Conical Map Projections

THE parallels and the meridians of a globe are transferred to a cone placed on the globe in such a way that its vertex is above one of the poles and it touches the globe along a parallel (Fig. 44). The parallel along which the cone touches the globe is called a *standard parallel*. The cone is unrolled into a a flat surface. The conical projections so formed have the following common properties :

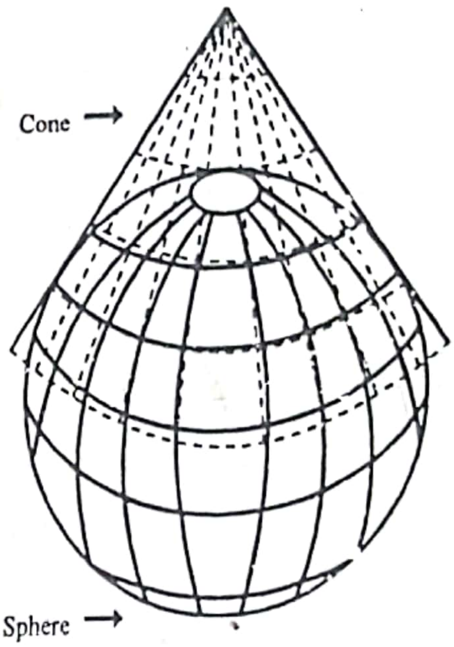


Fig. 44

1. Parallels are arcs of circles which are concentric in most of the conical projections.

2. The central meridian is a straight line.

3. Other meridians are either straight lines or curves.

4. The distances between the meridians decrease towards the pole.

5. They can represent only one hemisphere, at a time, northern or southern.

6. The standard parallel is correct to the scale.

These projections are most suitable for representing middle latitudes.

We shall study the following conical projections :

(i) Simple Conical Projection With One Standard Parallel.

(ii) Simple Conical Projection With Two Standard Parallels.

(iii) Bonne's Projection.

(iv) Polyconic Projection.

(v) International Map projection.

I. SIMPLE CONICAL PROJECTION WITH ONE STANDARD PARALLEL

(A) Let us draw a graticule on the Simple Conical Projection With One Standard Parallel on the scale of 1 : 180,000,000 for the area extending from the equator to 90°N. latitude and from 60°W. longitude to 100°E. longitude. Let its parallel interval be 15°, meridian interval 20° and standard parallel 45°N.

Construction

Radius of the earth=250,000,000 inches

∴ Radius(r) of the globe on the scale of 1 : 180,000,000

$$= \frac{1}{180,000,000} \times 250,000,000 \text{ inches}$$

$$= 1.388 \text{ inches}$$

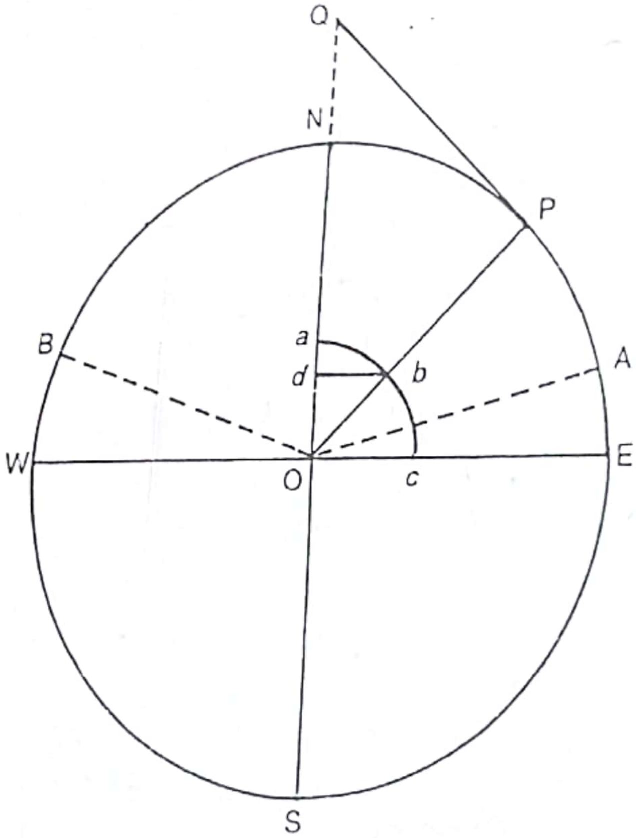


Fig. 44 A

Draw a circle (Fig. 44A) with radius equal to the radius of the globe, i.e. 1.388 inches. This cir represents the globe. Let NS its polar diameter and WE its equatorial diameter intersect each other at rig angles at O, the centre of the circle. Now the standard parallel is 45°N. Therefore, draw radius OP maki an angle of 45° with OE. Draw QP tangent (perpendicular) to PO and produce ON to meet PQ point Q.

