PATENT SPECIFICATION

815,464

Date of filing Complete Specification: Sept. 22, 1955.

Application Date: Sept. 27, 1954. No. 27781/54.

Complete Specification Published: June 24, 1959.

Index at acceptance:—Class 106(1), B5(A: F: GX).

International Classification:—G05g.

COMPLETE SPECIFICATION

A Dimension Calculator for use in the Bending of Metal Sheet and Strip

We, JOHN LESLIE BOYCE, a British Subject, of 73, Maida Vale Crescent, Coventry, formerly of Badgeworth Hall, Near Cheltenham, and ALFRED MEANWELL, a British Subject, of 87, Tunbridge Road, Whitley, Coventry, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

In the precision bending of metal sheet and strip it is often necessary to know certain fundamental dimensions which are not directly measurable but which may be calculated, although somewhat laboriously.

One such dimension, known as the developed length of an arc, can be expressed as

$$D = 0.01745 \times \theta \times (R + kT) \quad \ldots (1)$$

where:—

θ is the angle of the bend in degrees,

R is the internal radius of the bend in inches,

T is the thickness of the metal in inches, and

k is a constant determined by the position of the neutral axis of the metal sheet or strip.

Another such dimension measuring the distance from the extremity of the arc to the dimension point on the drawing, i.e., the hypothetical corner, can be expressed as

$$P = (R + T) \times \tan. \theta/2 \quad \ldots (2)$$

These dimensions D and P are usually given in tabulated form, but there is always the disadvantage that such tables may not give the answer to a particular set of conditions. If the tables were drawn up to be comprehensive, they would be bulky and inconvenient for workshop use.

According to the invention such dimensions are readily obtainable from a logarithmic scale calculator having relatively movable scales, one of which is calibrated in two linear variables scaled logarithmically, i.e., the internal radius of the bend (R) and the thickness of the metal (T), another of which bears an angular measurement scaled logarithmically, i.e., the angle of the bend (θ) calibrated in degrees, and another of which bears an angular function scaled logarithmically, i.e., the values for tan $\theta/2$ calibrated in degrees.

Preferably the calculator has two sides one of which is scaled for the solution of D and the other for the solution of P so that the required answer can be obtained from the summation of partial solutions derived from θ and R and from θ and T.

The calculator may be constructed in any suitable form either as a drum calculator, a slide rule or a disc calculator, though it is constructed most conveniently and cheaply in the latter form in which it is both compact and handy.

A disc calculator constructed in accordance with the invention will now be described, by way of example, with reference to the accompanying drawings, in which:—

Figure 1 illustrates one side of the disc calculator, such side being scaled to enable the calculation of the developed length of an arc, the aforesaid dimension D,

Figure 2 illustrates the opposite side of the calculator, scaled for the calculation of the dimension P,

Figure 3 is an end elevation of the calculator,

Figure 4 illustrates one edge of a piece of sheet material having a bend formed towards its centre, the figure showing the aforesaid dimensions P, R, T and the angle θ,

Figures 5 and 6 are end and side views respectively of a coil or spring formed from wire, and are included to illustrate how the calculator may be employed to determine the length of wire required to form the spring, and

Figure 7 is a diagram illustrating various data associated with a circle which can be calculated by means of the invention.

Referring to Figures 1 to 3 of the drawings, the disc calculator 10 shown therein comprises a disc 11 on both opposite faces of which smaller discs 12 and 13 are concentrically and rotatably mounted by means of a common eyelet, rivet or the like 14. One face 11*a* of the larger disc 11,—the face shown in Figure 1 and termed herein "the front face"—has the smaller disc 12 mounted thereon and is provided with an inner arcuate scale 15 arranged immediately adjacent the periphery of the smaller disc and graduated logarithmically all the way round in units of radius, for example from 0.004″ to 1.00″. An outer arcuate scale 16 formed along the outer edge of the scale 15 is also carried by the larger disc 11, the outer scale being formed for values of kT corresponding numerically to the units of radius on the scale 15 and calibrated in numbers of Standard Wire Gauge, the value of k in the calibration of these numbers being 0.445 for all gauges of material.

