

The use of

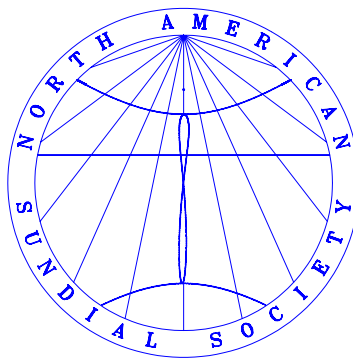
----- D I A L L I N G   S C A L E S -----

Supplied by

E. C. MIDDLETON

84 STANMORE ROAD.

BIRMINGHAM.



The North American Sundial Society's facsimile reprint of E.C. Middleton's 1913 instruction set for the scales he supplied for the construction of sundials.

----- TO USE THE DIALLING SCALES . -----

Horizontal Dials.

FIRST ASCERTAIN THE LATITUDE of the site that the dial will occupy, either by reference to an ordnance survey map, a Gazetteer, or other means; This being obtained proceed to set out your dial, say a horizontal dial for Birmingham, the Latitude of which City is  $52^{\circ} . 30''$  .

DRAW A HORIZONTAL LINE of Latitude or 6 o'clock line A. B. Fig. 1 - about the centre of this erect two parallel vertical lines, C. D. - E. F. these lines must be separated by a space equal to the thickness of the intended gnomon, which may be any suitable width determined by the size of the dial or other considerations.

BY THE SCALE OF LATITUDE set off from C to g and from E to j the Latitude with which will correspond the elevation of the style or gnomon, in this instance  $52^{\circ} . 30''$  . Starting from g to the line C. D. set off a distance equalling the whole 6 hours of the hour scale; from g to h, Lines ruled from the centre C, through the divisions of the hour scale, will give the morning hour lines.

REPEAT THIS FROM j to k for the afternoon hours, when lines ruled

from the centre E, through the divisions on the lines j. k, give the afternoon hours.

FOR THE EARLY MORNING hours of 4 and 5 o'clock, extend the afternoon hours of 4 and 5 and their subdivision through the centre E, this will give what is required.

FOR THE EVENING HOURS of 7 and 8 o'clock extend the morning hours of 7 and 8 o'clock and their subdivisions through the centre C, and this will give what is required.

THE GNOMON OR STYLE must equal in width the distance allowed between the lines C. E - D. F. in the working diagram, and the elevation or angle of it must equal the Latitude of the site of the dial - in this example  $52^{\circ}. 30''$ .

THE SIZE OF DIAL May be whatever is convenient or desirable, the hour angles being the same whatever the size.

THE POSITION OF THE DIAL face must be strictly horizontal, and the gnomon be true North and South, not magnetic North and South.

Direct South and North Vertical Dials.

ASCERTAIN THE LATITUDE as for Horizontal dials, for instance we will take in this instance a dial for York the Latitude being  $54^{\circ}$  - deduct the Latitude ( $54^{\circ}$ ) from  $90^{\circ}$  and this leaves  $36^{\circ}$

the Co-Latitude, which is also the angle of the gnomon.

DRAW A HORIZONTAL LINE - The line of Co-Latitude or 6 o'clock line

A. B. Fig. 2, at right angles to which erect two vertical lines C. D. - E. F. which must be separated by a distance equal to the thickness of the intended gnomon, which may be of any suitable width.

BY THE SCALE OF LATITUDES set off from C to g and from E to j the Co-Latitude which in direct vertical dials equals the styles height  $36^{\circ}$ . From g to the line C.D. set off a distance equalling the whole length of the six hours of the hour scale from g to h. Lines ruled from the centre C through the divisions on the hour scale will give the morning hour lines.

REPEAT THIS from j to k for the afternoon hours, ruling lines from the centre E through the divisions of the hour scale on the line j k - this gives the afternoon hour lines.

THIS COMPLETES THE DIAL as no vertical dial can shew more than 12 hours and in fixing the meridian or 12 o'clock line must be strictly vertical.

GNOMON OR STYLE must equal in width the distance separating the lines C. D. - E. F. in the working diagram and its angle of elevation must equal the co-latitude of the site of the dial,

i n this instance the Latitude is  $54^{\circ}$  the co-latitude is there-  
-fore  $36^{\circ}$  which will be the angle of the gnomon.

