N° 5142 A.D. 1900

Date of Application, 17th Mar., 1900

Complete Specification Left, 14th Nov., 1900—Accepted, 22nd Dec., 1900

PROVISIONAL SPECIFICATION.

An Improved Calculating Apparatus for Ascertaining the Section of Beams, Girders, Columns, and the like.

I, WILHELM DOHM, of Bielefeld, in the Kingdom of Prussia and Empire of Germany, Architect, do hereby declare the nature of this invention to be as follows:—

My invention consists of a calculating apparatus for ascertaining the size of the section required for a joist, column or the like, designed to sustain a certain load.

The joists or beams, as they are used in buildings, bridges, and so on, may be supported at both ends and the load may be placed on or suspended from some point of the joist between the supports, or the load may be distributed equally over the whole length or part of the length. The joists may also be fixed at the one end, while the load is placed on or suspended from the other end, or it may be distributed equally over the whole length.

In any of these cases the improved calculating apparatus will show the size of the required section of the joist for any load, length of joist, and safe limit of stress. In a similar manner the apparatus may be employed for ascertaining the section of a column or other structure subjected to a certain load under certain conditions.

The calculating apparatus is illustrated in the accompanying drawing, in which:

Figure 1 is a view of the complete apparatus.

Figure 2 is a vertical cross section of the same on the line A—B of Figure 1, and

Figures 3 and 4 show modifications of the apparatus.

Similar letters refer to similar parts throughout the several views.

The semicircular part *a* is rigidly connected with the base *b*, so as to form therewith a frame, the said base having secured at its middle portion a bolt *c*, which serves as a centre for the semicircular part *a*. On the bolt *c* is adapted to oscillate a lever *d*, while the said lever may be affixed in any position to the frame *a b* by a nut *f*.

The lever *d* is provided with suitable guides *m* and *n*, which overlap the semicircular part *a*, and if desired the said guides *m* and *n* may be extended over the semicircular part so as to form a single bridge in which a screw having a knurled head similar to the nut *f* may be placed for the purpose of securing the lever *d* in any desired position upon the semicircular part *a*. Since the lever *d* is arranged between the base *b* and the semicircular part *a*, Figure 2, the latter requires to be depressed with regard to the base *b* to allow of the lever *d* oscillating through an angle of nearly 180 degrees. For this reason the semicircular part *a*, in case it is made in one piece with the base *b* as shown, requires to be bent backward at the places where it connects with the base part *b*.

A rule *g* is arranged to slide on the base *b*, and is rigidly connected to the

[*Price* 8*d*.]

slide *i h* which is shaped like an inverted T and embraces the base *b* with the overlap h^1, while the inner end g^1 of the rule engages in a recess at the back of the base *b*. The rule *g* is at right angles to the base *b* and may be secured in any position thereon by means of the screw *k*. If desired the rule *g* may be made in one piece with the slide *i h* and the said rule when shifted to either end of the base, may be taken off or removed.

The calculating apparatus shown is arranged in accordance with metrical measurements and weights but it is obvious that it may be adapted for any other scale, such for example as English measures and weights and the said gauge is further assumed to be designed for iron I-beams.

The semicircular part *a* is provided with three concentric scales showing various loads in kilogrammes for the safe limits of stress of 750, 875 and 1000 kilogrammes per square centimetre respectively (see the figures above the upper line of the base *b*). The lever *d* which is provided with a slot *e* serves as an indicator for these three scales.

In the drawing the scales on the right hand of the initial or zero line *p o* are arranged for loads distributed equally over a length of 1 metre and running from 300, 350 and 400 kilogrammes respectively to 4000 kilogrammes, while the scales on the left hand of the said line are arranged for single loads running from 900, 1050 and 1200 kilogrammes respectively to 5000 and 6000 kilogrammes respectively.

The base *b* is provided with several parallel scales for various lengths of the joist up to 15 metres. The upper scale on the right hand of the zero line *p o* is arranged for loads distributed equally over the whole length of the joist; the upper scale on the left hand is for single loads in the middle of the joist supported at both ends. The ten lower scales on the right hand are for joists of the length of 10, 9, 8, 7, 6, 5, 4, 3, 2 and 1 metre respectively and for loads distributed equally over a part of the joist extending from one support. The ten lower scales on the left hand are for joists of similar lengths and for single loads on any point of the joist supported at both ends.

The lever *d* is provided with several vertical scales for I-beams classified after the German fashion. The first scale on the right hand from the line *p o* contains the German standard sections No. 12 to 40 for single loads and the second scale (marked with "D" at the top) shows certain coefficients. The first scale on the left hand contains the German standard sections No. 8 to 50 for loads distributed equally over the whole length and part of same. The second scale (marked with "W" at the top) contains the corresponding values W of the moment of inertia divided by the distance of neutral axis from bottom of section (such values are preferably used in German calculations). The third scale (marked with "*b*" at the top) refers to the breadths of the flanges of the joists and contains at the same time certain coefficients.

