Proportional Dividers

(kind of)

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"HOW @&%$"@ MUCH!" The afore mentioned cry of surprise resulted in Mrs A treating me for shock by wrapping me in a blanket (which was nice) and feeding me hot sweet tea (not nice, because I'm an unsweetened black coffee man. I think she did it to pay me back for the bad language.) What occasioned this outburst?

I wanted to copy some plans located close to the binding in a thick, hard backed book, so making photocopying impossible without splitting the binding, and thought I'd enlarge them at the same time using a set of Proportional Dividers to make working on them easier. After a search on the Internet, expecting a reasonable price for a precision instrument, I was astounded by the cost. Mostly US sites, $100 to over $300 depending on make.

If you are not familiar with this piece of drawing equipment, they are a double ended divider with an adjustable pivot point that sets the ratio of the measurements at each end so they can be used to scale up or down a drawing.

Figure 1: Proportional Dividers

Anyway, after recovery, I had a think and have come up with this design for a set of Proportional Dividers, admittedly not to the same precision of engineered brass ones, but very serviceable for the use they will get.

Instead of a sliding pivot, I have used a selection of fixed pivots to give a choice of several ratios between 1: 1.25 and 1: 3. How were the measurements of the pivot points obtained?

Cast your mind back to your schoolboy geometry and the Theory of Similar Triangles, see Figure 2 below.

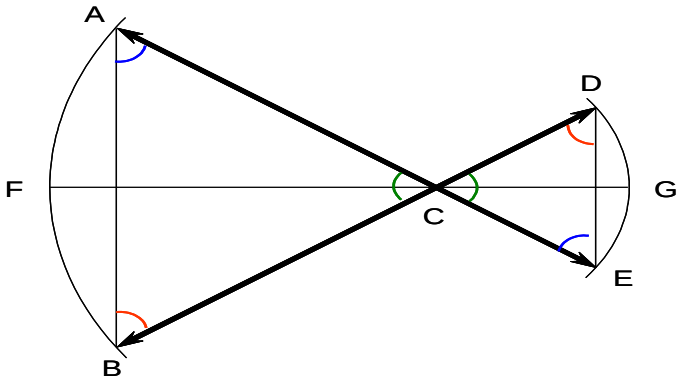

Figure 2:- Similar Triangles

- Lines FC, AC & BC = 4; Lines CG, CD & CE = 2
- Therefore Lines AE & BD are same length (6)
- Lines AB & DE are parallel
- <ACB & <DCE are Opposite angles
- <BAC & <DEC are Alternate angles
- <ABC & <CDE are Alternate angles

- Therefore triangles ABC & CDE are Similar
- This means that because line AC is 2 x line CE, i.e. the ratio 2:1, then Line AB is 2 x Line DE, therefore the ratio AB:DE is equal to the ratio AC:CE.
- If the ratio AC:CE is altered, by moving the pivot point 'c', then the ratio of AB:DE is altered proportionally.

Construction

I used two pieces of styrene from the local hobby shop. Clamp them together and sharpen the ends, ensuring they are symmetrical; Figure 3. The actual exact length does not matter, as will be seen later. Mine were about 8 inches. I started off the sharpening by using a pencil sharpener and then wet and dry abrasive paper until points were formed,

Figure 3: Sharpening the Ends

Next step is to mark the positions of the pivot for the various ratios. I used the following ratios in Table 1 below. I stopped at 1: 3 because of the physical size of the divider legs. Using the methods described, other ratios could be obtained if required. The columns labelled 'Ratio,' & 'Whole Number' speak for themselves, 'Division Point to A' & 'Division Point to Intersection' will be explained later.

Ratio	*Whole Number*	*Division Point to A*	*Division Point to Intersection*
1 : 1.25	4 : 5	9	5
1 : 1.50	2 : 3	15	6
1 : 1.75	4 : 7	11	7
1 : 2:00	1 : 2	15	5
1 : 2.50	2 : 5	14	4
1 : 2.75	4 : 11	15	11
1 : 3.00	1 : 3	12	3

Table 1

Marking the Pivot Points

Take a blank piece of paper. Draw a horizontal line longer than the divider legs and place one leg on it. Mark the length of the leg, and label it AB as shown in Figure 4.