Draw radius OA making an angle equal to the parallel interval, i.e., 15° with OE.

Draw line LM (Fig. 44B). This line represents the central meridian. With L as centre and QP as radi draw an arc intersecting LM at n. This arc describes the standard parallel, i.e. 45°N parallel.

To draw parallels, we should know the distance between the successive parallels. This is equal the arc subtended by 15° (parallel interval).

The length of the arc subtended by 15°

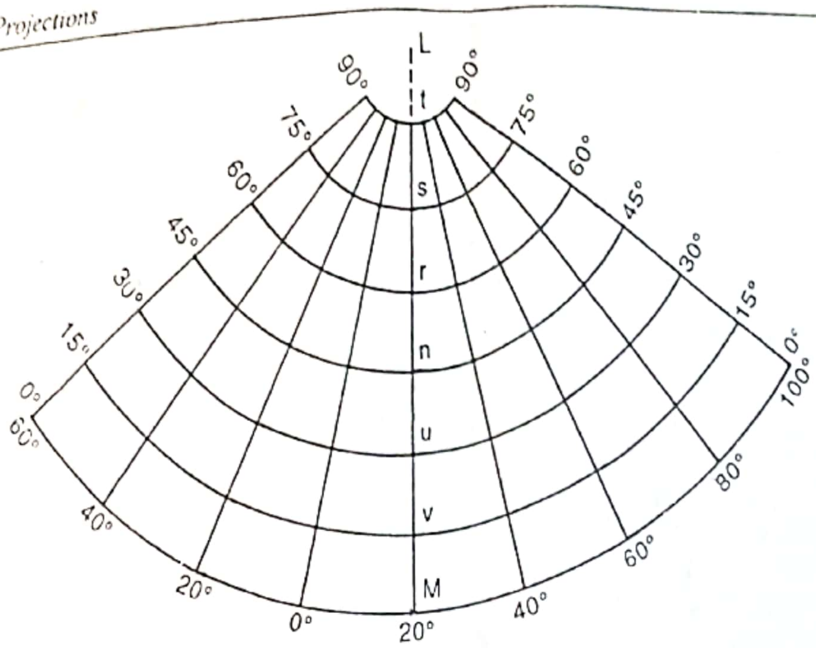


Fig. 44 B

$$= 2\pi r \times \frac{1}{360} \times 15$$

$$= 2 \times \frac{22}{7} \times 1.388 \times \frac{15}{360} \text{ inch}$$

$$= 0.364 \text{ inch}$$

From point n, mark off distances n r, r s, s t and distances n u, u v and v M, each distance being equal to the length of the arc subtended by 15° (parallel interval) or 0.364 inch.

Note. Students are required to draw map projections on scales which are in fact very small. On such map projections, the length of the arc subtended by degrees less than 10 is practically equal to the length of its chord. Therefore, the length of the chord (EA) instead of the length of the arc (EA) may be taken as the distance between the parallels when the parallel interval is less than 10°. When the parallel interval is 10° or more, the length of the arc should invariably be calculated.

With L as centre, draw arcs passing through the points t, s, r, u, v and M. These arcs represent the parallels.

To draw **meridians**, we have to find out the distance between the successive meridians. This distance is marked along the standard parallel. Draw OB making an angle equal to the meridian interval, i.e., 20° with OW. With O as centre and radius equal to the arc WB (0.485 inch) draw arc abc (Fig. 44A). The length of the arc WB is calculated as under :

Length of the arc subtended by 20°

$$= 2\pi r \times \frac{1}{360} \times 20$$

$$= 2 \times \frac{22}{7} \times 1.388 \times \frac{20}{360} \text{ inch}$$

$$= 0.485 \text{ inch}$$

From point b drop perpendicular bd on the line ON. Now db is the distance between the meridia In Fig. 44 B, tM is the central meridian. Keeping in view the number of the meridians to be drawn, m off distances along the standard parallel towards the east and the west of the point n, each distance be equal to db. Join point L with the points of divisions marked on the standard parallel and produce the lines to meet the equator. Mark the parallels and the meridians with degrees as shown in Fig. 44 B.