On the face of the smaller disc 12 adjacent the edge thereof two arcuate scales 17, 18 are arranged one inside the other, one of these scales 17 being a logarithmic scale of degrees from for example 5° to 165°, whilst the second scale 18 is scaled in the reverse direction to show the supplement of the angles on scale 17, i.e., from 15° to 175°, the choice of which of the scales 17, 18 is employed when using the calculator being dependent on whether the angle of bend θ is shown on the drawing illustrating the bend to be made, Figure 4 or φ, the internal angle between the straight limbs of the bend.

A radially arranged datum mark 19, formed as an arrow, is carried by the disc 12 and is disposed on the latter to take account of the constant conversion factor of 0.01745. Also secured to the discs by the central rivet 14 is a cursor 20 formed by two radially arranged arms 21, 22, such arms being preferably of transparent material, such as acrylic resin, and each arm carrying a radial indicating line 23 which extends across the scales on the discs 11 and 12 and 11 and 13 respectively. Alternatively the arms of the cursor may be of opaque material and one edge of each arm employed for indicating purposes. At their outer free ends the arms 21, 22 of the cursor are connected by a rivet 24 which passes through a distance piece 25 separating both arms.

To determine a required value of D, i.e., the developed length of an arc as shown in Figure 4, the datum arrow 19 is first set against the required internal radius R on the scale 15 of the disc 11. The cursor 20 is swung until the indicating line 23 thereon is set to the required angle of bend θ, or internal angle φ, on the scales 17 or 18 and the numerical value shown by the indicating line on the radius scale 15 is noted. Next, the arrow 19 is set against the required value of Standard Wire Gauge, T in Figure 4, on the thickness scale 16 of the disc 11 and the cursor 20 is swung until the indicating line 23 is set to the required angle on the angular scale 17 or 18, and the numerical value shown by the indicating line on the radius scale 15 is also noted. A summation of the two numerical values noted gives the required value of D.

In a similar manner the opposite face 11*b*, termed herein "the back face," of the larger disc 11 carrying the disc 13 also has an inner arcuate scale 26 adjacent the periphery of the disc 13, such scale being graduated logarithmically all the way round in units of radius. An outer scale 27 for values of T corresponding numerically to the units of radius and calibrated in numbers of Standard Wire Gauge is also provided on the face 11*b*. Around the periphery of the disc 13 mounted on the face 11*b* is a logarithmic scale 28 for values of tan. $\theta/2$ which scale is calibrated in degrees, a second scale 29 showing the supplement φ of the angle θ being also provided, as already described. Determination of a required value of P is carried out in the same manner as for D, firstly to obtain the product $R \times \tan.\theta/2$ and then the product $T \times \tan.\theta/2$, the summation of the two numerical values noted giving the required value of P. It will be appreciated from Figure 4 that the total length of material required to form the bend equals $L_1 + L_2 + D - 2P$.

In order to calculate the length of wire needed to make the coil or spring shown in Figures 5 and 6, such spring consisting of N complete turns of internal radius R with flying leads of lengths A and B the angle between which is φ, the length D is found in the aforesaid manner from the given data using the angle φ. A dimension D_2 is also calculated employing an angle $\theta = 180°$. The length of wire required equals $(A + B + D + 2ND_2)$. Similarly, if the length of wire is given, one of the other dimensions can be calculated assuming the remaining data is given.

Referring to Figure 7, if it is desired to calculate the length of the arc D the front face 11*a* of the disc is employed and the arrow 19 on the smaller disc 12 is set against the radius R on the scale 15. The indicating line 23 on the cursor 20 is set against the given value of θ or φ on the scale 17 or 18 and the value indicated by the indicating line on the scale 15 is the length of the arc. In order to calculate the length of the intersecting tangents P_1 the same procedure is followed, the back face 11*b* of the larger disc and the smaller disc 13 being employed. It will be understood that in these last series of calculations there is no thickness of material to be considered.

