(12) UK Patent Application (19) GB (11) 2 155 672 A

(43) Application published 25 Sep 1985

(21) Application No 8409206

(22) Date of filing 10 Apr 1984

(30) Priority data
(31) 8333645 (32) 16 Dec 1983 (33) GB

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(51) INT CL[4]
G06G 1/12

(52) Domestic classification
G4B AC

(56) Documents cited
GB 0842008

(58) Field of search
G4B

(54) Slide rule

(57) Apparatus for determining the shape of a two dimensional blank for the fabrication therefrom of a three dimensional article comprises a slide rule having scales thereupon calibrated according to certain characteristics equations relating the dimensions of the blank and the finished article.

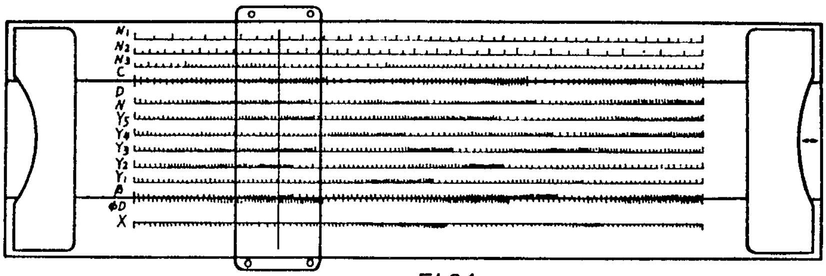

FIG.1a.

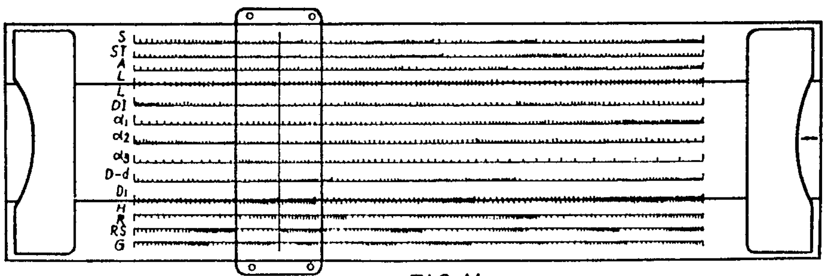

FIG.1b.

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The drawing(s) originally filed was/were informal and the print here reproduced is taken from a later filed formal copy.

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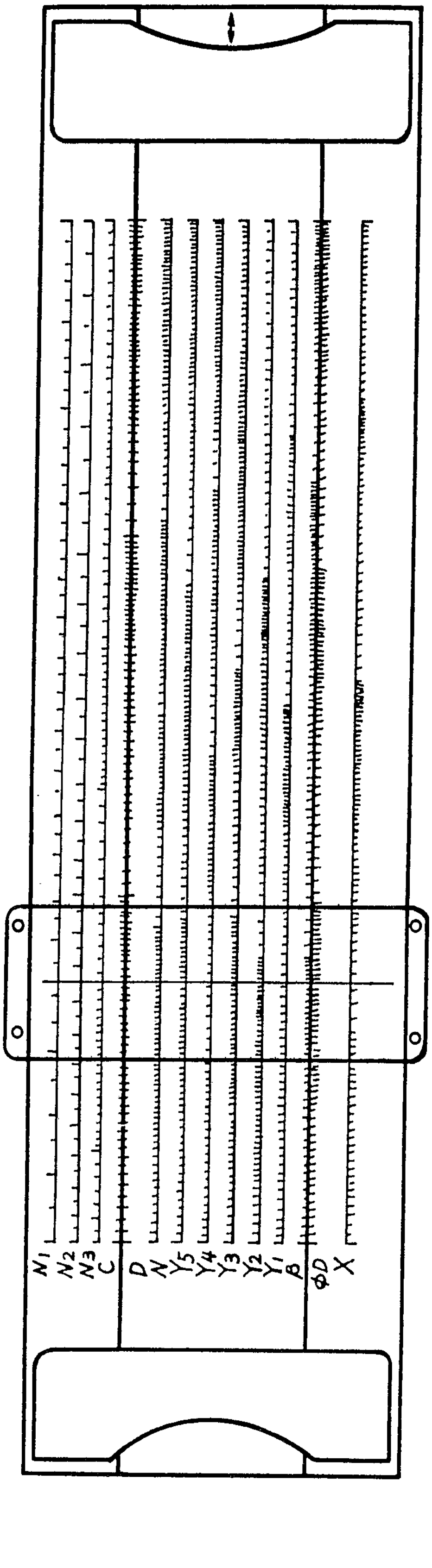