THE DIRECT NORTH DIAL is simply a south dial and gnomon turned upside  
down - the 6 o'clock line being at the bottom instead of top -  
and the other hour lines differently figures - it will be use-  
-less to delineate more than the 4. 5. and 6. morning lines  
and the 6. 7. and 8. evening hour lines as the sun cannot  
shine on a North aspect after 6 in the morning or after that  
until after six in the evening.

THE GNOMON is as regards angle exactly as a South dial but turned up-  
-side down compared with the latter, and in fixing the 6  
o'clock line must be strictly horizontal.

#### Equinoctial Dial.

IN THIS DIAL the dial plane C. D. Fig. 3, is placed at an angle equal  
to the Latitude of the dials position say London  $51^{\circ}. 30''$  the  
gnomon is a rectangular plate, see A Fig. 3a - and the hour  
lines are parallel instead of converging to a centre, to  
construct such a dial.

WITH A RADIUS equal to half the length of the hour scale - i.e. 12  
to 3, strike two semi-circles separated by intended width of

gnomon from the two centres C. E. through which draw a horizontal or 6 o'clock line, A. B. and a line parallel to it as G. H. at a distance equal to the radius of the circle, subdivide the quadrant j. k. which gives the 3 o'clock line where it intersects G. H.

THEN PLACE THE 3 o'clock division of the hour scale upon this sub-division and one half of the hour scale will extend to j the other to k, set off the hour divisions of the scale, and by ruling lines from the centre E through the divisions marked by the scale to their intersection of the line G. H. the hour distances will be given. Erect vertical lines as marked 1. 2. 3. 4. 5. and these will be the hour lines, the lines C. D. - E. F. being the meridian or 12 o'clock.

TREAT THE SEMICIRCLE A, g, C, proceed in the same way for the morning hours, or a simpler method is to set off from C towards A distances corresponding with the distances of the hour lines upon the line E. B. It is not worth while commencing the hour lines before 5 in the morning or extending them after 5 for the evening.

THE DIAL FACE OR PLANE must be elevated to an angle equal to the Latitude and the line G. H. kept strictly horizontal and truly

East and West.

THE GNOMON must be rectangular of the width allowed between the lines C. E. and its height equal to the radius of the semi-circle or a distance equal to 12 to 3 on the hour scale.

East and West Dials.

THE EAST DIAL is entirely a morning one shewing the hours from sunrise until say 11 or if a very long surface is available 11-30, to construct one proceed exactly as if constructing the afternoon portion of an Equinoctial dial but number the 12 o'clock line 6 for the morning hour of six, and the figures 1. 2. 3. 4. 5. of the Equinoctial dial will be re-numbered 7, 8 . 9. 10. 11. and the only other hours shewn need be the morning ones 4 and 5 extending from C towards A and numbered 10. 11. in Fig. 4. these being re-numbered 4 and 5 as indicated.

THE WEST DIAL is strictly an afternoon dial and must be an exact reversal of the East dial, proceed as if constructing the before noon portion of an Equinoctial dial the 12 o'clock line being numbered 6 for the evening 6 o'clock, and the 11. 10. 9. 8. 7. hours of the Equinoctial dial will represent the hours 5. 4. 3. 2. 1. of the West dial, and the hours 1. 2. in Fig. 4 will require re-numbering 7. 8. in this dial for the evening

hours.

THE GNOMON in size position and shape will correspond with the style of the Equinoctial dial.

THE POSITION of the dial must be so arranged that whether it be East or West the line G. H. must be at an angle to the Horizon equalling the co-latitude - and the hour lines must be at an angle corresponding to the Latitude of the dial's position.

#### Declining Dials.

DECLINING DIALS are such as do not face the cardinal points N. S. E. W. and are less simple to construct than the regular dials. In addition to the Latitude it is necessary to know the declination of the plane as its variation from the North or South is termed. And upon this data are calculated what are known as

#### THE THREE REQUISITES,

1. e. 1st. The distance of the substyle from the Meridian.
- 2nd. The Elevation of the Pole or Gnomon.
- 3rd. The Inclination of the Meridian.

