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“New Method of Dividing Surveying Circles.”

By JOHN COLEMAN FERGUSON, M. Inst. C.E.

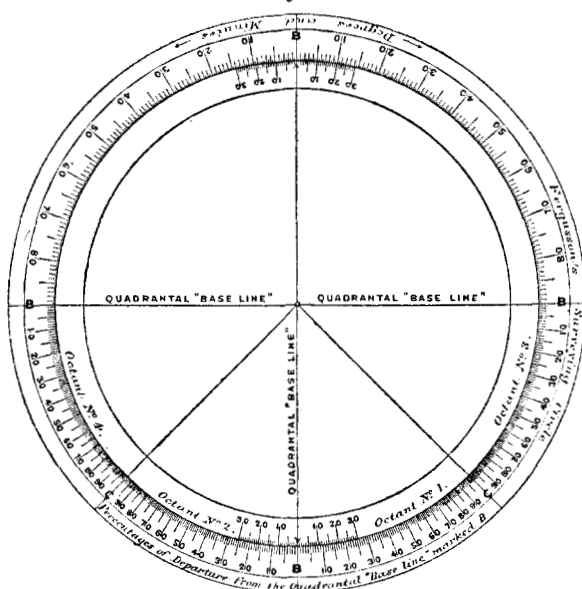
(Abridged.)

IN making a rapid survey with a tacheometer for many miles in very mountainous and broken country in British Columbia, the tediousness of the calculations, even with the aid of special Tables, led the Author to devise a new method of dividing the circle, which so simplifies the calculations as to enable the surveyor to dispense with the use of Tables.

Whilst the ordinary division into degrees is retained for half the circle, so that the instrument can still be used in the usual manner, the other half is divided in a novel way, each of the four octants of the semicircle, or arcs subtended by angles of  $45^\circ$ , being divided into a hundred unequal divisions, commencing in every case from one of the main quadrantal lines, B, of the circle as zero, *Fig. 1*. The principle on which these octants are divided may be readily understood from the following description and diagram, *Fig. 2*. The length of a tangent to a circle between its tangent point B, at the extremity of a radius A B, and the point D where it is intersected by another radius A C produced, making an angle of  $45^\circ$  with the radius A B, is equal to the radius of the circle, or  $BD = AB$ , *Fig. 2*. Then dividing the tangent BD into one hundred equal parts, and drawing straight lines from the centre, A, of the circle, through the octant arc BC to the divisions on the tangent as represented for every ten divisions in *Fig. 2*, the octant BC, or circular arc subtending an angle of  $45^\circ$ , is divided by these lines into one hundred unequal divisions, decreasing consecutively in size from 34 minutes 23 seconds at B, to 17 minutes 16 seconds at C, but each subtending equal lengths along BD, of one one-hundredth of the radius. This is the method which has been adopted for dividing the octants of half the circular plate, *Fig. 1*, commencing in each case from a main quadrantal radius, such as those marked B, *Fig. 1*, or A B, *Fig. 2*. By dividing the circular plates of a theodolite in this manner, the horizontal distance

from the instrument, measured along the base-line, of a staff held horizontally or vertically at right angles to the direction of the

Fig. 1.



DIVISION OF CIRCLE.

base-line coinciding with a main quadrantal radius, is readily obtained by observing the space on the staff covered by the difference between two readings on the staff with the theodolite, in turning it through a definite number of these special divisions, and multiplying this observed length by 100, and dividing it by the number of divisions through which the theodolite was turned. The perpendicular distance, moreover, of the staff from the base-line, either horizontally or vertically, is simply the percentage of the horizontal distance of the staff from the instrument along the base-line, as indicated by the number of divisions along the plate from the zero, or in fact the reading, corresponding to the line of sight of the telescope directed to the staff.

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Fig. 2.