(B) Let us draw a graticule for Simple Conical Projection With One Standard Parallel on the sc of $\frac{1}{225,000,000}$. Let it extend from 20°N latitude to 80°N latitude and from 30°W longitude to 70 longitude, its standard parallel be 50°N and the interval between the parallels and the meridians be 1

Construction

Radius of the earth = 635,000,000 cm.

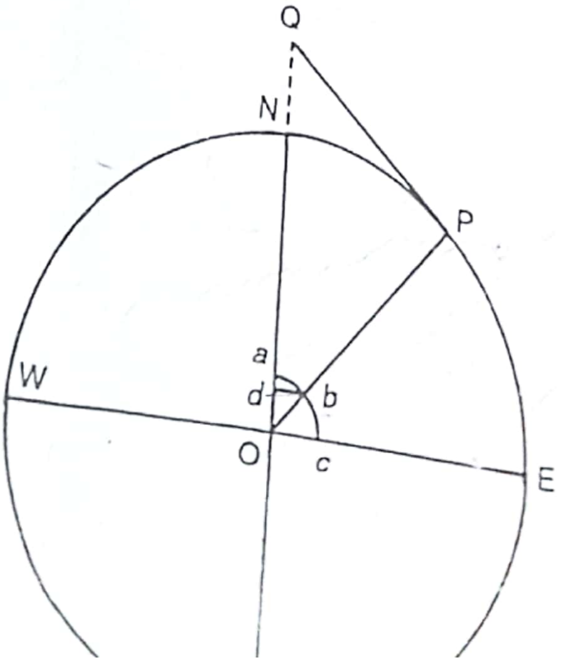
∴ Radius(r) of the globe on the scale of $\frac{1}{225,000,000}$

$$= \frac{1}{225,000,000} \times 635,000,000$$

$$= 2.822 \text{ cm.}$$

Draw a circle (Fig. 45) with radius equal to the radius of the globe, i.e., 2.822 cm This circle represe the globe. Let NS its polar diameter and WE its equatorial diameter intersect each other at right an at O, the centre of the circle. Now the standard parallel is 50°N. Draw radius OP making an angle of with OE.

Draw tangent QP (perpendicular) to PO and produce ON to meet PQ at the point Q. Draw a line



This line represents the central meridian. With L as centre and QP as radius draw an arc intersecting LM at n. This arc describes the standard parallel, i.e., 50°N parallel (Fig. 46).

To draw parallels, we should find out the distance between the successive parallels. This distance is equal to the arc subtended by 10° (parallel interval).

The length of the arc subtended by 10°

$$= 2\pi r \times \frac{1}{360} \times 10$$

$$= 2 \times \frac{22}{7} \times 2.822 \times \frac{10}{360} \text{ cm.}$$

$$= 0.493 \text{ cm.}$$

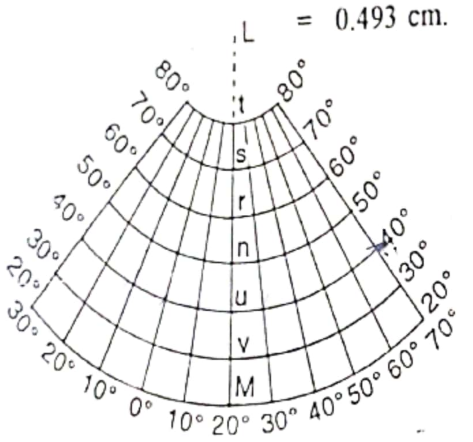


Fig. 46

From point n mark off distances n r, r s and s t and distances n u, u v and vM, each distance being equal to the arc subtended by 10° (the interval between the parallels) or 0.493 cm. With L as centre, draw arcs passing through the points t, s, r, u, v and M. These arcs represents the parallels.

To draw meridians, let us know the distance between the successive meridians. This distance is marked along the standard parallel. Now the meridian interval is 10°.