The rule *g* has no scale, since it serves simply as an indicator.

In order to better explain the use of the apparatus I will now take several examples.

1. Given an I-beam 5.6 metres long between the supports loaded with 1000 kilogrammes per metre distributed equally, *i.e.* with $5.6 \times 1000 = 5600$ kilogrammes in all, distributed equally over the whole length, what is the size of the section?

First adjust the lever *d* on the right hand side of the semicircular part *a* as indicated by the dotted lines, and so that the line *p o* in the slot *e* coincides with the division line for 1000 kilogrammes in the respective scale, for example that for the safe limit of stress of 875 kilogrammes per square centimetre. Then move the rule *g* on the base *b* and adjust it in such a manner that its edge coincides with the division line for 5.6 metres in the upper scale on the base *b*. The crossing point of the edge of the rule *g* and of the line *p o* will show the German standard No. 28 and the value of W as 392.

2. Given a joist 7 metres long supported on both ends, which, for a length of 4 metres from the one support is loaded with 2500 kilogrammes per metre

(*i.e.* in all 4 × 2500 = 10,000 kilogrammes) equally distributed and the iron allows a safe limit of stress of 750 kilogrammes per square centimetre, what is the size of the section?

Adjust the lever *d* on the right hand side so that the line *p o* coincides with the division line for 2500 kilogrammes on the scale for the safe limit of stress of 750, and adjust the rule *g* so that its edge coincides with the division line 4 in the horizontal scale marked 7. The crossing point of the rule *g* and lever *d* will then give the value W as 1360 [it being 1274 + ($4\frac{1}{3}$ division lines × 20) = 1274 + 86 = 1360]. At the same time the German standard size and the breadth may be read off.

If the joist be supported on both ends and loaded with a single load either in the middle or at any distance from one support, the lever *d* should be adjusted on the left hand side and the rule *g* adjusted to the respective division line in one of the scales on base *b* when the crossing point of lever and rule will show the size of section, which should be read off the first scale on the right hand of the line *p o* on lever *d*.

3. A joist 5.5 metres long supported on both ends is loaded in the middle with a single load of 3500 kilogrammes and the safe limit of stress should be 875 kilogrammes per square centimetre. Adjust lever and rule in the indicated manner and the crossing point will show W as 550.

4. A joist 6 metres long supported on both ends is loaded at a distance of 2.5 metres from one support with a single load of 4500 kilogrammes and the safe limit of stress is 750 kilogrammes per square centimetre. The apparatus will give W as 865.

5. A joist 1.5 metres long is fixed at one end and loaded at the other end with 1800 kilogrammes and the safe limit of stress is 1000 kilogrammes per square centimetre. Adjust the lever *d* as usual and the rule *g* to double the length *i.e.* 3 metres, when the crossing point will show W as 270.

6. The same joist as before is loaded with 1500 kilogrammes per metre distributed equally, *i.e.* with 1.5 × 1500 = 2250 kilogrammes in all, distributed equally over the whole length, and the safe limit of stress is 1000 kilogrammes per square centimetre. Adjust the lever as usual on the right hand side and the rule *g* to double the length *i.e.* 3 metres, when the crossing point will show W as 162 + 1 division line × 8 = 162 + 8 = 170.

It is obvious that the calculating apparatus may be arranged for any load and for any section of the joist, also for any material of same and consequently for any safe limit of stress. If it is desired to arrange the gauge not only for iron I-beams, as above, but also for wooden beams of any section, all that is required is to add further suitable scales to those on the semicircular part *a* and on the lever *d*. Instead of the values W used above other values, such as moments of inertia and the like may be adopted. The members of the scales on parts *a* and *b* and on lever *d* may be chosen at pleasure.

The calculating apparatus may also be used for ascertaining the section of a column of a certain height under a given load and according to the manner in which the column is fixed at the bottom and also at the top. In these cases additional scales on the semicircular part *a* may be used, while the lever is replaced by another one provided with suitable scales containing the moments of inertia, the sizes of section and so on. Also the lever may be retained and a slide containing the respective values may be introduced into a recess of the lever in some known manner. Also several slides may be used instead of the one arranged on the lever *d*. The construction of such slides and of the lever is immaterial, since the slides form a rigid whole with the lever, and the lever is adjusted by simply turning round the pivot *c* as above explained. The apparatus may also be arranged for columns exclusively.

In a similar manner the calculating apparatus may be arranged for other parts of structures, since it remains the same while only the scales require to be altered.

