The length of a logarithmic tangent is measured off from the commencement of the line at the left hand, by extending the compasses to the degree or minute required. We give two examples of the application of the scale to the solution of questions in trigonometry. 1. The base of a right-angled triangle is 25, and the perpendicular 15, what is the angle opposite to the perpendicular? Here, if the base is considered radius, the perpendicular will be the tangent of the angle opposite to it; therefore,

As 25 : 15 :: Radius : Tangent.

Extend the compasses from 15 to 25 on the line of numbers, and this opening will reach backwards from 45 degrees on the line of tangents to 31 degrees, the angle required. 2. The base of a right-angled triangle is 20, and the angle opposite to the perpendicular 50 degrees, what is the perpendicular?

As Radius : Tan. 50° :: 20 : Perpendicular sought.

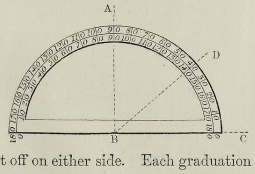
Extend the compasses from 45 degrees to 50 on the line of tangents, and apply them, thus opened, from 20 towards the right hand, to $23\frac{3}{4}$, the perpendicular. This example shows the method of working when the angle exceeds 45 degrees. The extent taken from the tangents is only from 45 to 40, the complement of 50 degrees; and we therefore apply it from 20 towards *the right hand* to obtain the length of the perpendicular; but had the angle been 40 degrees, the extent would have been applied from 20 towards *the left hand*, to $16\frac{3}{4}$, which would, in that case, have been the perpendicular.

We have now gone systematically through the sector, which contains a great deal of what may be termed mechanical mathematics, and offers much that is valuable to the draughtsman in the way of suggestion for the construction and management of scales.

Protractors.

We have already referred to the protractor on the plain scale. The semicircle (*Fig.* 21), though different in form, is the same in principle. It is a half circle of brass, or other metal, having a double graduation on its circular edge. The degrees run both ways to 180; so that any angle, from 1 to 90 degrees may be set off on either side. Each graduation marks an angle and its supplement; thus, 10, 20, 30, coincide with 170, 160, 150; and are the supplements of each other. An angle is protracted or measured by this instrument with great facility. To protract an angle, draw a line, and lay the straight edge of the protractor upon it, with its centre on the point where the angle is to be formed; the required number of degrees is next marked off close to the circular edge; the instrument is then laid aside, and a line drawn from the angular point, to the one which measures the extent of the angle. Thus in the figure, B is the centre, or angular point, D the measure of the angle, and B D the line by which it is formed. The converse operation of measuring an angle is equally simple; the angular point and the centre of the protractor are made to coincide, and the straight edge of the instrument is laid exactly upon one line of the angle, when the other will intersect the circular edge, and indicate the number of degrees. The plain scale protractor is used in the same manner; but it is by no means so convenient an instrument as the semicircle. Either of them may be employed occasionally to raise short perpendiculars. For this purpose, make the centre and the graduation of 90 degrees coincide with the line upon which the perpendicular is to be raised.

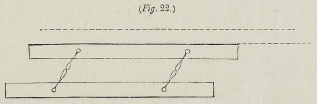
(*Fig.* 21.)



Parallel Ruler.

This is a well-known instrument, consisting of two rulers connected by slides, moving on pivots, and so adjusted, that at every opening of the instrument, the rulers and the slides form a parallelogram. In use, its edge is made to coincide exactly with the line to which others are to be drawn parallel; the lower ruler is then held firmly down, and the upper one raised to any required distance, when a line drawn along its edge will be parallel to that from which it started (*Fig.* 22). There are several methods

(*Fig.* 22.)



of uniting the rulers; but we are not aware that any one has very decided advantages over the others. The ordinary form, as shown in the figure, is perhaps the simplest, and, therefore, the best. The straight edge of the drawing-board and the T square, are the surest means of all for drawing parallels and perpendiculars; and the parallel ruler will never be used when these can be employed.

(*Fig.* 23.)

Drawing Pens.

The drawing pen differs from the pen-leg of the compasses only in its having a long straight handle, the top of which usually unscrews and forms a tracer or pin, to set off angles by the edge of the protractor (*Fig.* 23). The dotting pen is a similar modification of another leg of the movable compasses. The use of both is to draw straight, continuous, or dotted lines in ink. A place is usually provided in the drawing case for a thin pencil, to rule in straight lines, that may afterwards either be obliterated or made permanent by the ink pen.

Pricker.

This is a simple instrument, consisting of a fine needle-point firmly fixed into the end of a wooden