∴ The length of the arc subtended by 10°

$$= 2\pi r \times \frac{1}{360} \times 10$$

$$= 2 \times \frac{22}{7} \times 2.822 \times \frac{10}{360} \text{ cm.}$$

$$= 0.493 \text{ cm.}$$

With O as centre and radius equal to 0.493 cm. draw arc abc (Fig. 45). From point b drop perpendicular b d on the line ON. Now b d is the distance between the successive meridians.

In Fig. 46, tM is the central meridian. Mark off distances along the standard parallel towards the east and the west of point n, each distance being equal to db. Join point L with the points of divisions marked on the standard parallel and produce these lines to meet 20° parallel. These lines will be the required meridians. Mark the parallels and the meridians with degrees as shown in Fig. 46.

Properties

1. The parallels are concentric arcs of circles. The pole is represented by an arc.
2. The meridians are straight lines.
3. The meridians intersect the parallels at right angles.

4. The distance between any two parallels on this projection is true. Thus, scale along meridians is correct.
5. The distances between the meridians decrease towards the poles, i.e. the meridians are to each other towards the poles.
6. The scale is correct along the standard parallel but very large along all other parallel exaggeration increasing away from the standard parallel. Thus, areas lying adjacent standard parallel are fairly correctly represented on this projection.
7. This projection is neither equal-area nor orthomorphic.

Limitations

The scale along the meridians is true. But it goes on increasing along the parallels away fro standard parallel. Therefore, away from the standard parallel, areas are exaggerated and their distorted. It is suitable only for a narrow strip of land lying adjacent to the standard parallel.

Uses

A long narrow strip of land running along the standard parallel in the east-west direction is fairly correctly on this projection. Railways, roads, narrow river valleys and the international boun running in the east-west direction for a long distance can be shown on this projection. The Canadian Railway, Trans-Siberian Railway, international boundary between Canada and the U.S.A., the Na Valley, etc., may be shown on this projection. The parallel running close to the railway, road, the river the international boundary, etc., shall be selected as the standard parallel.

The scale along the meridians is also correct. A narrow strip along a meridian is, thus, repre in a satisfactory way. It can be used for showing Chile, the Rockies, etc.

II. CONICAL PROJECTION WITH TWO STANDARD PARALLELS

Let us draw Conical Projection With Two Standard Parallels on the scale of 1/200,000,000 sp its parallels and meridians at an interval of 10° Let it extend from 30°N latitude to 70°N latitude and 30°W longitude to 70°E longitude.

Construction

Generally those parallels are selected as standard parallels which enclose about half to two-th the total area of the graticule of the projection. It is, therefore advisable to select those two paral standard parallels, one of which passes through the middle of the southern half of the map and the through the middle of the northern half of the map. Accordingly we shall choose 40°N and 60°N pa as standard parallels.

Radius of the earth = 250,000,000 inches.

Radius (r) of the globe on the scale of $\frac{1}{200,000,000}$

$$= \frac{1}{200,000,000} \times 250,000,000 = 1.25 \text{ inches}$$

Draw a circle (Fig. 47) with radius equal to the radius of the globe , i.e. 1.25 inches. This represents the globe. Let NS its polar diameter and WE its equatorial diameter intersect each other angles at O, the centre of the circle. Let radii OP and OQ make angles of 40° and 60° respectively OE.

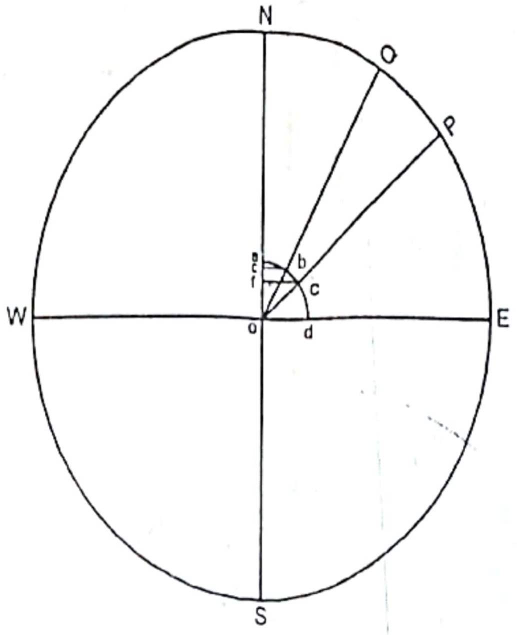


Fig. 47

We are required to draw meridians at an interval of 10°. Therefore, the length of the arc subtended by 10°.

$$= 2\pi r \times \frac{10}{360} = 2 \times \frac{22}{7} \times 1.25 \times \frac{10}{360} = 0.218 \text{ inch}$$

With O as centre and radius equal to 0.218 inch draw arc abcd. From points b and c drop perpendiculars b e and c f on line ON. Perpendicular b e represents the distance between the meridians crossing the 60°N parallel and c f represents the distance between the meridians crossing the 40°N parallel.