More geometry I'm afraid. Bisect AB to find the centre and mark as 'c'. This will be used later.

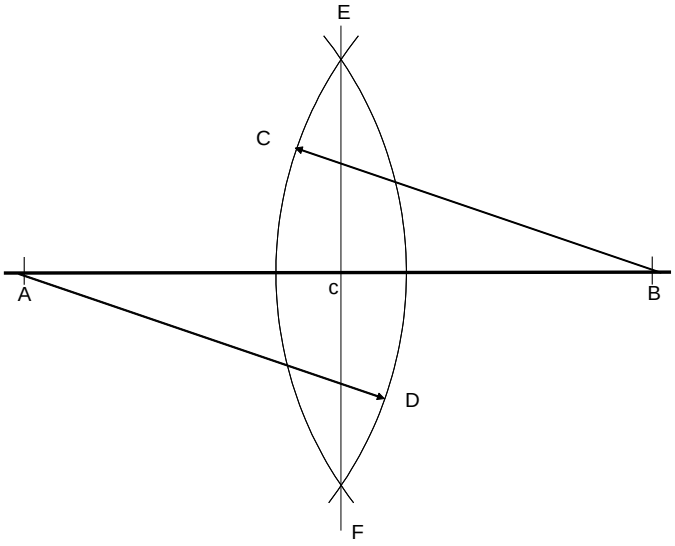

Figure 4: Marking and Bisecting AB

Now, how are the legs of the dividers (of unknown length AB) marked out so that the ratios in Table 1 can be achieved? There is a nice neat way of accurately dividing any straight line into any number of equal divisions. No ruler needed except to draw a straight line. This is how it's done:

- Draw a line at approximately 30^O from 'B', about the same length as AB, and label it BC.
- Using compasses, mark off 15 equal divisions up BC, and number them 1 to 15 as shown. This is because the maximum number of divisions needed for the ratios in Table 1 is 15.
- Now, for example, if AB requires to be divided into 7 equal sections, then draw a line from Point 7 to Point A.
- Using setsquares as shown, draw parallel a line parallel to Line A7 passing through Point 6 and Line AB, by placing the 30^O setsquare against A7, putting one edge of the other set square (or a ruler) against it, and slide the 30^O setsquare in the direction of the arrow until it lines up with Point 6.
- Then do the same but using Point 5 and so on. AB will then have 7 equal sections.

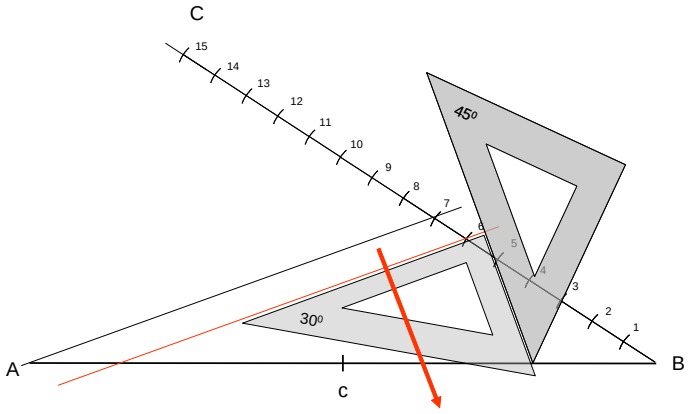

Figure 5:- Dividing a Line into Equal lengths

This is the method of marking the position of the pivot points. In Table 1, for each ratio pivot point, I've listed the:-

- 'Division Point to A' - the point from which to draw the line to Point A.
- 'Division Point to Intersection.' - the point to use for drawing the line parallel to the line through A.

This will give a spread of pivot points about the centre 'c' so that one end of the legs doesn't end up looking like a piece of Belgian Lace, with the breaking strain of a Kit-Kat.

We'll start with an easy one first; ratio 1: 2, Figure 6

- Using the information in Table 1,
- Draw a line from Division Point No 15, to point A
- Draw a line from Division Point N^o 5, parallel to Line 15A, so that it intersects line AB.
- This intersection is the pivot point for the ratio 1:2.

