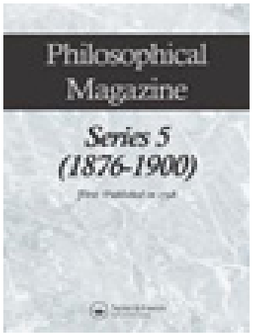

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XXXI. The uses of a line-divider

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The same physicists have quite recently made a determination, not of the Volta-effect, but of the true contact-force between two liquids, by the use of mercury electrodes; employing for this purpose a theorem of Helmholtz, that if by judicious polarization the capillary constant of a mercury-liquid surface be made a maximum, then between the mercury and the liquid there is no difference of potential*.

Their account of this last determination has not yet been published, but it will appear shortly (before this is printed probably) in the *Comptes Rendus*.

The theorem gives evidently an admirably simple method of measuring liquid / liquid contact-force, if it can be made to work practically.

MM. Bichat and Blondlot apparently hope, by a comparison of the two methods, the results of which are quite different (in accordance with the views expressed in the present communication), to be able to obtain values for air / liquid contacts. This would be a most important and useful piece of work: the only difficulty in accomplishing it is the difficulty of getting both sets of measurements thoroughly dependable. I hope they may succeed in overcoming all obstacles.

[To be continued.]

XXXI. *The Uses of a Line-Divider.* *By* Miss Sarah Marks†.

THE ordinary method of dividing a given straight line AB into any number of equal parts (fig. 1), without using a special instrument, is to draw a line AC at any angle to it, to cut off from AC the given number of equal parts AD′, D′E′, &c., to join M, the last of the points so taken, to B, and from D′, E′, &c. to draw lines parallel to MB, meeting AB in D, E, &c. These points D, E, &c. divide AB into the required number of equal parts. This is exactly the method adopted in using the line-divider.

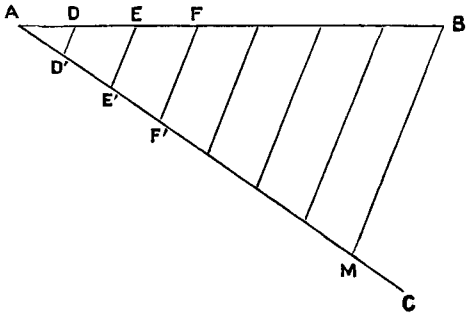
It consists of a hinged rule with a firm joint, having the left-hand limb fitted to slide in an undercut groove upon the plain rule. Both limbs are bevelled on their inner edges, and the left one is divided both on the bevel and on the top into eighths, quarters, half-inches, and inches, which are consecutively numbered, beginning at the hinged end, so that any

* *Monatsberichte der Berliner Akad.* November 3, 1881.

† Communicated by the Physical Society. Read February 14, 1885.

set may be used. The plain rule has two needle-points on its underside to prevent it from slipping when placed in any

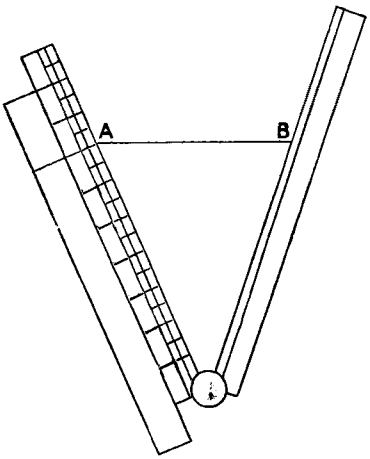
Fig. 1.



position, and on the top has a single line drawn perpendicular to its longer edges.