The calculating apparatus may further be modified in the manner shown in Figure 3, the lever *d* being extended beyond its axis. By this means the advantage is obtained, that the slot *e* need not be in the scales, because the latter are placed on the other arm of the lever. The rule *g* requires, of course, to be placed on the side opposite to the semicircular part *a*.

Where it is desired to employ distinct scales on the semicircular part, say for example a series of scales for joists and another series for columns, this may be done by doubling the semicircular parts *a*, *i.e.* by converting the semicircular part *a* into a circular part as shown in Figure 4. One and the same lever *d* may be used for both semicircular parts. Or the lever *d* may have two arms as shown in Figure 3.

If desired, the semicircular part may be formed as a full disk or plate with concentric scales round the edge.

The improved calculating apparatus may be made of any material such as wood, brass, or other material.

Dated this 17th day of March 1900.

HASELTINE, LAKE & Co.,
45, Southampton Buildings, London, W.C.,
Agents for the Applicant.

COMPLETE SPECIFICATION.

An Improved Calculating Apparatus for Ascertaining the Section of Beams, Girders, Columns, and the like.

I, WILHELM DOHM, of Bielefeld, in the Kingdom of Prussia and Empire of Germany, Architect, 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:—

My invention consists of a calculating apparatus for ascertaining the size of the section required for a joist, column or the like, designed to sustain a certain load.

The joists or beams, as they are used in buildings, bridges and so on, may be supported at both ends and the load may be placed on or suspended from some point of the joist between the supports, or the load may be distributed equally over the whole length or part of the length. The joists may also be fixed at the one end, while the load is placed on or suspended from the other end, or it may be distributed equally over the whole length.

In any of these cases the improved calculating apparatus will show the size of the required section of the joist for any load, length of joist and safe limit of stress. In a similar manner the apparatus may be employed for ascertaining the section of a column or other structure subjected to a certain load under certain conditions.

The calculating apparatus is illustrated in the drawings accompanying my Provisional Specification in which:

Figure 1 is a view of the complete apparatus.

Figure 2 is a vertical cross section of the same on the line A—B of Figure 1, and

Figures 3 and 4 show modifications of the apparatus.

Similar letters refer to similar parts throughout the several views.

The semicircular part *a* is rigidly connected with the base *b*, so as to form therewith a frame, the said base having secured at its middle portion a bolt *c*, which serves as a centre for the semicircular part *a*. On the bolt *c* is adapted

to oscillate a lever *d*, while the said lever may be affixed in any position to the frame *a b* by a nut *f*.

The lever *d* is provided with suitable guides *m* and *n*, which overlap the semicircular part *a*, and if desired the said guides *m* and *n* may be extended over the semicircular part so as to form a single bridge in which a screw having a knurled head similar to the nut *f* may be placed for the purpose of securing the lever *d* in any desired position upon the semicircular part *a*. Since the lever *d* is arranged between the base *b* and the semicircular part *a*, Figure 2, the latter requires to be depressed with regard to the base *b* to allow of the lever *d* oscillating through an angle of nearly 180 degrees. For this reason the semicircular part *a*, in case it is made in one piece with the base *b* as shown, requires to be bent backward at the places where it connects with the base part *b*.

A rule *g* is arranged to slide on the base *b*, and is rigidly connected to the slide *i h* which is shaped like an inverted T and embraces the base *b* with the overlap h^1, while the inner end g^1 of the rule engages in a recess at the back of the base *b*. The rule *g* is at right angles to the base *b* and may be secured in any position thereon by means of the screw *k*. If desired the rule *g* may be made in one piece with the slide *i h* and the said rule when shifted to either end of the base, may be taken off or removed.

The calculating apparatus shown is arranged in accordance with metrical measurements and weights but it is obvious that it may be adapted for any other scale, such for example as English measures and weights and the said gauge is further assumed to be designed for iron I-beams.

The semicircular part *a* is provided with three concentric scales showing various loads in kilogrammes for the safe limits of stress of 750, 875 and 1000 kilogrammes per square centimetre respectively (see the figures above the upper line of the base *b*). The lever *d* which is provided with a slot *e* serves as an indicator for these three scales.

In the drawing the scales on the right hand of the initial or zero line *p o* are arranged for loads distributed equally over a length of 1 metre and running from 300, 350 and 400 kilogrammes respectively to 4000 kilogrammes, while the scales on the left hand of the said line are arranged for single loads running from 900, 1050 and 1200 kilogrammes respectively to 5000 and 6000 kilogrammes respectively.

The base *b* is provided with several parallel scales for various lengths of the joist up to 15 metres. The upper scale on the right hand of the zero line *p o* is arranged for loads distributed equally over the whole length of the joist; the upper scale on the left hand is for single loads in the middle of the joist supported at both ends. The ten lower scales on the right hand are for joists of the length of 10, 9, 8, 7, 6, 5, 4, 3, 2 and 1 metre respectively and for loads distributed equally over a part of the joist extending from one support. The ten lower scales on the left hand are for joists of similar lengths and for single loads on any point of the joist supported at both ends.