It will be appreciated that the calculator may be readily constructed to give the required answers within acceptable limits of accuracy, and accurate answers are obtainable with the calculator for intermediate or non-standard cases which are not catered for in the usual tables.

WHAT WE CLAIM IS:—

1. A dimension calculator for use in the bending of metal sheet and strip to enable the developed length of an arc (D) and the distance from either extremity of such arc to the hypothetical corner of the bend (P) to be obtained according to the formulæ herein set forth, comprising relatively movable scales, one of which is calibrated in two linear variables scaled logarithmically, i.e., the internal radius of the bend (R) and the thickness of the metal (T), another of which bears an angular measurement scaled logarithmically, i.e., the angle of the bend (θ) calibrated in degrees, and another of which bears an angular function scaled logarithmically, i.e., the values for tan $\theta/2$ calibrated in degrees.

2. A calculator according to claim 1, wherein the calculator has two sides one of which is scaled for the solution of D and the other for the solution of P so that the required answer can be obtained from the summation of partial solutions derived from the angle of the bend in degrees (θ) and R and from θ and T.

3. A calculator according to claim 1 or 2, wherein R is expressed in inches and T in Standard Wire Gauge values.

4. A calculator according to any of the preceding claims, wherein said scales bearing said angular measurement and said angular function respectively each carry a datum mark which is disposed on the scale to take account of the constant conversion factor of 0.01745.

5. A calculator according to any of the preceding claims, wherein the calculator comprises a disc each side of which carries one of said relatively movable scales and a smaller disc carrying another of said relatively movable scales is concentrically and rotatably mounted on each side of said disc.

6. A calculator according to claim 5, wherein each side of said disc carries an arcuate scale graduated logarithmically in units of radius and a further arcuate scale arranged adjacent the radius scale for values of kT corresponding numerically to the units of radius and calibrated in numbers of Standard Wire Gauge, and said smaller discs carry respectively said scale of an angular measurement and said scale of an angular function.

7. A calculator according to claim 5 or 6, wherein each of said smaller discs carries a second scale arranged immediately adjacent said angular scale and calibrated to show the supplement of the angle shown on the angular scale.

8. A calculator according to any of claims 5 to 7, wherein a radially arranged cursor is provided, substantially for the purpose set forth.

9. A dimension calculator for use in the bending of metal sheet and strip, constructed substantially as herein described with reference to Figures 1 to 3 of the accompanying drawings.

ARTHUR R. DAVIES,
Chartered Patent Agent,
Royal Chambers, Promenade, Cheltenham,
Agent for the Applicants.

PROVISIONAL SPECIFICATION

A Dimension Calculator for use in the Bending of Metal Sheet and Strip

We, JOHN LESLIE BOYCE, a British Subject, of Badgeworth Hall, Near Cheltenham, and ALFRED MEANWELL, a British Subject, of 87, Tunbridge Road, Whitley, Coventry, do hereby declare this invention to be described in the following statement:—

In the precision bending of metal sheet and strip it is often necessary to know certain fundamental dimensions which are not directly measurable but which may be calculated, although somewhat laboriously.

One such dimension, known as the developed length of an arc, can be expressed as

$$D = 0.01745 \times \theta \times (R + kT) \qquad \ldots (1)$$

where:—

θ is the angle of the bend in degrees,

R is the internal radius of the bend in inches,

T is the thickness of the metal in inches, and

k is a constant determined by the thickness of the metal.

Another such dimension measuring the distance from the extremity of the arc to the dimension point on the drawing, i.e., the hypothetical corner, can be expressed as

$$P = (R + T) \times \tan. \theta/2 \qquad \ldots (2)$$

These dimensions D and P are usually given in tabulated form, but there is always the disadvantage that such tables may not give the answer to a particular set of conditions. If the tables were drawn up to be comprehensive, they would be bulky and inconvenient for workshop use.