FIG.1a.

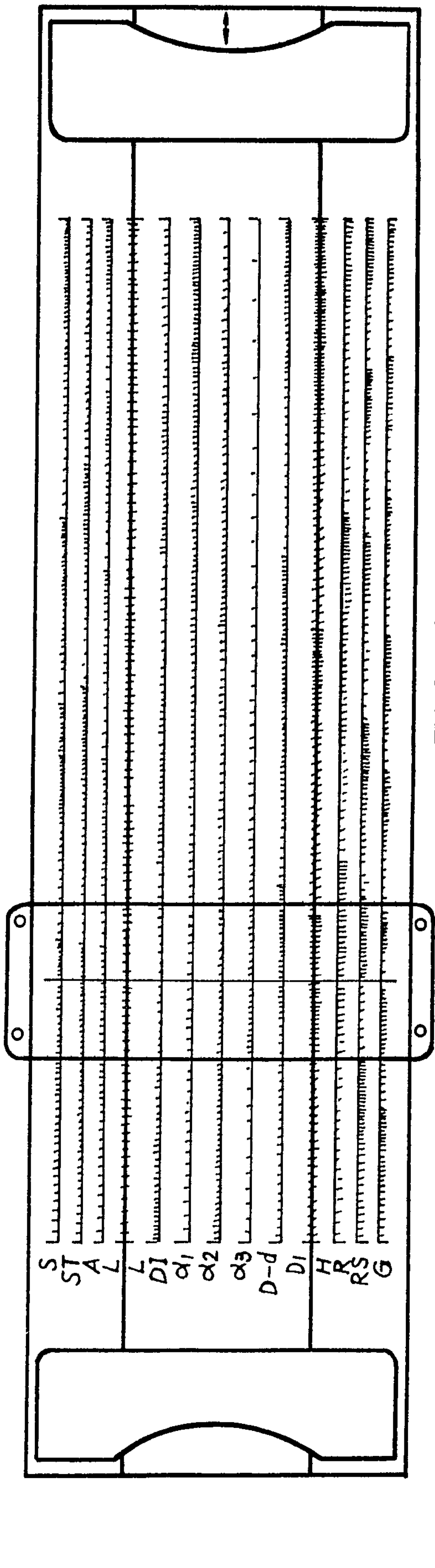

FIG.1b.

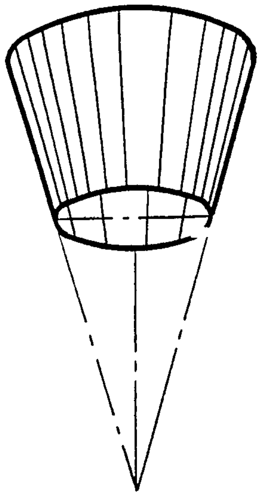

FIG.2a.

