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PATENT SPECIFICATION

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Complete Accepted, Mar. 25, 1918.

COMPLETE SPECIFICATION.

Improvements in Calculating Rules.

I, JERMIAH LEASK MANSON, of 37, Lombard Street, West Bromwich, Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The present invention relates to improvements in slide rules for assisting in the calculation of problems on springs, comprising one or more parts movable relatively to each other and bearing logarithmic or the like scales, and adapted to co-operate with one or more cursors, of the type in which a correction value scale or a logarithmic scale corresponding to the ratios of a series of varying factors to the factor taken as constant in the graduation of one or more of the normal scales of the rule, is provided preferably on the slide, which by a further manipulation of slide and cursor allows for the correction of any value determined by the usual manipulation of the scales and cursor, for a factor different to that forming one of the fixed factors in the preliminary calculation.

It has been proposed to provide correction scales for various metals, on slide rules for calculating dimensions of metal bars, angles and the like.

According to the present invention a scale of this type for springs is improved by the addition of graduations whereby with the assistance of a cursor any calculation for round wire which has resulted in the attainment of a quotient may be corrected to give the equivalent quotient for square wire or for rectangular wire of any desired dimension of cross-section.

Further the slide may be provided with scales for allowing the length and weight of wire forming the spring to be determined.

Two different scales capable of solving various problems in connection with the calculation of wire springs are illustrated in Figures 1 and 2 of the accompanying drawings, but it is obvious that these may be placed back to back to form a single instrument if desired.

Figure 3 shows an additional form of centre scale or slide which may obviously be placed on the reverse side of the centre slide of Figure 2.

The device consists of a body *a* having the usual central groove adapted to receive a slide *b* which may be of greater length than the body *a*. The body *a* has a scale *c* upon it, which in the above instance corresponds to the load in pounds per inch of deflection of a spring. This scale *c* co-operates with a scale *d*, which in the above instance corresponds to the number of free coils. On the other edge of the slide *b* is arranged a graduated scale *e* which corresponds to the diameter in inches of the wire of which the spring is manu-

[*Price* 6*d.*]

factured. This scale *e* co-operates with a scale *f* on the body *a*, which corresponds to values of the mean diameter of the coils of a coiled spring. The calculations can be effected on this slide rule by means of a sliding cursor with reading wire or mark *g* in known manner.

It will be seen therefore that this instrument allows of all calculations for springs involving the factors of the mean diameter D of the coils, the diameter of the wire *d*, the number of free coils N, and the loading W on the spring.

If desired, a further scale *h* may be provided corresponding to the empirical numbers of the standard wire gauge (S.W.G.), or other gauges.

Supposing now that the scales are graduated for circular cross section of coil, then to allow of determinations to be obtained for rectangular wire for instance, it will be necessary to make a certain correction of any determined value. This correction can be effected, according to the present invention, by the addition on the slide *b* of a correction scale *i*. Again supposing the scale to be graduated for steel of a given modulus of elasticity, then if it is desired to calculate for, for instance, brass springs, it will be necessary to make a certain correction of any value determined for steel, but for this purpose according to the present invention, the slide *b* may be provided with a further correction scale *k* graduated to the logarithmic coefficients of the ratios of the moduli of elasticity of varying substances to the modulus of elasticity of steel.

Similarly in the case of the scale illustrated in Figure 2, here the body *l* has again the usual central depression or groove *m* in which moves a slide *n*. The slide *n* has a scale *o* upon it corresponding to the load on the spring adapted to co-operate with a scale *p* on the body *l* corresponding to the mean diameter of the coil of the spring.

The slide *n* also has a scale *q* corresponding to the diameter of the wire which co-operates with a scale *r* on the body corresponding to the stress in pounds per square inch.

With these scales calculations may be effected in known manner by means of the reading wire *s* or mark on the cursor.