The lever *d* is provided with several vertical scales for I-beams classified after the German fashion. The first scale on the right hand from the line *p o* contains the German standard sections No. 12 to 40 for single loads and the second scale (marked with "D" at the top) shows certain coefficients. The first scale on the left hand contains the German standard sections No. 8 to 50 for loads distributed equally over the whole length and part of same. The second scale (marked with "W" at the top) contains the corresponding values W of the moment of inertia divided by the distance of neutral axis from bottom of section (such values are preferably used in German calculations). The third scale (marked with "*b*" at the top) refers to the breadths of the flanges of the joists and contains at the same time certain coefficients.

The rule *g* has no scale, since it serves simply as an indicator.

In order to better explain the use of the apparatus I will now take several examples.

Improved Calculating Apparatus for Ascertaining the Section of Beams, &c.

1. Given an I-beam 5·6 metres long between the supports loaded with 1000 kilogrammes per metre distributed equally, *i.e.* with 5.6 × 1000 = 5600 kilogrammes in all, distributed equally over the whole length, what is the size of the section?

First adjust the lever *d* on the right hand side of the semicircular part *a* as indicated by the dotted lines and so that the line *p o* in the slot *e* coincides with the division line for 1000 kilogrammes in the respective scale, for example that for the safe limit of stress of 875 kilogrammes per square centimetre. Then move the rule *g* on the base *b* and adjust it in such a manner that its edge coincides with the division line for 5.6 metres in the upper scale on the base *b*. The crossing point of the edge of the rule *g* and of the line *p o* will show the German standard No. 28 and the value of W as 392.

2. Given a joist 7 metres long supported on both ends which for a length of 4 metres from the one support is loaded with 2500 kilogrammes per metre (*i.e.* in all 4 × 2500 10,000 kilogrammes) equally distributed and the iron allows a safe limit of stress of 750 kilogrammes per square centimetre, what is the size of the section?

Adjust the lever *d* on the right hand side so that the line *p o* coincides with the division line for 2500 kilogrammes on the scale for the safe limit of stress of 750, and adjust the rule *g* so that its edge coincides with the division line 4 in the horizontal scale, marked 7. The crossing point of the rule *g* and lever *d* will then give the value of W as 1360 (it being 1274 + 4¼ division lines × 20) = 1274 + 86 = 1360). At the same time the German standard size and the breadth may be read off.

If the joist be supported on both ends and loaded with a single load either in the middle or at any distance from one support, the lever *d* should be adjusted on the left hand side and the rule *g* adjusted to the respective division line in one of the scales on base *b* when the crossing point of lever and rule will show the size of section, which should be read off the first scale on the right hand of the line *p o* on lever *d*.

3. A joist 5.5 metres long supported on both ends is loaded in the middle with a single load of 3500 kilogrammes and the safe limit of stress should be 875 kilogrammes per square centimetre. Adjust lever and rule in the indicated manner and the crossing point will show W at 350.

4. A joist 6 metres long supported on both ends is loaded at a distance of 2.5 metre from one support with a single load of 4500 kilogrammes and the safe limit of stress is 750 kilogrammes per square centimetre. The apparatus will give W as 865.

5. A joist 1.5 metres long is fixed at one end and loaded at the other end with 1800 kilogrammes and the safe limit of stress is 1000 kilogrammes per square centimetre. Adjust the lever *d* as usual and the rule *g* to double the length *i.e.* 3 metres, when the crossing point will show W as 270.

6. The same joist as before is loaded with 1500 kilogrammes per meter distributed equally, *i.e.* with 1.5 × 1500 = 2250 kilogrammes in all, distributed equally over the whole length, and the safe limit of stress is 1000 kilogrammes per square centimetre. Adjust the lever as usual on the right hand side and the rule *g* to double the length *i.e.* 3 metres, when the crossing point will show W as 162 + 1 division line × 8 = 162 + 8 = 170.

It is obvious that the calculating apparatus may be arranged for any load and for any section of the joist, also for any material of same and consequently for any safe limit of stress. If it is desired to arrange the gauge not only for iron I-beams, as above but also for wooden beams of any section, all that is required is to add further suitable scales to those on the semicircular part *a* and on the lever *d*. Instead of the values W used above other values, such as moments of inertia and the like may be adopted. The members of the scales on parts *a* and *b* and on lever *d* may be chosen at pleasure.