To draw the parallels, find out the length of the arc between P and Q, i.e., the arc subtended by 60°—40° or 20°.

$$\text{The length of } 20° \text{ arc} = 2\pi r \times \frac{1}{360} \times 20$$

$$= 2 \times \frac{22}{7} \times 1.25 \times \frac{20}{360} \text{ inch.}$$

$$= 0.436 \text{ inch.}$$

Draw a line xy equal to 0.436 inch (Fig. 48). Draw perpendiculars gx and hy at points x and y respectively. Let g x be equal to e b and h y equal to f c. Produce y x to point z. Join h g and produce it to meet line y x z at point z. Now x y represents the arc QP. The point x represents 60°N latitude and point y 40°N latitude. Since we are required to draw parallels at an interval of 10°, bisect x y to get the position of 50°N latitude. Produce line z x y to R. Open a pair of compasses equal to 10° arc, i.e., 0.218″ and mark off point s from x and point R from y. Point s represents 70°N latitude and point R represents 30°N latitude.

Fig. 48

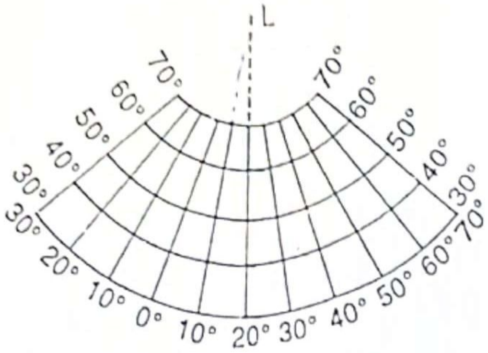


Fig. 49

Draw a line LM (Fig. 49). This line repres central meridian. With L as centre and zs, zx, zT zR as radii draw arcs. These arcs represent the pa Now f c and c b represent the spacings betw maridians along 40° parallel and 60° parallel respe Mark off distances along the 40°N standard p towards the east and west of the central meridia distance being equal to f c. Also mark off distance the 60°N standard parallel towards the east and wes central meridian, each distance being equal to c these points of divisions by straight lines and produc to meet 70°N and 30°N parallels, i.e. the outermost parallels. These lines represent the meridian

Properties

1. The parallels are concentric arcs of circles. The pole is represented by an arc.
2. The meridians are straight lines.
3. The meridians interest the parallels at right angles.
4. The meridians are correctly divided for spacing the parallels. The scale along all the mer is, therefore, correct.

5. The scale is correct along the standard parallels but relatively small along the parallels between the standard parallels and relatively large along all other parallels (Fig. 50). This projection is, therefore, suitable for an area which has small extent in latitude only. In such a case those standard parallels are chosen which are quite close to each other. We, thus eliminate to some extent the inaccuracy caused due to different scales of the parallels lying between the standards parallels and outside the standard parallels.

6. A belt of an area having very small latitudinal extent but great longitudinal extent can be shown quite satisfactorily on this projection.

7. This projection is neither equal-area nor orthomorphic.

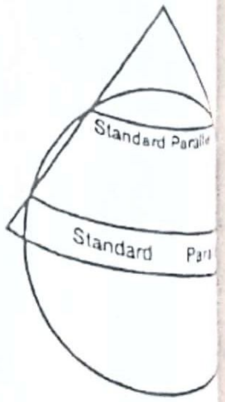


Fig. 50

Limitations

The scale being either too large or too small along the parallels other than the standard parallels far away from the standard parallels are not accurately represented on this projection. Therefore, for representation, an area should be of small latitudinal extent.