To divide the line AB into any number of equal parts, say seven (fig. 2): slide the plain rule along the divided limb till its

Fig. 2.



line coincides with one of the lines of this limb against which the number 7 is marked (it is generally best to use the largest possible divisions), place the corresponding line on the bevel

of the limb on the point A, and open or close the rule till the bevel of the undivided limb is on the point B. Now press the plain rule down so that the needle-points enter the paper, and keep it in position. Slide the hinged rule up till the line numbered 6 on the line of reference is coincident with the line on the plain rule, and mark the point where the bevel of the undivided limb meets the line AB. Continue to move the hinged rule up one division at a time till the whole line is divided. It is evident that the ordinary method has been used; for the divided limb forms a line at some angle to AB, and is divided into seven equal parts, and against the undivided limb I can draw parallel lines through the points of section of the divided limb cutting AB in points equidistant from one another.

This is the first method of using the instrument, and is useful in many ways :—to artists, for squaring out their canvases when they wish to enlarge or diminish their drawings, although the second method would perhaps be best for this if a very large divider were used ; to decorators, who frequently find it necessary to divide lines into given numbers of equal parts in order to get patterns into a certain space; it would also be useful for finding the divisions on the scales of thermometers, as the distance between the freezing- and boiling-points is always an unknown length.

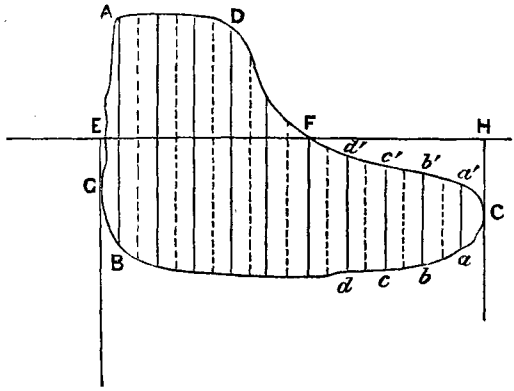
The second method of using the instrument is this :—Let ABCD be an area to be divided into any number of parts, say five, by equidistant lines parallel to AD or BC. Produce AD both ways : place the bevelled edge of the undivided limb along BC, open or close the rule till the end of one of the lines marked 5 on the bevel of the divided limb is on the line AD. Slide the plain rule up, taking care that it is held high enough for its points not to tear the paper, till its line coincides with the 5-line, and press the points firmly into the paper. Now slide the hinged rule up till the division marked 4 coincides with the line on the plain rule, and draw a line along the undivided limb cutting AB and CD. Bring each of the other three divisions against the line on the plain rule, and draw lines as before. These are the lines required.

It is evident that, since the angle ABC may be any angle, it may be a right angle, so that lines can be drawn perpendicular to AB, dividing it into any given number of equal parts. This method is used in finding the mean pressure in gas- and steam-engines by means of an indicator-diagram.

Let A B C D (fig. 3) be an indicator-diagram, E F the atmospheric line ; G E, H C, tangents at the extremities of the diagram perpendicular to E F. To find the length of the line

which represents the mean pressure of the engine, divide the area E H C G into ten parts by lines parallel to H C and E B,

Fig. 3.



and equidistant from one another; bisect each of the areas thus obtained by lines parallel to the last. Let the points where these last lines meet the diagram be $a\,a'$, $b\,b'$, &c. . . . . Add together the lengths $a\,a'$, $b\,b'$, &c., and divide by 10; the result will give the line representing the mean pressure of the engine. This process of dividing the diagram, first by ten equidistant lines and then bisecting the spaces between these lines, is generally a very troublesome one, effected by means of a system of parallel rulers and a T-square. In the figure the dotted lines are those not required when the line-divider is used.

To divide the diagram by means of the rule, place the rule as if for dividing the area by 20 equidistant lines parallel to HC. Draw the first of these lines, and then every alternate one, and the diagram is divided as required.

This method of dividing areas is also convenient for drawing treads and rises of stairs, joists, roof-timbers.