According to the invention such dimensions are readily obtainable from a logarithmic scale calculator having relatively movable scales, one of which bears an angular function scaled logarithmically, and the other of which bears a linear function scaled logarithmically. The latter scale is preferably calibrated in the two variables R and T, T being conveniently expressed in Standard Wire Gauge values, so that the required answer can be obtained from the summation of partial solutions derived from θ and R and from θ and T. This method is applicable to the solution of both D in equation (1) and P in equation (2).

In practice, it is preferred to scale one side of the calculator for the solution of D, and the other side for the solution of P.

The calculator may be constructed in any suitable form either as a drum calculator, a slide rule or a disc calculator, though it is constructed most conveniently and cheaply in the latter form in which it is both compact and handy.

A disc calculator constructed in accordance with the invention will now be described by way of example. A large disc is provided on opposite faces with inner discs which are rotatable on a common eyelet, rivet or the like. One face, termed herein "the front face," of the large disc has an inner scale which is graduated logarithmically all the way round in units of radius. An outer scale is formed for values of kT corresponding numerically to the units of radius and calibrated in numbers of Standard Wire Gauge. The calibration of these numbers takes account of a value of $k=0.5$ for thicknesses from 24 to 16 S.W.G. and a value of $k=0.4$ for thicknesses of 14 S.W.G. and over. The inner disc on the front face has a logarithmic scale of degrees from 5—180, and a datum mark, formed as an arrow, which is disposed to take account of the constant conversion factor of 0.01745.

To determine a required value of D, the arrow on the inner disc is first set against the required radius on the large disc and the numerical value on the radius scale corresponding to the required angle of bend on the angular scale is noted. Next, the arrow is set against the required value of S.W.G. on the thickness scale and the numerical value on the radius scale corresponding to the required angle of bend on the angular scale is noted. A summation of the two numerical values noted gives the required value of D.

The opposite face, termed herein "the back face," of the large disc also has an inner scale which is graduated logarithmically all the way round in units of radius, and an outer scale for values of T corresponding numerically to the units of radius and calibrated in numbers of Standard Wire Gauge. The inner disc on the back face has a logarithmic scale for values of tan. $\theta/2$ which is calibrated in degrees. Determination of a required value of P is carried out in the same manner as for D, firstly to obtain the product $R \times \tan. \theta/2$ and then the product $T \times \tan. \theta/2$, the summation of the two numerical values noted giving the required value of P.

It will be appreciated that the calculator may be readily constructed to give the required answers within acceptable limits of accuracy, and accurate answers are obtainable with the calculator for intermediate or non-standard cases which are not catered for in the usual tables.

ARTHUR R. DAVIES,
Chartered Patent Agent,
Royal Chambers, Promenade, Cheltenham,
Agent for the Applicants.

Leamington Spa: Printed for Her Majesty's Stationery Office, by the Courier Press.—1959.
Published by The Patent Office, 25, Southampton Buildings, London, W.C.2. from which copies may be obtained.

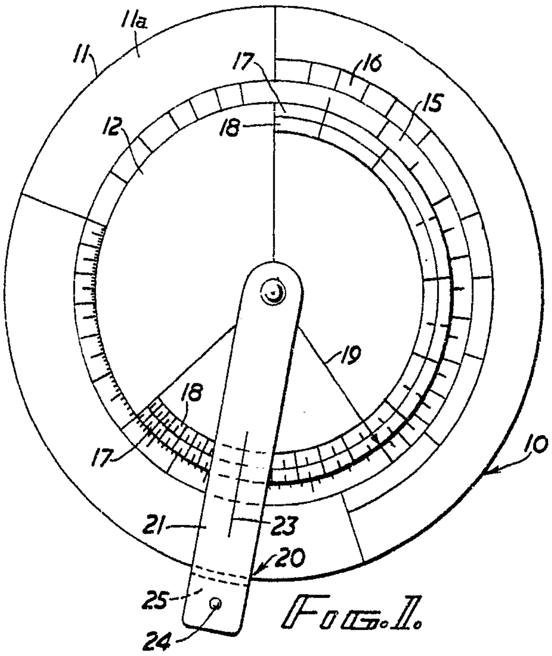

FIG. 1.