For example a South Vertical dial, For Latitude  $52^{\circ}. 30''$  Declining West  $4^{\circ}. 0''$ . being required, first

TO ASCERTAIN THE POSITION OF THE SUBSTYLE

As the Radius	10.000.000
Is to the sine of the Declination $4^{\circ}.0''$ .	8.843.585
So is the co-tangent of the Latitude $52^{\circ}.30''$ .	<u>9.884.980</u>
To the tangent	<u>18.728.565</u> $-3^{\circ}.4''$

TO ASCERTAIN THE ELEVATION OF THE POLE

As the Radius	10.000.000
Is to the co-sine of the Latitude $52^{\circ}.30''$	9.784.447
So is the co-sine of the Declination $4^{\circ}.0''$	<u>9.998.941</u>
To the sine	<u>19.783.388</u> $-37^{\circ}.23''$

TO ASCERTAIN THE INCLINATION OF THE MERIDIAN

As the Radius	10.000.000
Is to the sine of the Latitude $52^{\circ}.30''$	9.899.467
So is the co-tangent of the Declination $4^{\circ}.0''$	<u>11.155.356</u>
To co-tangent	<u>21.054.823</u> $-5^{\circ}.2''$

Thus these calculations give the

SUBSTYLES distance from Meridian	<u><math>3^{\circ}.4''</math></u>
ELEVATION OF GNOMON.	<u><math>37^{\circ}.23''</math></u>
INCLINATION of Meridian.	<u><math>5^{\circ}.2''</math></u>

as the three requisites for a dial Declining West  $4^{\circ}$  at the Latitude of  $52^{\circ}.30''$ . Of course in any other instance the figures of Declination and Latitude must be substituted for those above, and the resulting figures will differ in result,

but the method to be pursued will be the same in all cases and whether the dial decline East or West from North or South.

DRAW A LINE C. 12. Fig 4 for the meridian and at the angle already found as the 1st requisite draw the Substylar lines C.D.E.F. separated by the intended width of the gnomon. Draw A.C.E.B. at right angles to the substylar line and set off from C to g and E to j from the scale of Latitudes  $37^{\circ}.23''$  the styles height, then reduce to time the Inclination of the Meridian  $5^{\circ}.2''$  this allowing 4 minutes of time to the degree of Inclination will give 20 minutes (the  $2''$  may be disregarded) set off the entire length of the hour scale from g to h and from j to k.

(NOTE - The figures of the scale will not fall upon the hour lines of these declining dials, for obvious reasons.

It is therefore better to ignore the hour divisions of the scales and regard it simply as a scale of minutes).

Set off 20 minutes from one end of the scale at h. towards g. this will give the meridian or 12 o'clock line. In this instance next set off another 60 minutes by the scale, making in all 80 minutes from the end of the scale - this gives the hour line of 11. 140 minutes from the end of the scale will give the hour line of 10 and so on, putting in all the hours

and sub-divisions, by the minutes of the scale.

AFTERNOON HOURS Setting the scale from K to j, one has to remember that in this instance 20 minutes are already provided for between the 12 o'clock line and the substyle at K, therefore taking 40 more minutes upon the scale one marks off the hour line of 1 - 100 minutes from the end of the scale gives the hour line of 2 - and so are the hours and sub-divisions of the afternoon hours put in.

THE MERIDIAN or 12 o'clock line must be vertical in all Declining dials and

THE GNOMON must be set at right angles to the dial plane immediately over the substylar line - the elevation or angle of the gnomon varying with each degree of declination.

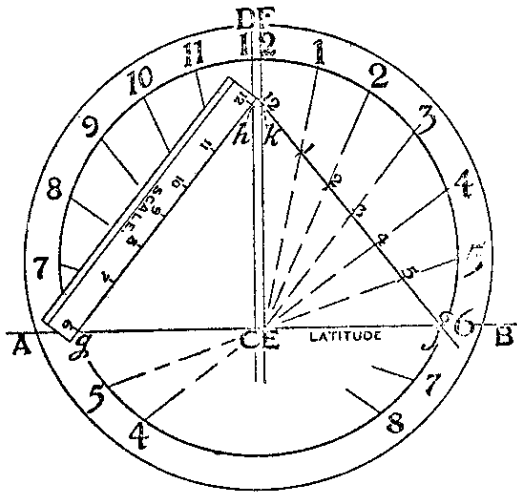


Fig 1.