The slide *n* is provided, according to the present invention, with a graduation T to allow for correction to be made for square wire and with a scale *t* to allow for correction for rectangular wire of differing dimensions.

In the case of the slide *u* shown in Figure 3 scales *v* and *w* are provided corresponding respectively to the number of coils and to the diameter of the wire arranged to give the total weight of the spring in co-operation with the scale *r* on the body, whilst correction graduations *x* may be provided for varying factors, and also a logarithmic scale *y* being a corrective device for rectangular values, and a scale *z* enabling rapid calculation to be effected for the weight of a number of coils of the spring.

By the scale of the present invention it is therefore possible to calculate completely on the slide rule without mental endeavours, problems involving the following formula:—

$$\delta = \frac{8\ W\ D^3\ n}{G d^4}$$

Taking this formula by way of example, where δ equals unity, and W equals the load per inch of deflection, then

$$1 = 8\ \frac{W\ D^3\ n}{G\ d^4}$$

$$\therefore O = \log.\ W + 3\ \log.\ D + \log.\ n - 4\ \log.\ d - \log.\ \frac{G}{8}$$

or

$$-\log.\ W = 3\ \log.\ D - \left(4\ \log.\ d + \log.\ \frac{G}{8}\right) + \log.\ n.$$

The markings follow from this, the principle for other formulæ being similar.

It will be noticed that a double scale is used in this particular instance to obtain larger divisions. For square wire the formula—

$$\delta = \frac{6.2\ W\ D^3\ n}{G\ b^4}$$

where b is the side of the square, will be used. It is also possible to calculate for stress from the formula—

$$f_s = \frac{8\ L\ D}{\pi\ d^3}$$

where L is the load which will be for round wire, or from the formula—

$$f_s = \frac{7.54\ L\ D}{\pi\ d^3}$$

which will be for square wire (where f_s is the shear stress on the material).

Now the rule will be only graduated according to one of these formulæ; the ratio of the formula for square wire to the formula for round wire being expressed as indicated for instance at the left hand end of the correction device i (Fig. 1).

The following further formula can also be calculated, for the length of a spring—

$$D \times n \times \pi$$

For the weight of a spring—

$$D \times n \times \pi \times \left(\frac{\pi}{4} d^2\right) \times \text{density}.$$

In the case of square wire b^2 will be used instead of $\frac{\pi}{4} d^2$ and then of course the weight per number of coils can be calculated. This correction device is indicated at z (Fig. 3).

As an instance of the use of the rule to find the diameter of wire ("d") of a spring having a mean diameter of 3″ and 35 free coils with a rate of loading of 100 pounds per inch; the slide b will be displaced until the value 100 on the scale c lies below the value 35 on the scale d, then the cursor g is brought over the value 3 on the scale f whence "d" will be immediately obtained on the scale e and will be shown as .5″. This is for round wire. If a correction for square wire is desired, the slide b will require to be displaced a distance corresponding to that indicated between the line *sq* and the line *rd* on the correction device i. That is to say, the cursor g is brought over the line indicated with a star on the correction device i and the slide b is moved until the *sq* mark comes under the cursor. The cursor is moved back to the reading 3″, the mean diameter on the scale f, and the size of the square wire is given underneath as .461″ on the scale e.

The correction devices for various materials such as brass, German silver, *etc.* having varying moduli of elasticity, can be found in a similar manner on the correction device at k; that is to say, that, supposing the above value in the problem taken by way of example has been obtained for steel spring and it is required to find the same value for brass spring of round section, then the slide is so placed that .5 on the scale e will be opposite 3 on the scale f, then the cursor is brought over the starred line on the correction device k (Fig. 1), then the slide is moved until the value 6, being the corresponding modulus of elasticity for brass lies underneath the cursor g, when the cursor g can be returned to the value 3 on the scale f, and the size of the round brass wire will be given as approximately .595 inches.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. A slide rule of the type described, in which graduations are provided on the slide for permitting immediate revision of a calculation from a quotient determined for round wire to a desired equivalent quotient for square or rectangular wire substantially as described.