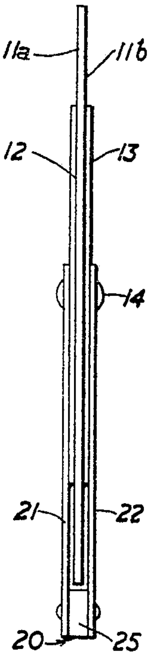

FIG. 3.

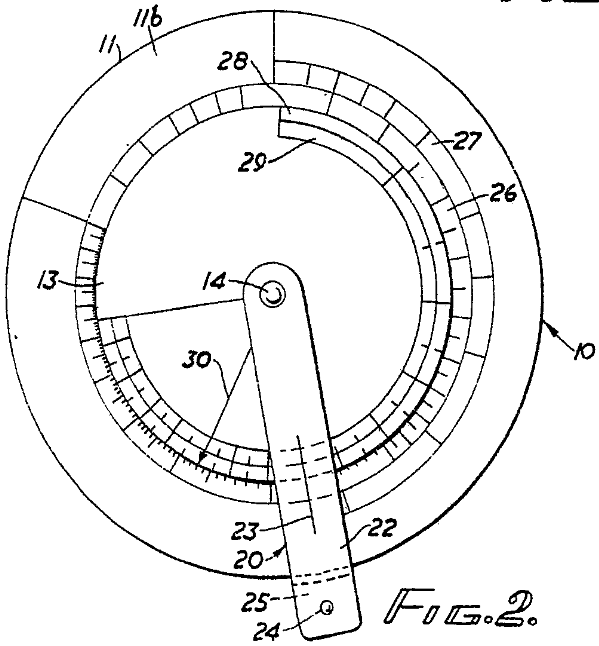

FIG. 2.

815,464 COMPLETE SPECIFICATION
2 SHEETS
This drawing is a reproduction of the Original on a reduced scale.
SHEETS 1 & 2