Uses

1. Being neither equal-area nor orthomorphic, this projection is not used for a specific pu It is, therefore, used for general-purpose maps.
2. A long narrow strip of land running in the east-west direction is shown fairly correctly o projection. The Canadian Pacific Railway, Trans-Sibarian Railway and international bo between the U.S.A. and Canada can be shown fairly accurately on this projection, the ac being more than it is in the case of Conical Projection With One Standard Parallel.
3. The projection is quite satisfactory for showing small countries having small lat extent.

III. BONNE'S PROJECTION

It is a modified Conical Projection With One Standard Parallel. It was invented by Rigobert Bonne (1727—1795), a French cartographer.

Let us construct a network of Bonne's Projection on a scale of 1 : 200,000,000 spacing the parallels and the meridians at an interval of 15° for an area which extends from the equator to the North Pole and from 75°W to 75°E longitude.

Construction

Radius of the earth=250,000,000 inches.

∴ Radius (r) of the globe on the scale of $\frac{1}{200,000,000}$

$$= \frac{1}{200,000,000} \times 250,000,000,$$

$$= 1.25 \text{ inches}$$

Draw a circle (Fig. 51) with radius equal to the radius of the globe, i.e. 1.25 inches. This circle represents the globe. Let NS its polar diameter and WE its equatorial diameter intersect each other at right angles at O, the centre of the circle. This projection is a modified Simple Conical Projection With One Standard Parallel. Like the Simple Conical Projection With One Standard Parallel, Bonne's Projection has one standard parallel. The parallel running through the central part of the projection will obviously be a suitable standard parallel. Therefore, we choose 45°N parallel of latitude as the standard parallel. Let radius OP make an angle of 45° with OE. Also draw radii Or, Os, Ot and Ou making angles of 15°, 30°, 60°, 75° respectively with OE.

We are required to draw meridians at an interval of 15°.

The length of the arc subtended by 15° $= 2\pi r \times \frac{1}{360} \times 15$

$$= 2 \times \frac{22}{7} \times 1.25 \times \frac{15}{360} \text{ inch.}$$

$$= 0.328 \text{ inch.}$$

With O as centre and radius equal to 0.328 inch draw an arc a b c d e f g. This arc cuts the radii Or, Os, Op, Ot and Ou at b, c, d, e and f. From points b, c, d, e and f drop perpendiculars b l, c k, dj, e i and f h on ON.

Draw QP perpendicular to PO. Produce ON to meet PQ at Q. Draw a line LM (Fig. 52). This line represents the central meridian. With L as centre and QP as radius draw an arc intersecting LM at N'. This arc will describe the standard parallel i.e. 45°N parallel.

To draw parallels we have to find out the distance between the successive parallels. This distance is equal to the length of the arc subtended by the parallel interval which is 15° in this example.

∴ The length of the arc subtended by 15°

$$= 2\pi r \times \frac{1}{360} \times 15$$

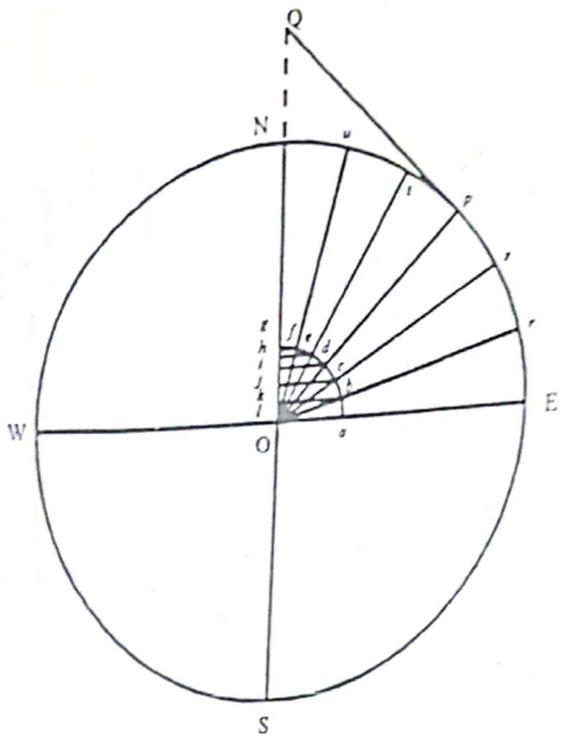


Fig. 51

$$= 2 \times \frac{22}{7} \times 1.25 \times \frac{15}{360} \text{ inch.}$$

$$= 0.328 \text{ inch.}$$

From the point N', mark off distance N'w, w x and x 90° towards L and distances N'y, y z and zM... M, each distance being equal to the arc subtended by 15°, i.e., 0.328 inch. With L as centre, draw arcs... through the points x, w, y, z and M. The arcs passing through x, w, y and z will represent the paral... the arc passing through M the equator.

