 70 degree N latitude and 96 degree W longitude in the northern hemisphere.

Dip of magnetic Needle:- if the needle is perfectly balanced at the centre of gravity before magnetisation, it doesn't remains so after magnetisation due to the magnetic influence of the earth. The lines of the force run from south geographical pole to north geographical pole and near equator these are parallel to the surface.

Compass traversing: Important Definition

- **True meridian: Line or plane passing through geographical north pole and geographical south pole**

- **Magnetic meridian: When the magnetic needle is suspended freely and balanced properly, unaffected by magnetic substances, it indicates a direction. This direction is known as magnetic meridian. The angle between the magnetic meridian and a line is known as magnetic bearing or simple bearing of the line.**



True Meridian :- the line of intersection of the earth surface by a plane containing a North pole , South pole and observers position is called True meridian or geographical meridian. Geographical meridian are not parallel to each other. These converge to a point in northern and southern hemisphere.

Equatorial circumference of the earth surface is divided into 360 degree. The true meridian of Greenwich has been assumed internationally as 0 degree. Determination of true meridian at any place precisely is made by making astronomical observations to heavenly bodies i.e. sun and stars. The true meridian at any place is not variable. In engg surveys it is very useful to save time in laying the surveying lines during constructions . it may be mentioned here that the maps prepared by National survey deptt in any country are based on true meridian.

Convergence of True meridian:- convergence of the meridian varies according to the latitude of the place. It is higher near the equator.

The convergence of meridian at latitude (θ) is the angle between their tangent at latitude (0)

Grid Meridian:-

In every country, state survey maps are based on one or more true meridians o the place so chosen that they are centrally placed in definite belts bounded by some geographical meridians and paralles.such maps have a rectangular grid plotted on them.

Azimuth and bearing :-

True bearing :- the horizontal angle between the true meridian and the survey line measured in the clockwise direction is called true bearing.

Azimuth :- the interior angle (smaller) angle which a survey line makes with the true meridian is called Azimuth, Azimuth doesn't specify the direction of measuring the angle.

Calculation of Azimuth :-

1. If the true bearing of any line is more than 180◦, the azimuth of line may be calculated by subtracting it by 360◦.

2. If the true bearing is less than 180 , the azimuth of the line will be equal to the true bearing.

Magnetic bearing :- the horizontal angle of survey line makes with the magnetic meridian is called magnetic bearing . it is not constant at a point but varies with laps in time.

- **Forward and backward bearing :-**

- A line may be defined by two bearing. one observed at either end of the line. Both the bearing differ each other by 180. The bearing of line in the direction of progress of survey is called Fore while the bearing in the opposite direction of the progress of survey line is called back bearing.

- **Arbitrary meridian: Convenient direction is assumed as a meridian.**

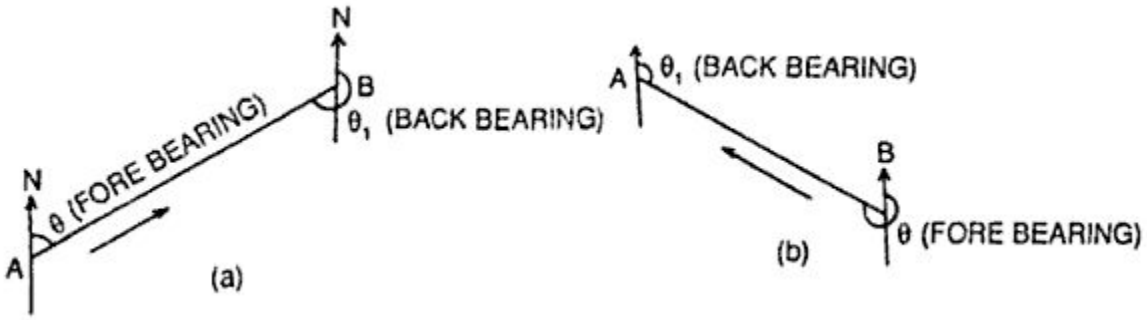
- **Grid meridian: Sometimes for preparing a map some state agencies assume several lines parallel to the true meridian for a particular zone these lines are termed as grid meridian.**

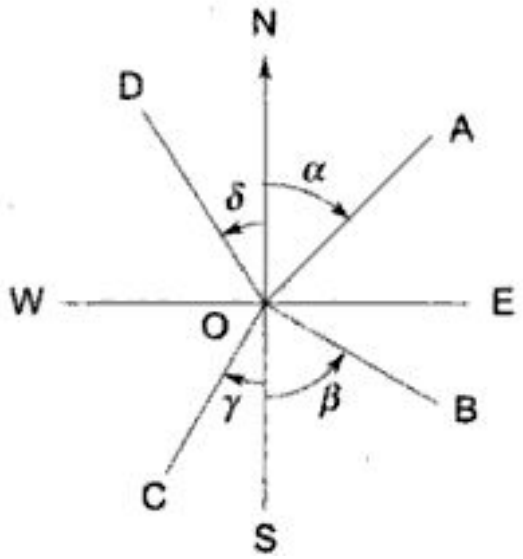
- **<u>Designation of magnetic bearing</u>**
  - Whole circle bearing (WCB)
  - Quadrantal bearing (QB)