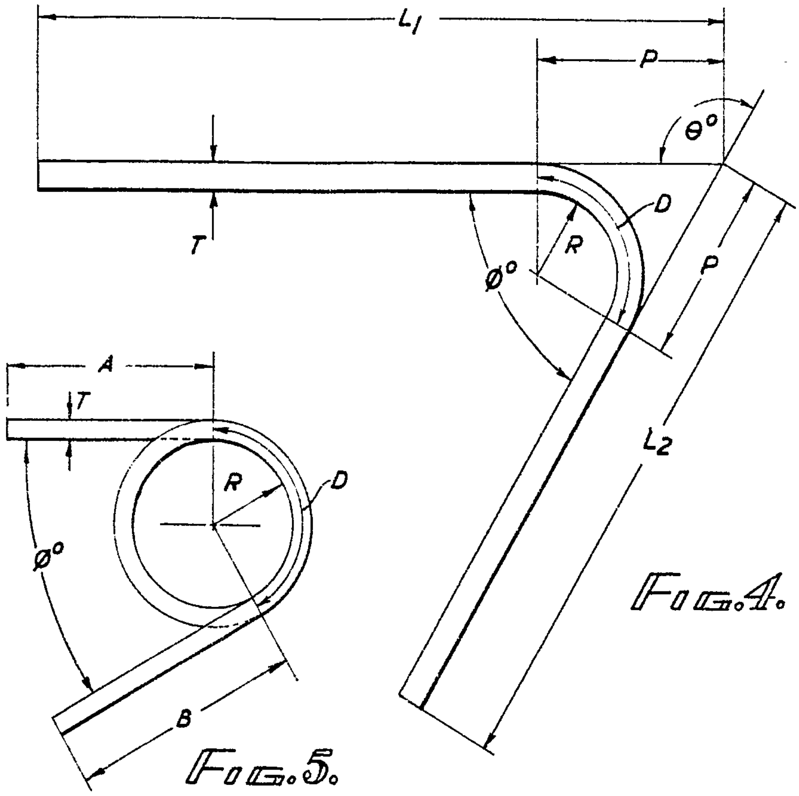

FIG. 4.

FIG. 5.

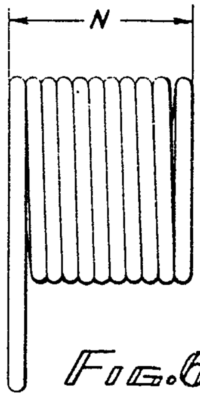

FIG. 6.

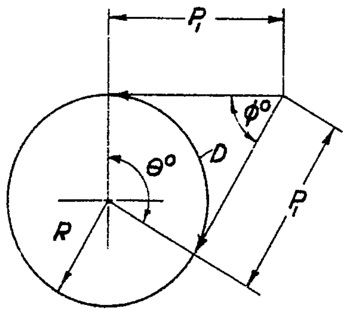

FIG. 7.

815,464 COMPLETE SPECIFICATION
2 SHEETS This drawing is a reproduction of the Original on a reduced scale.
SHEETS 1 & 2

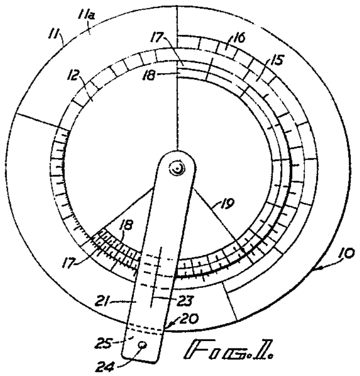

Fig.1.

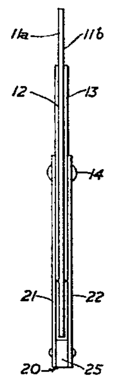

Fig.3.

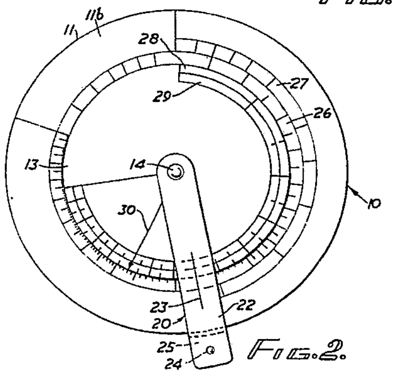

Fig.2.

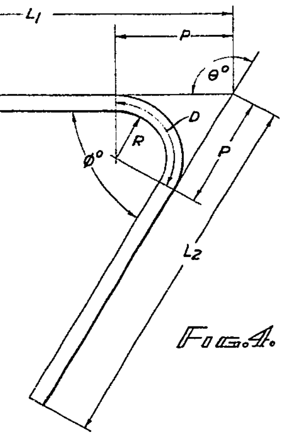

Fig.4.

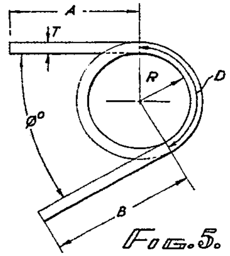

Fig.5.

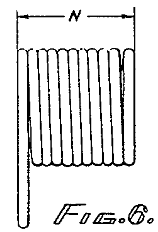

Fig.6.

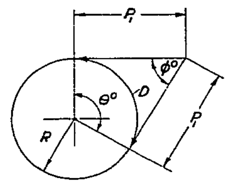

Fig.7.