Now aO, b l, c k, d j, e i and f h represent the spacings between the meridians along the e... 15°, 30°, 45°, 60° and 75° parallels respectively. Since the area is bounded by 75°W and 75°E me... and the meridian interval is 15°, we need to draw 75/15, i.e. 5 meridians to the west of the central me... (0°) and 75/15, i.e. 5 meridians to the east of the central meridian. Starting outwards from the c... meridian mark off distances along the equator, each distance being equal to aO. Similarly mark off dis... b l, c k, dj, e i and f h along 15°, 30°, 45°, 60°, and 75° parallels respectively. Join the points of di... on the parallels by smooth curves and let these curves also pass through the pole and the points of di... on the equator. The curves represent the meridians.

Note. Had the meridian interval been 25° instead of 15° in the above projection, the radius of... a b c d e f g in Fig. 51 should have been equal to

$$2 \times \frac{22}{7} \times 1.25 \times \frac{25}{360} \text{ inch or } 0.545 \text{ inch.}$$

Properties

1. The parallels are concentric arcs of circles. The pole is represented as a point on this pro...
2. All the parallels are correctly divided for spacing the meridians. Tha scale along all the p...

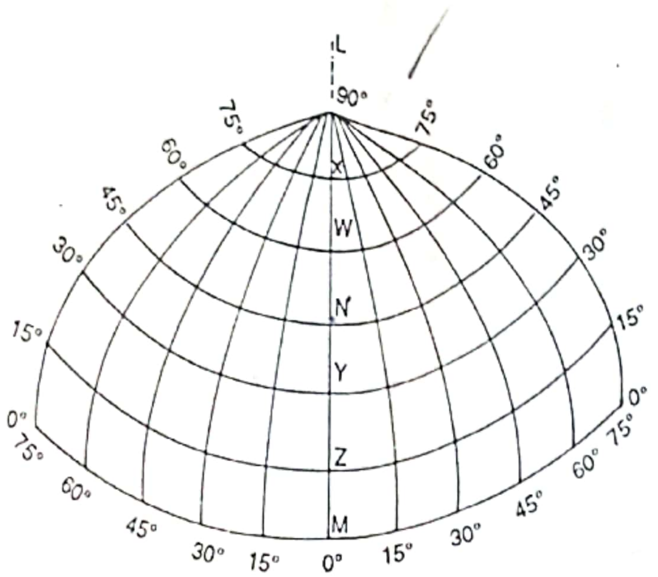


Fig. 52

is, thus, correct.

3. The central meridian is a straight line and it is correctly divided for spacing the parallels. The scale along the central meridian is, thus, correct. Other meridians being curves are longer than the corresponding meridians on the globe. The scale along them is, thus, enlarged. The scale along the meridians increases away from the central meridian.

4. The central meridian intersects all parallels at right angles. Other meridians intersect the standard parallel at right angles but all other parallels obliquely. The shapes are, therefore, preserved along the central meridian and the standard parallel only. Elsewhere they are distorted, the distortion increasing towards the margins of the projection. This projection is, therefore, not orthomorphic.

5. The scale along the parallels is correct and the distance (perpendicular) between them is also correct. Evidently, the area between any two parallels on this projection is equal to the area between the same two parallels on the globe. It is, therefore, an equal-area projection.

Limitations

The shapes away from the central meridian are distorted, the distortion increasing away from the central meridian. The shapes in the margins of the projection showing a large area such as Asia are much distorted. Therefore, this projection maintains shapes satisfactorily along with its equal-area property if areas are small and compact and have not large longitudinal extent.

Uses

1. Since it is an equal-area projection and since shapes are maintained satisfactorily for small areas, this projection is commonly used for showing maps of European countries such as Spain, France, Germany, etc. It can also be used for drawing general-purpose map of India.

2. Large areas such as North America and Australia (Fig. 53) are also shown on this projection in some atlases.

3. This projection is also used by small countries of middle latitudes for making topographical sheets.