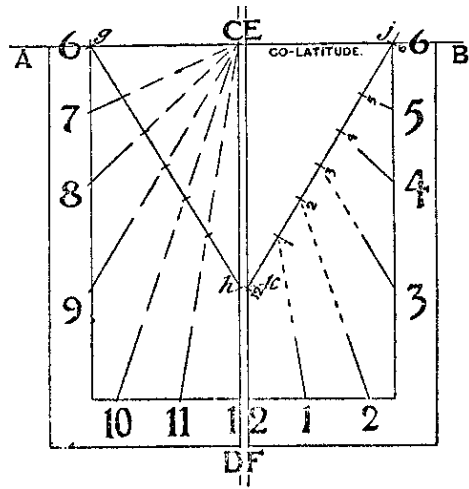


Fig 2.

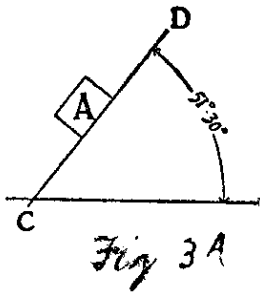


Fig 3A

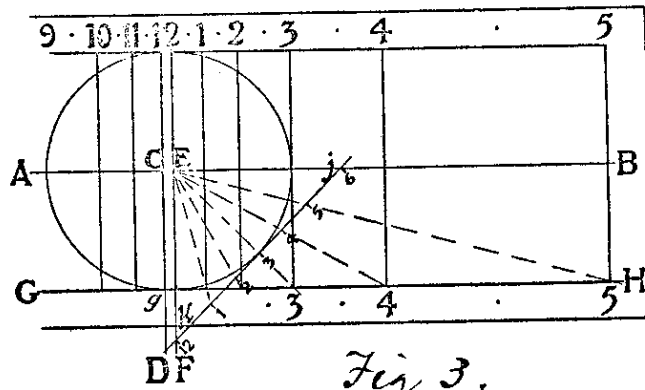


Fig 3.

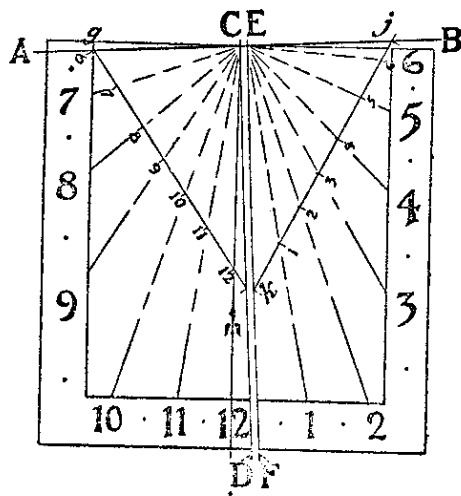


Fig 4.

A D D E N D U M.

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Having met with an instance in which the correspondent had failed to see the application of the instructions for declining dials on pages 8 and 9 - where the declination exceeded 1 hour the following additional particulars are now given.

EXAMPLE - A South Vertical dial for Latitude  $52^{\circ}.30''$   
Declining West  $22^{\circ}$ .

TO ASCERTAIN THE THREE REQUISITES follow the course previously given using the Latitude  $52^{\circ}.30''$  as before - but adopting the new declination  $22^{\circ}$  instead of  $4^{\circ}$  as in previous example - this will give the following -

THE POSITION of the Substyle from the Meridian -  $16^{\circ} 2''$   
Elevation of the Pole -  $34^{\circ} 22''$   
Inclination of the Meridian -  $26^{\circ} 59''$ .

Fig. 6.