- WCB: The magnetic bearing of a line measured **clockwise from the North Pole** towards the line is known as WCB. Varies 0-360°

- **Quadrantal Bearing:** The magnetic bearing of a line measured clockwise or anticlockwise from NP or SP (whichever is nearer to the line) towards the east or west is known as QB. This system consists of 4-quadrants NE, SE, NW, SW. The values lie between 0-90°
  - QB of OA = N a E
- **Reduced Bearing:** When the whole circle bearing of a line is converted to quadrantal bearing it is termed as reduced bearing.
- **Fore and Back Bearing:**

  In WCB the difference between FB and BB should be exactly 180°
  - BB=FB+/-180°
  - Use the +ve sign when FB<180°
  - Use the –ve sign when FB> 180°





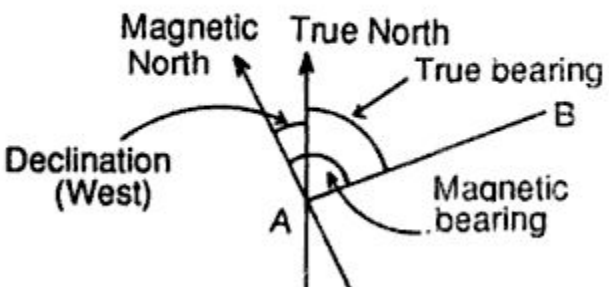
- **Magnetic declination:** The horizontal angle between the magnetic meridian and true meridian is known as magnetic declination.

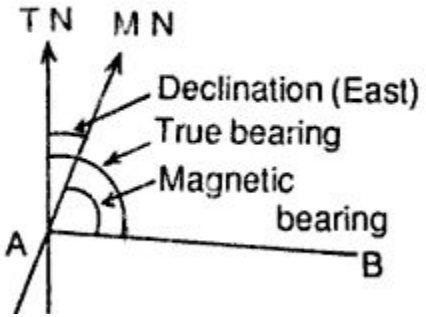
- **Dip of the magnetic needle:** If the needle is perfectly balanced before magnetisation, it does not remain in the balanced position after it is magnetised. This is due to the magnetic influence of the earth. The needle is found to be inclined towards the pole. This **inclination of the needle with the horizontal** is known as dip of the magnetic needle.

- **Local Attraction**
- **Method of correction for traverse:**
  - **First method:** Sum of the interior angle should be equal to (2n-4) x 90. if not than distribute the total error equally to all interior angles of the traverse. Then starting from unaffected line the bearings of all the lines are corrected using corrected interior angles.

  - **Second method:** Unaffected line is first detected. Then, commencing from the unaffected line, the bearing of other affected lines are corrected by finding the amount of correction at each station.

Remember the following:





Determination of true bearing and magnetic bearing:

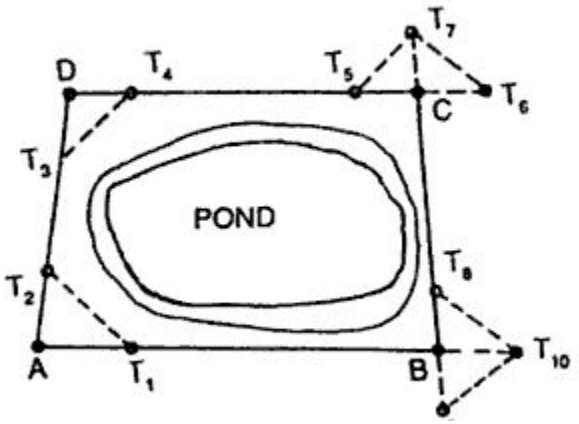
(a) True bearing = magnetic bearing ± declination

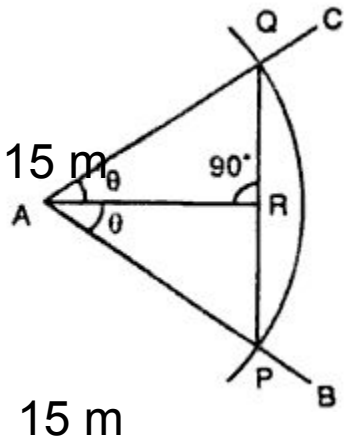
Note [use the positive sign when declination east, and the negative sign when declination west.]

(b) Magnetic bearing = true bearing ± declination

Note [Use the positive sign when declination west, and the negative sign when declination east.]