The calculating apparatus may also be used for ascertaining the section of a column of a certain height under a given load and according to the manner in

which the column is fixed at the bottom and also at the top. In these cases additional scales on the semicircular part *a* may be used, while the lever is replaced by another one provided with suitable scales containing the moments of inertia, the sizes of section and so on. Also the lever may be retained and a slide containing the respective values may be introduced into a recess of the lever in some known manner. Also several slides may be used instead of the one arranged on the lever *d*. The construction of such slides and of the lever is immaterial, since the slides form a rigid whole with the lever and the lever is adjusted by simply turning round the pivot *c* as above explained. The apparatus may also be arranged for columns exclusively.

In a similar manner the calculating apparatus may be arranged for other parts of structures, since it remains the same while only the scales require to be altered.

The calculating apparatus may further be modified in the manner shown in Figure 3, the lever *d* being extended beyond its axis. By this means the advantage is obtained, that the slot *e* need not be in the scales, because the latter are placed on the other arm of the lever. The rule *g* requires, of course, to be placed on the side opposite to the semicircular part *a*.

Where it is desired to employ distinct scales on the semicircular part, say for example a series of scales for joists and another series for columns, this may be done by doubling the semicircular parts *a*, *i.e.* by converting the semicircular part *a* into a circular part as shown in Figure 4. One and the same lever *d* may be used for both semicircular parts. Or the lever *d* may have two arms as shown in Figure 3.

If desired, the semicircular part may be formed as a full disk or plate with concentric scales round the edge.

The improved calculating apparatus may be made of any material such as wood, brass, or other material.

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 calculating apparatus for ascertaining the section of a structure part, consisting of a semicircular part with a pivot at its centre and secured to a base connected with said semicircular part, a lever arranged to revolve around said pivot and to serve as indicator for concentric scales provided on said semicircular part, and a rule rectangular to said base and arranged to slide thereon and to serve as an indicator for scales provided on said base and on lever, substantially as set forth.

2. A calculating apparatus for ascertaining the section of a structure part, consisting of a semicircular part covered with concentric load scales for certain safe limits of stress, a base part connecting the ends of said semicircular part and carrying at the centre of same a pivot and being covered with straight scales for lengths of the structure part, a lever mounted to revolve around said pivot to serve as an indicator to said concentric scales and being covered with straight scales for sizes and moments of inertia or similar values of the section to be ascertained, and a rule rectangular to said base part and arranged to slide thereon and to serve as an indicator to said scales on said base part and on said lever, substantially as set forth.

3. A calculating apparatus for ascertaining the section of a structure part under a certain load, consisting of a semicircular part covered on the front side with concentric load scales for certain safe limits of stress, a base part connecting the ends of said semicircular part and carrying at the centre of same and on the rear thereof a pivot, and being provided on the front side with scales for lengths of the structure part and distances of the loads acting thereon, a lever mounted on said pivot to revolve and provided with a slot to serve as an indicator to said concentric scales, said lever being covered on the front side with straight scales

for sizes, moments of inertia and the like of various sections of the structure part, guides arranged at the rear side of said lever for grasping said semicircular part, means for securing said lever in any position to said semicircular part, and a rule rectangular to said base part and arranged to slide thereon and to serve as an indicator to the scales on said base part and on said lever, substantially as set forth.

4. A calculating apparatus for ascertaining the required section of a structure part under a certain load, consisting of a semicircular part covered on the front side with concentric load scales for certain safe limits of stress, a base part connecting the ends of said semicircular part and carrying at the centre of same on the rear side a pivot and being provided on the front side with scales for lengths of the structure part and distances of the loads acting thereon, a lever mounted on said pivot to revolve and provided with a slot to serve as an indicator to said concentric scales, said lever being covered on the front side with straight scales for sizes, moments of inertia and the like of various sections of the structure part, the said semicircular part and the said base part being so arranged as to leave sufficient room for said lever to revolve, guides provided at the back side of said lever for grasping said semicircular part, means for securing said lever in any position to said semicircular part, a rule rectangular to said base part and arranged to slide thereon and to serve as an indicator to the scales on said base part and on said lever, and means for securing said rule in any position, substantially as set forth.

Dated this 14th day of November 1900.

HASELTINE, LAKE & Co.,
45, Southampton Buildings, London, W.C.,
Agents for the Applicant.

Redhill: Printed for Her Majesty's Stationery Office, by Malcomson & Co., Ltd.—1901.

A.D. 1900 March 17. N°. 5142.
DORMS. Provisional Specification.