2. A slide rule of the type described having additional scales enabling the length and weight of a wire forming a spring to be determined, the rule enabling the calculations for the characteristics of a spring to be determined, substantially as described.

3. A slide rule for assisting in the calculation of problems on springs, constructed and arranged to operate substantially as described with reference to the accompanying drawings.

Dated this 22nd day of February, 1917.

For the Applicant,
W. P. THOMPSON & Co.,
6, Lord Street, Liverpool, and at
Bradford & London,
Chartered Patent Agents.

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[This Drawing is a reproduction of the Original on a reduced scale.]

Fig. 1.

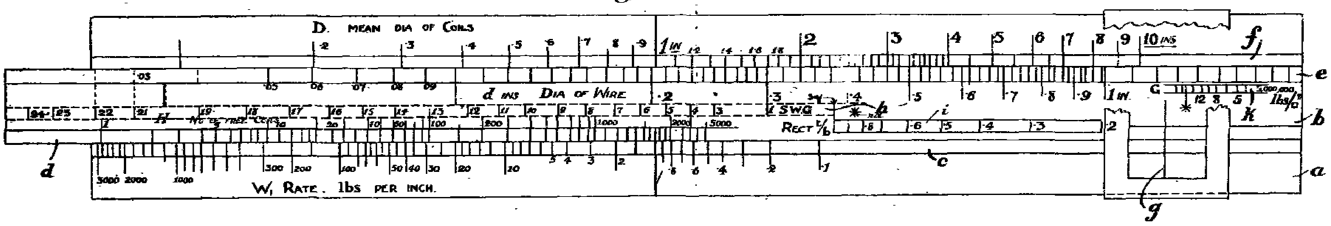


Fig. 2.

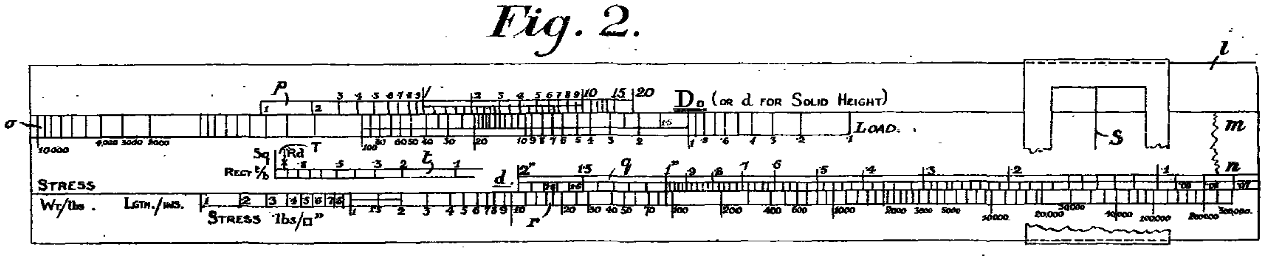
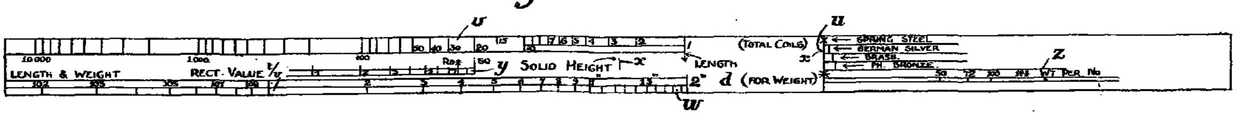


Fig. 3.