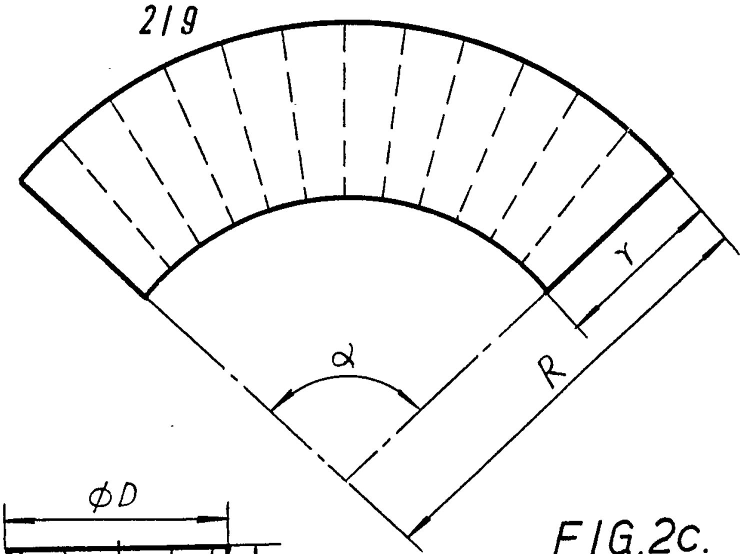

FIG.2c.

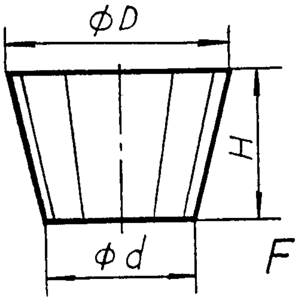

FIG.2b.

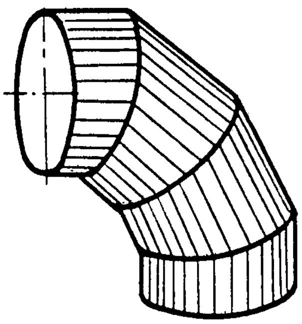

FIG.3a.

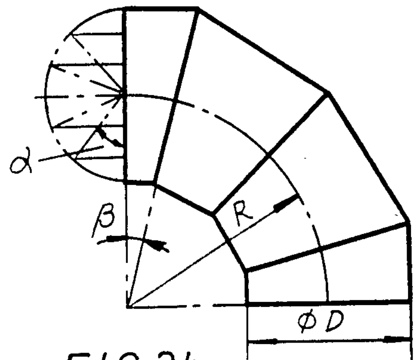

FIG.3b.

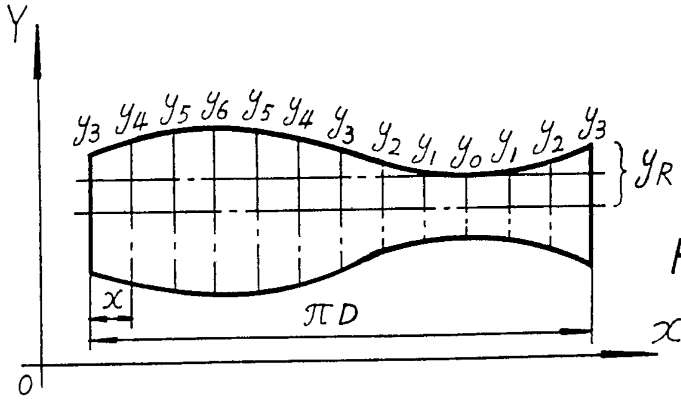

FIG.3c.

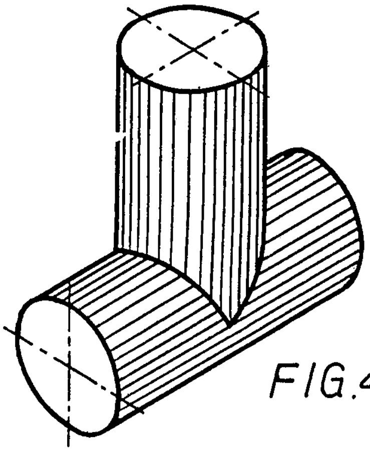

FIG.4a.