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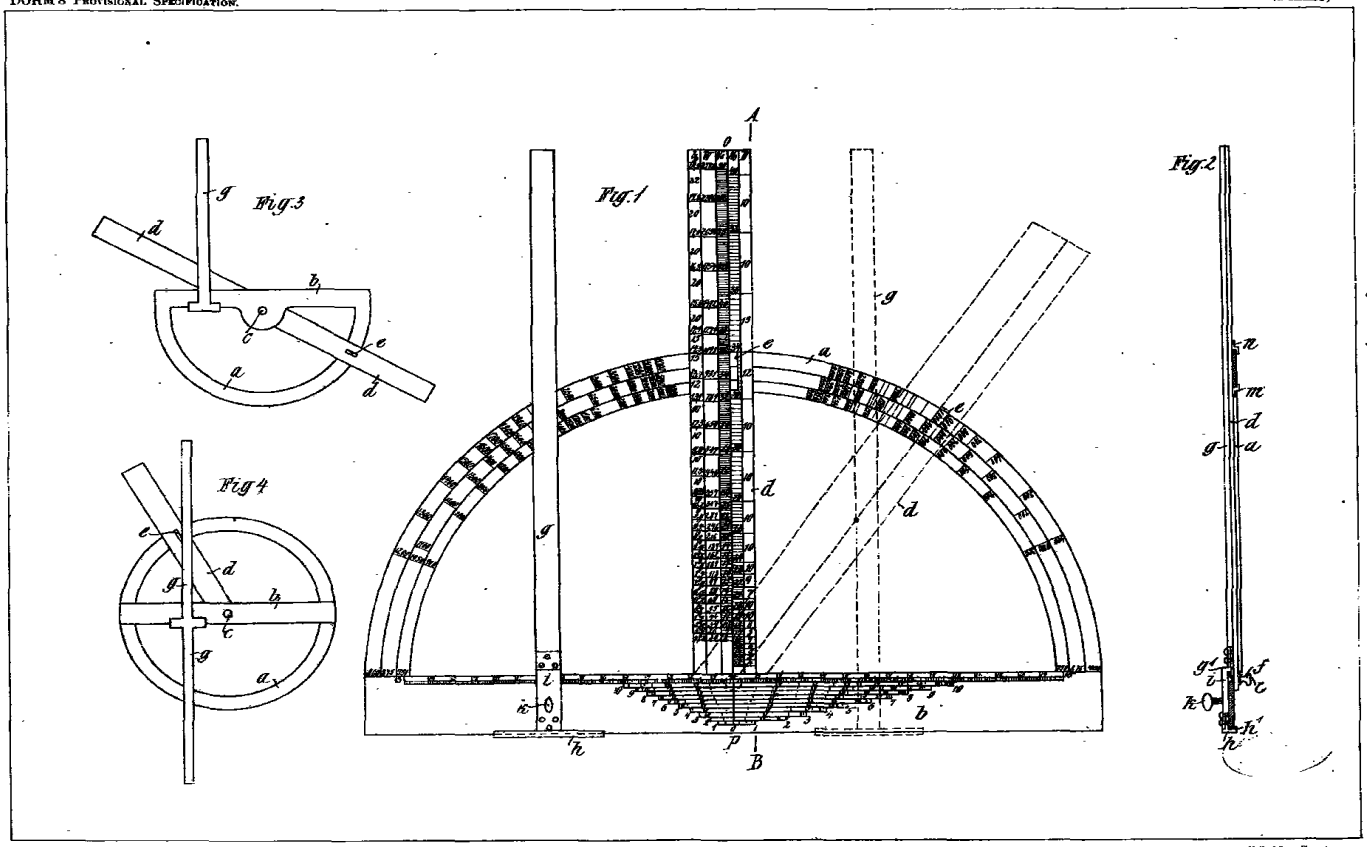

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[This Drawing is a reproduction of the Original on a reduced scale.]