DRAW A LINE C.12 for the Meridian - and at the angle as given by the first requisite  $16^{\circ} 2''$  draw substylar lines C.D. & E.F. separated by width of gnomon. Draw A.B. at right angles to substylar lines, and set off from C. to g and E. to j from the Scale of Latitudes  $34^{\circ} 22''$  i.e. equal to the styles height

or elevation given as the second requisite -  
Then reduce the third requisite -  $26^{\circ}59''$  to time  
allowing 4 minutes to each degree of Inclination,  
the minute of degree may be ignored and the  
inclination considered as 27 degrees which  
multiplied by 4 shews a difference of 108 minutes  
of time, or 1 hour and 48 minutes, lay the scale  
of hours from g to h, at 48 minutes of the hour  
scale - make your first hour line that will be the  
1 o'clock line - at 1 hour and 48 minutes from h  
will be the 12 o'clock or Meridian line at 2  
hours and 48 minutes of the hour scale from h  
will be the 11 o'clock hour line and so on -  
starting to set out the hours from K to j, 48  
minutes having been used from h to the 11 o'clock  
hour line out of the 60 minutes forming an hour  
we start by setting out 12 minutes from K on the  
hour scale, this gives the 2 o'clock hour line.  
1 hour and 12 minutes of the scales gives the  
three o'clock line and so on.

IT IS IMPOSSIBLE to give the whole application of the  
scales in less than a considerable volume, but  
the principle of the Art of Dialling once under-  
-stood an intelligent consideration of the  
problem in hand will suggest the application  
of the scale to its solution.

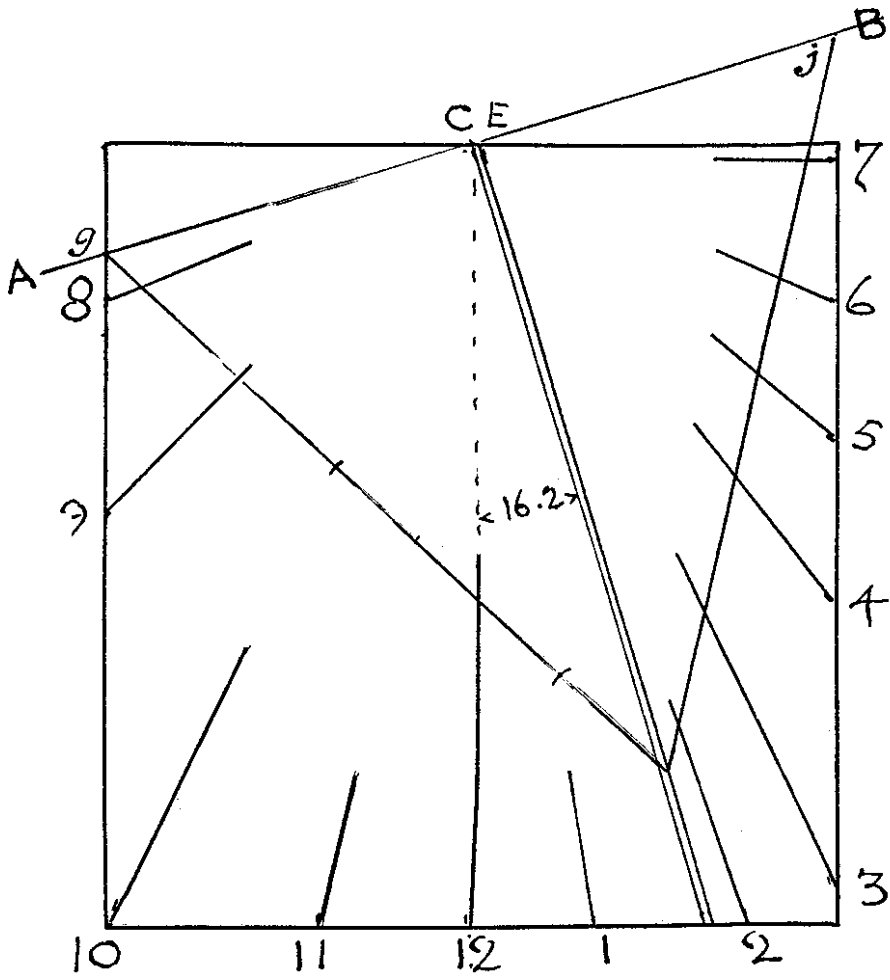


FIG 6.  
 - South Vertical Dial -  
 (Reclining West 22°)