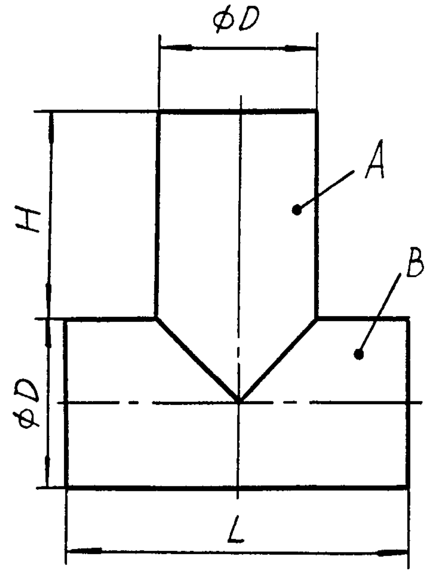

FIG.4b.

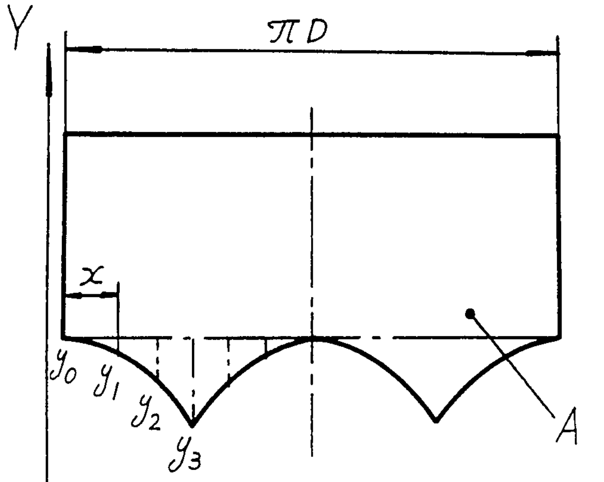

FIG.4c.

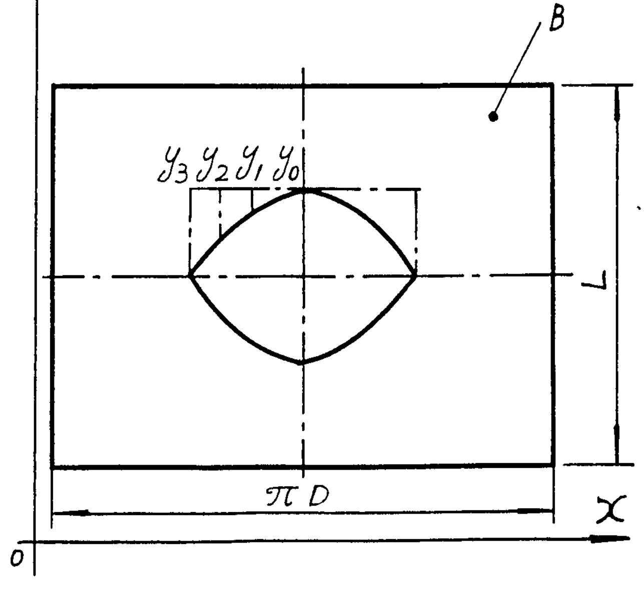

FIG.4d.