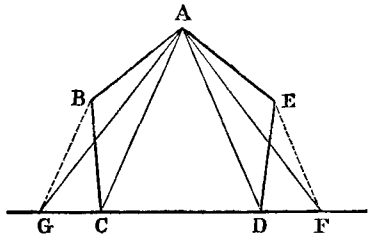
In the third method the divider is used simply as a parallel ruler. As such it has the advantage of having a wide range, and of being firmly fixed at the same time. In graphical statics, where it is often necessary to draw a line parallel to another at a considerable distance from it, set squares have often to be placed and replaced five or six times before the necessary line can be drawn. This instrument will at once draw the line. The range as a parallel ruler may be still further increased by having the plain rule considerably longer than the hinged one.

The special advantages of this instrument as a parallel ruler may best be seen by drawing what surveyors call the "give and take line."

When two fields are divided by a curved boundary, it is often required to find a straight boundary which will divide the fields in the same proportions as before. This straight boundary is what is called the "give and take" line.

In order to understand the method of finding it, it will be necessary to recall the method of finding a rectangle which shall be equal to a given polygon.

Fig. 4.



Let A B C D E (fig. 4) be the given polygon: produce C D both ways, and join A D and A C.

Draw E F ‖ to A D, and B G ‖ to A C, and join A G, A F. Then △ A F G is equal in area to the polygon A B C D E. For ∵ △'s A F D and A E D are on the same base A D and between the same ‖'s A D, E F,

∴ they are equal.

Similarly △ A G C = △ A B C.

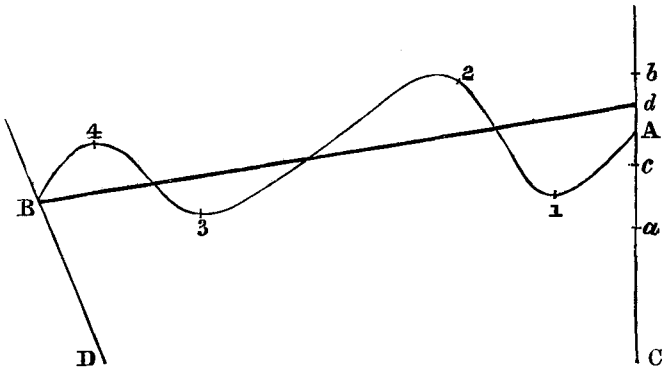
Having this triangle, it is easy to draw a rectangle equal to it.

Now let A 1 2 3 4 B (fig. 5) be the curved boundary of a field of which AC, BD are fixed boundaries; it is required to find a straight boundary to replace the curved one through A and B.

Place the divided limb roughly parallel to AC, with its bevelled edge nearest to AC, and at a distance about equal to the breadth of either limb from it, and fix the points firmly in the paper. Now move the undivided limb till it cuts AC at A and 1 2 at 2; slide it along till it is on the point 1, and mark the point *a* where it meets AC. Move it till it is against *a* and 3, and slide it along till it is against 2, marking the point *b* where it meets AC produced, if necessary. Move it till it is on *b* and 4, slide it till it is on 3, and mark *c*,

the point where it meets AC. Move it on to c B, slide back to 4, and mark point d where it meets AC; join d B. d B is

Fig. 5.



the line required, as may easily be seen by comparing the portions given and taken by the respective fields. This line would only divide the fields perfectly accurately as before, if A 1 2, 2 3 4, &c., were rectilineal angles ; but it is the nearest approximation possible, and the one always used.

The divider would also be useful on board ships for drawing lines on charts parallel to other lines at some distance. It would be much better for this purpose than an ordinary parallel ruler on account of its very large range and capability of being fixed.

Of course the line-divider can be used in all cases in which parallel rulers are ordinarily used.

In summing up, the advantages of the line-divider appear to be these :—

1. Lines of division can be drawn at any angle to the line to be divided.

2. Areas can be divided by equidistant lines parallel to any given line.

3. Since the divisions on the instrument are all equal, they may conveniently be made inches and parts of an inch; and

4, consequently the number of divisions may be made as great as we like without materially increasing the cost.

5. Lastly, the cost of the instrument is small, and it is made by Messrs. Stanley in three sizes—6, 12, and 24 inches in length.