Methods of traversing





Let $\angle PAR = \theta$

Then $\angle BAC = 2\theta$

Here $AP = AQ = 15$ m

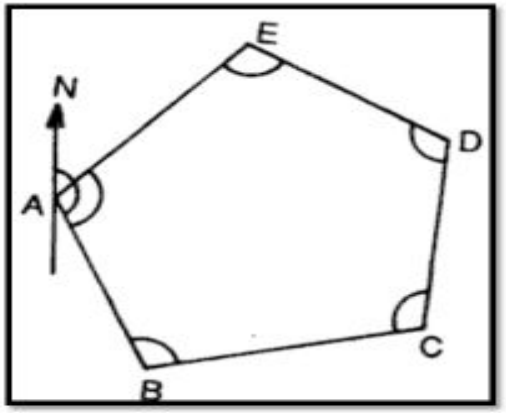
In triangle PAR,

$$\sin\theta = \frac{PR}{AP} = \frac{2PR}{2AP} = \frac{PQ}{30}$$

$$\therefore \quad \theta = \sin^{-1}\frac{PQ}{30}$$

- **<u>Compass traversing:</u>** Fore bearings and back bearings between the traverse leg are measured
- **<u>Theodolite traversing:</u>** Horizontal angles between the traverse legs are measured. The length of the traverse legs are measured by chain/tape or by stadia method
- **<u>Plane table traversing:</u>** Plane table is set at every traverse station in clockwise and anticlockwise direction and the circuit is finally closed. During traversing the sides of the traverse are plotted according to any suitable scale.

- Method of traversing
  - Included angle method
  - Deflection angle method
  - Fast angle (or magnetic bearing method)



Computation of latitude and departure

- Latitude of a line is the distances measured parallel to the north south of the North-South direction
- Departure of the line is the distance measured parallel to the east-west direction

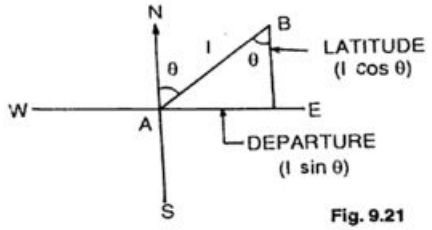
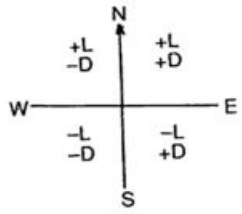


Fig. 9.21



The latitude and departure of lines are also expressed in the following ways:

Northing = latitude towards north = + L
Southing = latitude towards south = – L
Easting = departure towards east = + D
Westing = departure towards west = – D

Computing latitude and departure

Table 9.6 *Table for computing latitude and departure*

Line	Length (L)	Reduced bearing (θ)	Latitude ($L \cos \theta$)	Departure ($L \sin \theta$)
AB	L	N θ E	+ L cos θ	+ L sin θ
BC	L	S θ E	− L cos θ	+ L sin θ
CD	L	S θ W	− L cos θ	− L sin θ
DA	L	N θ W	+ L cos θ	− L sin θ

Check for closed traverse

1. The algebraic sum of latitudes must be equal to zero.
2. The algebraic sum of departures must also be equal to zero.

Table 9.7

Line	Length	Reduced bearing	Consecutive Coordinates			
	(L)	(θ)	Northing (+)	Southing (−)	Easting (+)	Westing (−)
AB	L	N θ E	$L \cos \theta$		$L \sin \theta$	
BC	L	S θ E		$L \cos \theta$	$L \sin \theta$	
CD	L	S θ W		$L \cos \theta$		$L \sin \theta$
DA	L	N θ W	$L \cos \theta$			$L \sin \theta$

Check for closed traverse

1. Sum of northings = sum of southings
2. Sum of eastings = sum of westings

Checks on traverse: Closed traverse

- Check on closed traverse:
  - Sum of the measured interior angles (2n-4) x 90°
  - Sum of the measured exterior angles (2n+4) x 90 °
  - The algebric sum of the deflection angles should be equal to 360°. Right hand deflection is considered +ve, left hand deflection –ve

- Check on linear measurement
  - The lines should be measured once each on two different days (along opposite directions). Both measurement should tally.
  - Linear measurement should also be taken by the stadia method. The measurement by chaining and stadia method should tally.

- Conclusion:-
- Merits
- compass survey is good for dense forest covered regions where GPS and other signal based modern equipments can't work in this particular situation.
- Compass survey is good when the large area under survey measurement is undulating ground survey requirement is urgent.

Economical and easy to understand .

Demerits

not recommended in the area which is magnetically disturbed.

Not suitable in the area where high tension electricity line or microwave tower, power grid station , industrial area etc.

Without proper knowledge of converting magnetic bearing into true or grid bearing , we may deviate few meters to few kilometers distance from the actual maps which are based on National Spatial Reference coordinate system (NSRCF) of the country.