Fig. 3

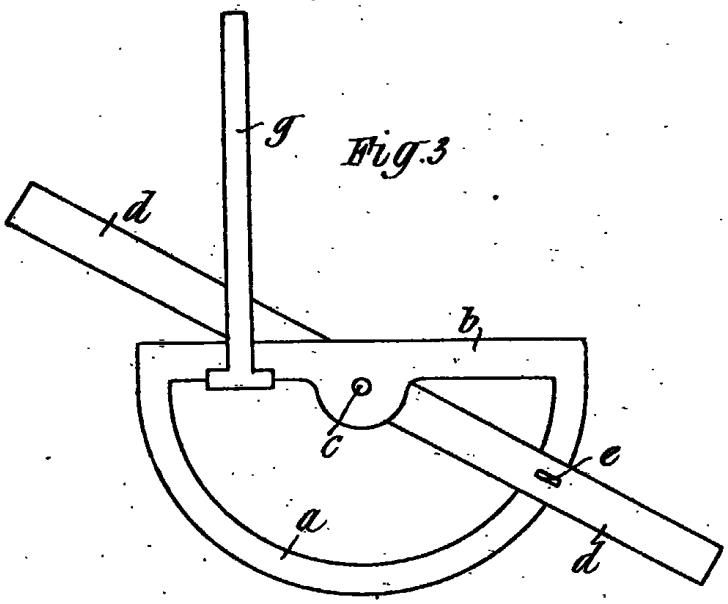


Fig. 1

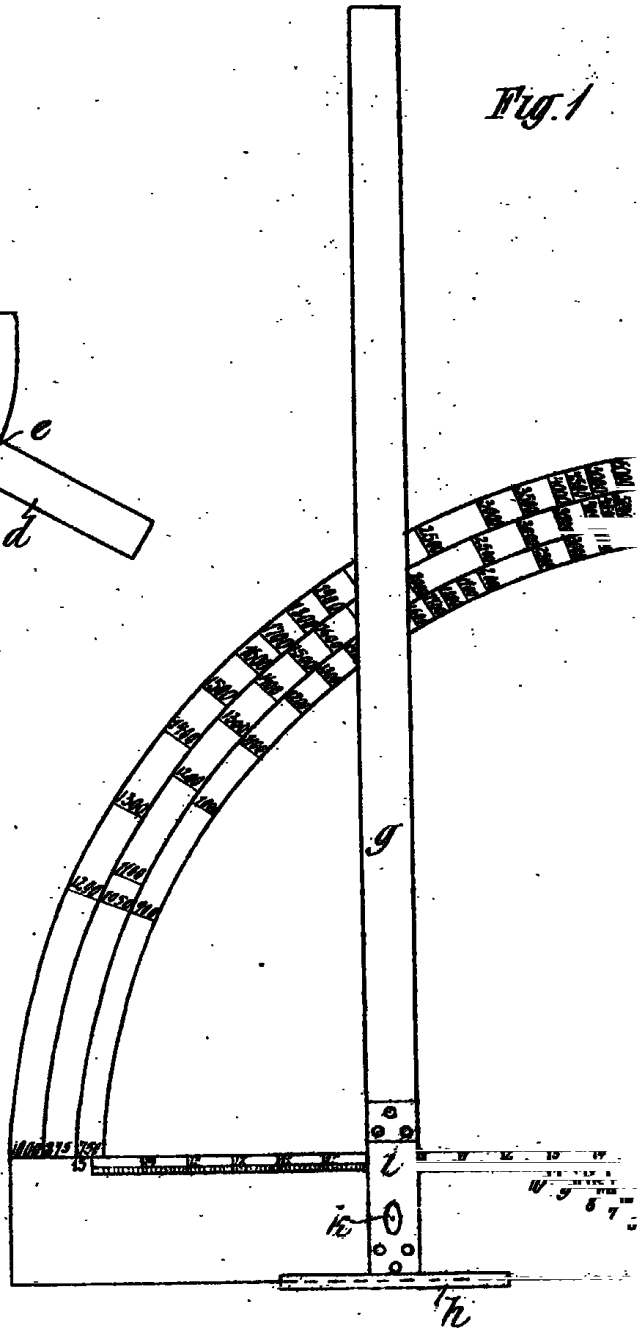
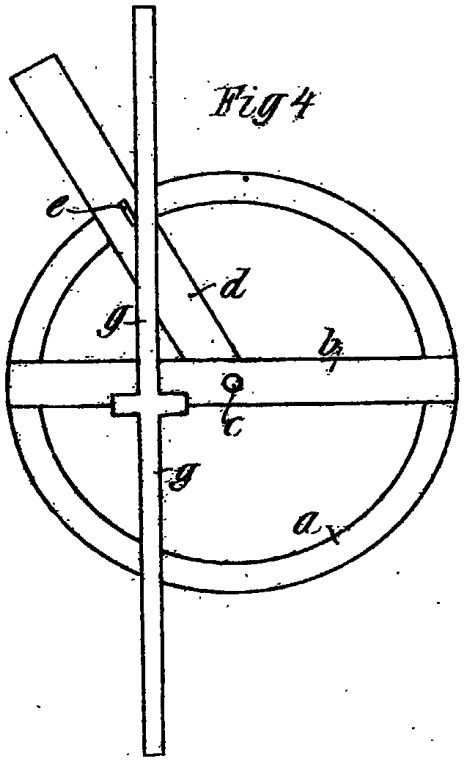