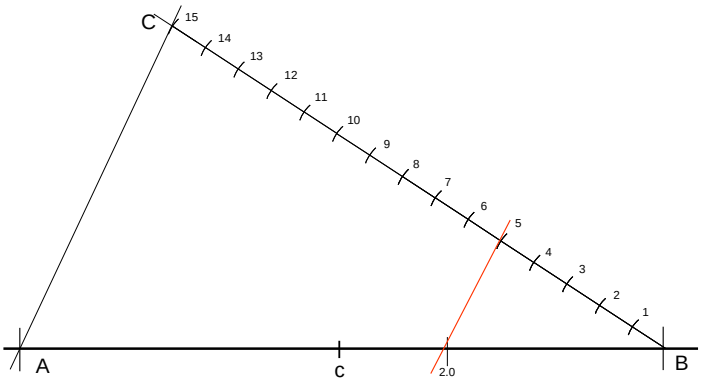

Figure 6: Marking of the Pivot Point for 1:2

Similarly for the ratio 1: 1.25, Figure 7.

- From Division Point No 9, draw a line to point A.
- Now, from Division Point No 4, draw a line parallel to line 3A, so that it intersects line AB.
- This intersection is the pivot point for the ratio 1 : 1.25

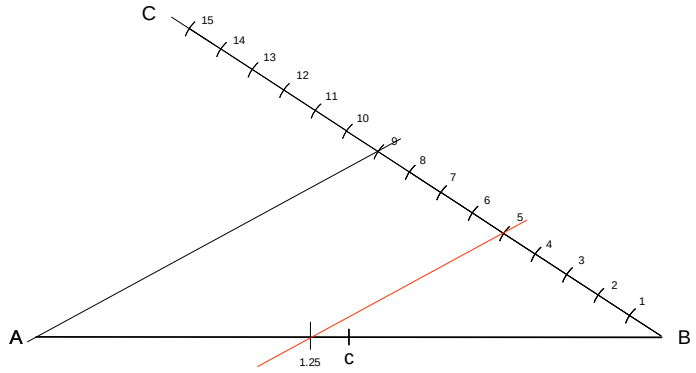

Figure 7: Marking of the Pivot Point for 1:1.25

And so on for the other ratios.

Transferring Measurements to the Legs

Because the above measurements are flat, and the legs are pointed at the end, transferring them accurately from paper to leg has its difficulties. The following has one awkward measurement, and then the rest are easy. Using a pair of dividers, lift of the distance from A to c, and mark on one leg as shown in Figure 8, using the other leg as a thickness piece keep the dividers level.

Once ‘c’ is marked, then the pivot points positions can be transferred easily to one of the legs using the distances from ‘c’ to the respective pivot point.

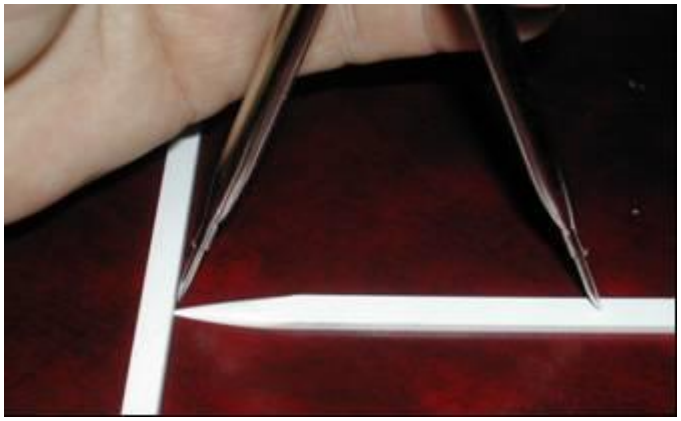

Figure 8: Marking the Centre, ‘c’

Clamp the legs together and drill the pivot point holes as a pair.

Figure 9: Ready for drilling

Mark the ratios on one of the legs and hold together with a M3 screw, nut, washes and spring washer to complete the dividers.

Figure 10: Ready for use.

On the other hand, if you want the really easy way, photocopy the enclosed diagram below and enlarge or shrink on a photocopier to fit the length of your divider legs.