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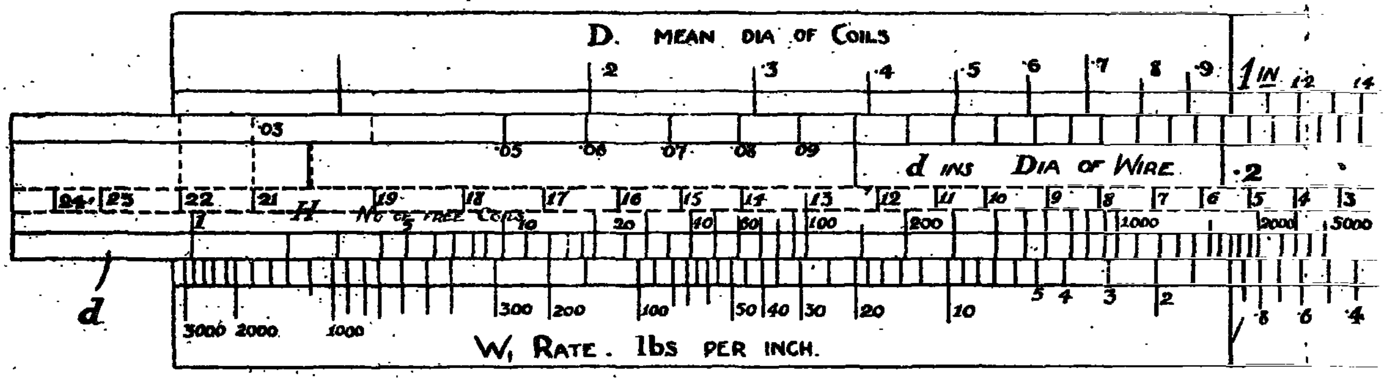


Fig. 2.

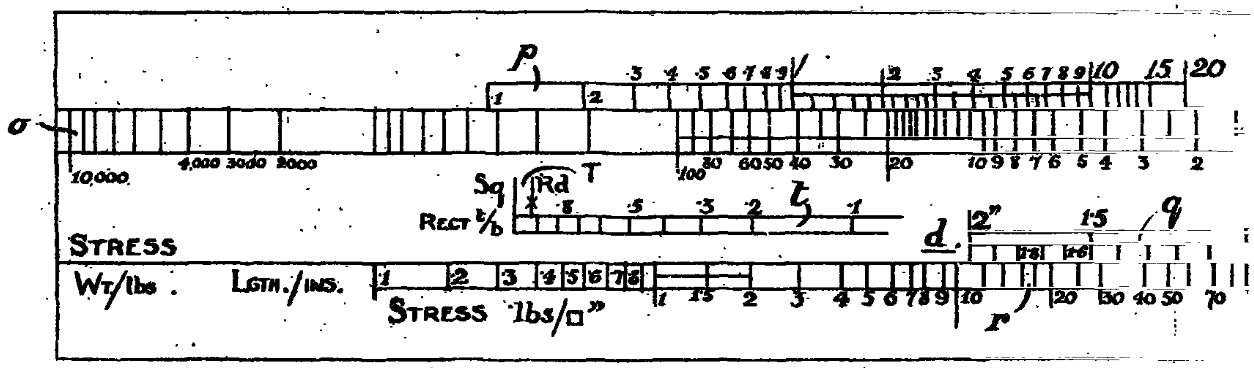
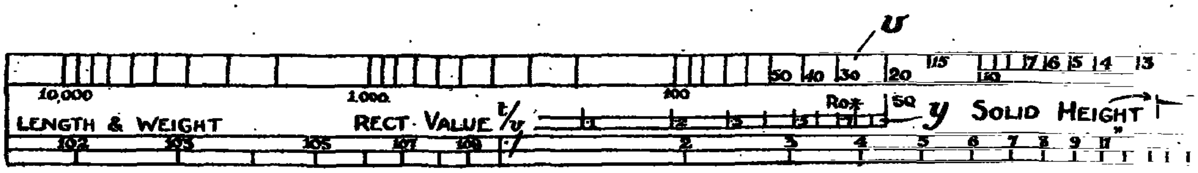


Fig. 3.