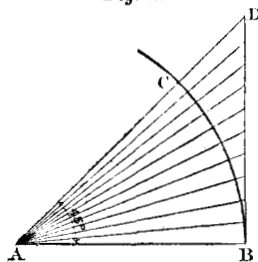


DIAGRAM SHOWING METHOD  
OF DIVIDING CIRCLE.

2 A

Angles can be read on both halves of the circle, either in terms of a percentage of departure, or in degrees, *Fig. 1*; and a surveying instrument provided with this circle is thus converted into a telemetric instrument, as shown by the following examples:—

*Fig. 3.*

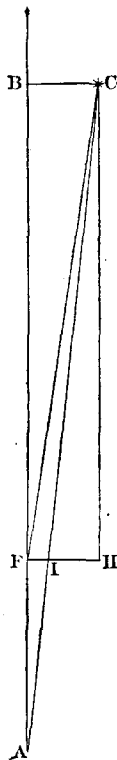


DIAGRAM  
ILLUSTRATING  
APPLICATION  
OF CIRCLE.

*Examples of the Use of the New Circle.*—If, on a staff held horizontally at right angles to the base-line, three divisions on the circle subtend 4·23 feet, then the distance of the staff from the instrument along the base-line is  $\frac{1}{3}$  (4·23 feet  $\times$  100) = 141 feet. The departure of the position of the staff is the percentage of this distance indicated by the index on the octant; if this reading is, say 20, the departure is 141 feet  $\times$  0·20 = 28·2 feet. To take the direct distance of a station with the azimuth circle, the station is sighted through the telescope with the horizontal plates clamped at zero; then the line of sight is over the base-line. The level of the station is the horizontal distance along the line of sight multiplied by the percentage read on the octant from a horizontal base-line on the vertical circle, with a correction for the height of the instrument.

The direction, latitude, and departure of a course can be obtained with the new circle in the following manner. Having set the quadrantal base-lines to correspond with the cardinal points of the compass, suppose that an object marking the line of the course lies to the east of the north base-line, and its direction reads 14 divisions on the adjoining eastern octant, then the direction of the course is 14 feet east for every 100 feet north, or 14 per cent. east of north, and can be at once set out with any scale on a plan. To find the latitude, the staff is held horizontally over the object, pointing east and west, and therefore at right angles to the north base-line; and supposing the telescope, directed on the object, when turned through three divisions on the octant subtends 9·75 feet on the staff, the distance along the north base-line, or the latitude of the course, is  $\frac{1}{3}$  (9·75 feet  $\times$  100) = 325 feet. The easting or departure is 14 per cent. of the distance along the north base-line, or 14 per cent. of 325 feet = 45·5 feet.

The application of the new surveying circle in simplifying observations taken at sea is indicated by the following example.

Setting one of the base-lines in the line of the ship's course A B, *Fig. 3*, it is required to find the distance, A B, the ship has to steam to get abreast of a lighthouse C, and the distance, B C, at which she will pass the lighthouse. The bearing of the lighthouse at A is, say 10 divisions on the octant, east of the ship's course; and, after having steamed 10 miles by the log to F, the bearing is, say 14 divisions to the east. Now the number of divisions subtended by the angle A C F is equal to the divisions on the octant subtended by the angle B F C less those subtended by the angle B A C, or  $14 - 10 = 4$  divisions. But the departure at F from the first bearing A C, or F I, is 10 per cent. of the distance A F, namely, 1 mile, and this distance, F I, may be regarded as the space on the tangent F H covered by the 4 divisions subtended by the angle A C F, so that the distance along the base-line C H is  $\frac{1}{4} (1 \text{ mile} \times 100) = 25$  miles, which is also the length B F; and therefore A B, the distance steamed, = 35 miles. The length B C, accordingly, is  $\frac{25 \text{ miles} \times 14}{100}$  or  $\frac{35 \text{ miles} \times 10}{100} = 3.5$  miles, the distance off the lighthouse at which the ship passes.

The Paper is accompanied by four photographs and a diagram, from which the Figures in the text have been prepared.