Fig 4



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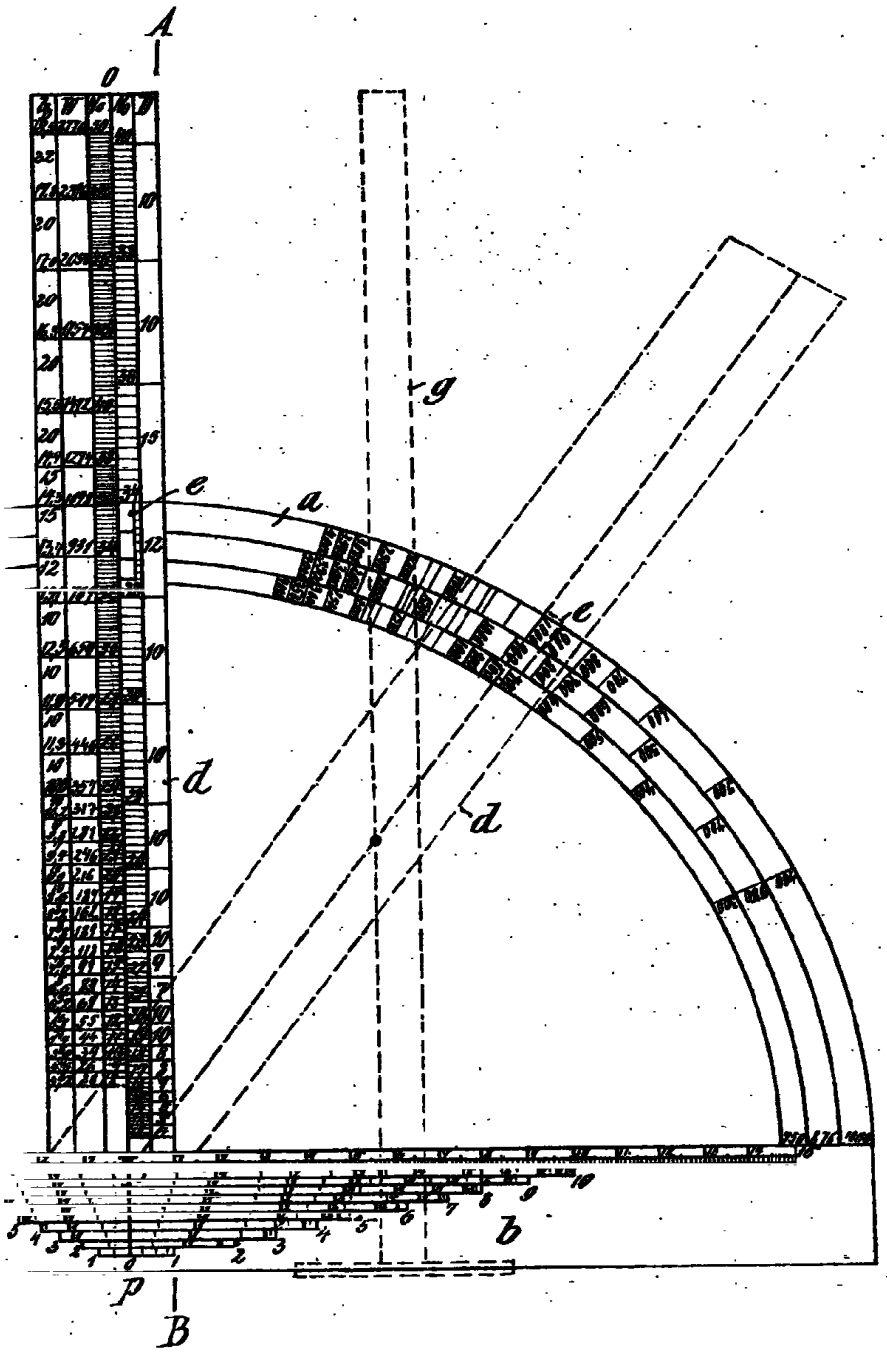
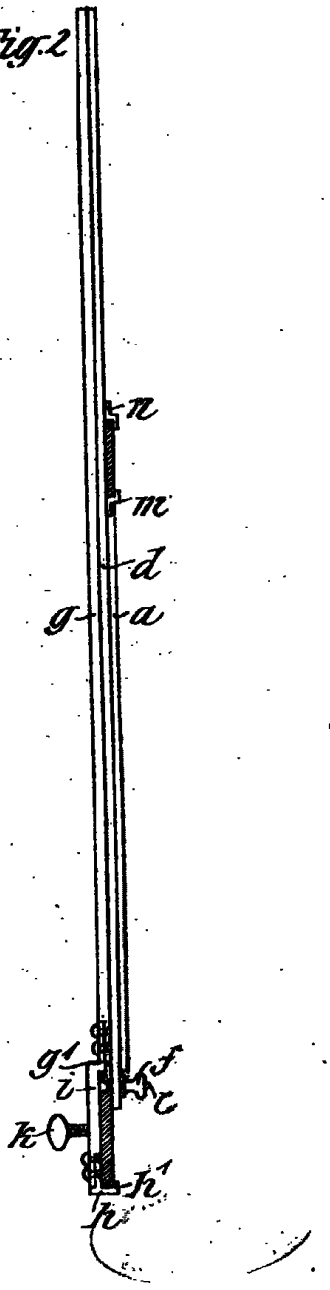


Fig. 2



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