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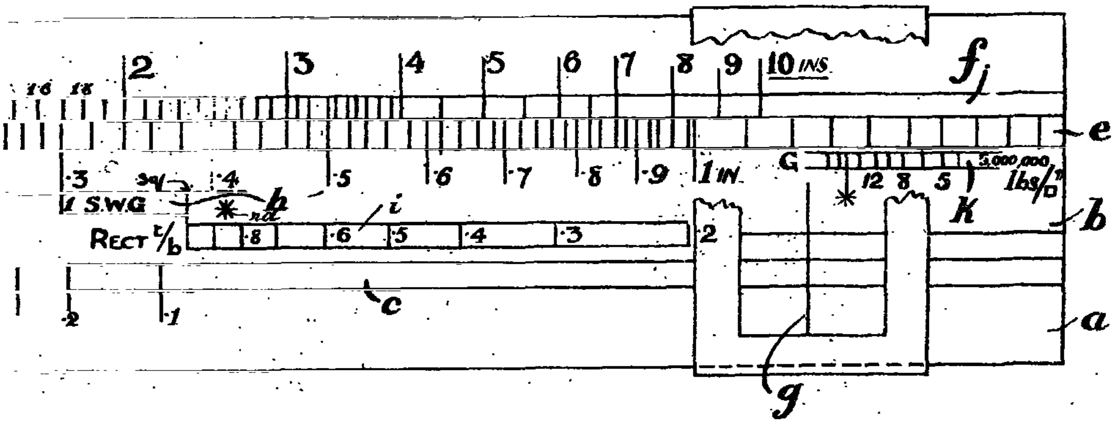

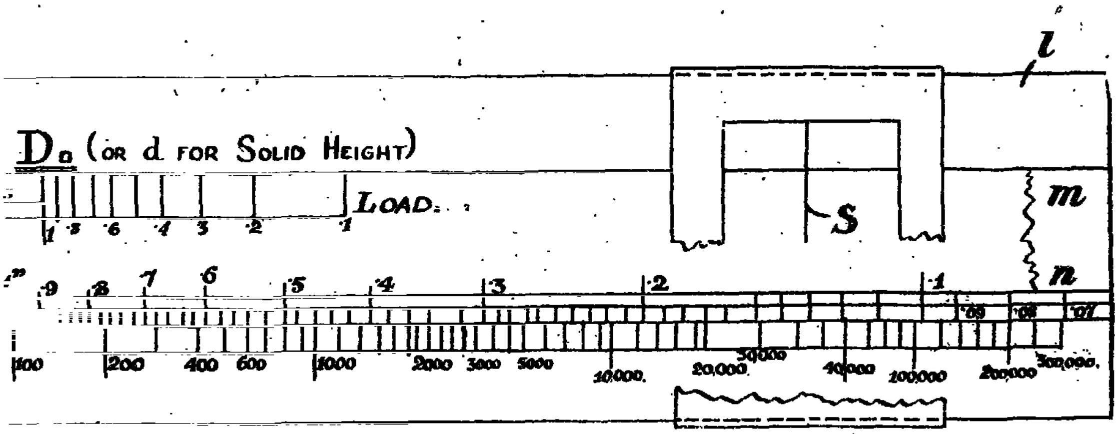

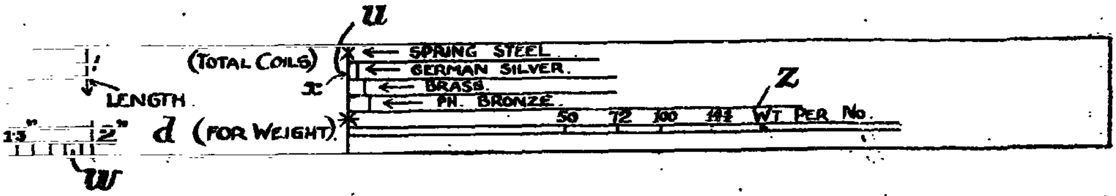

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