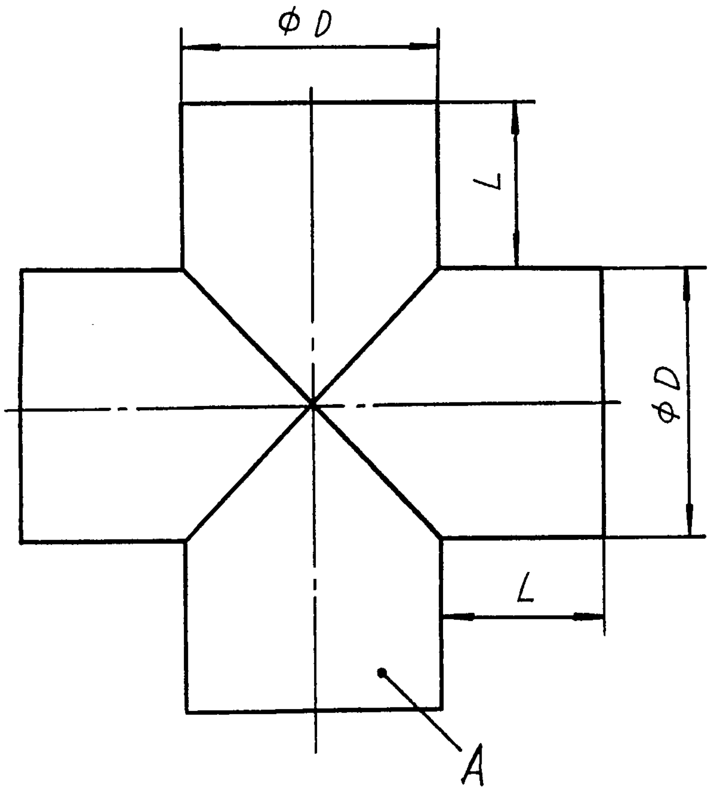

FIG.5a.

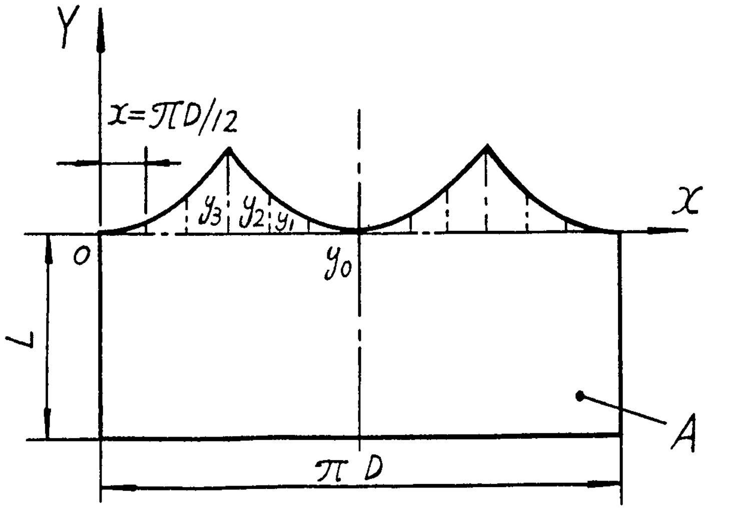

FIG.5b.

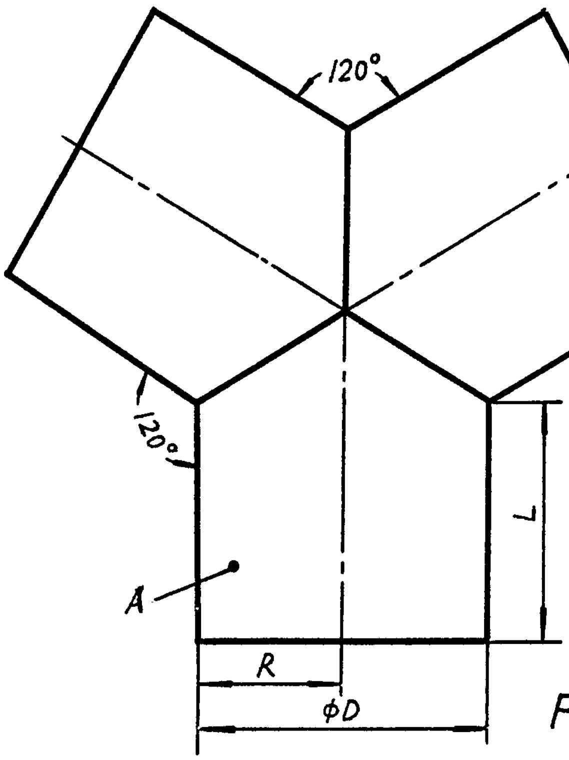

FIG.6a.

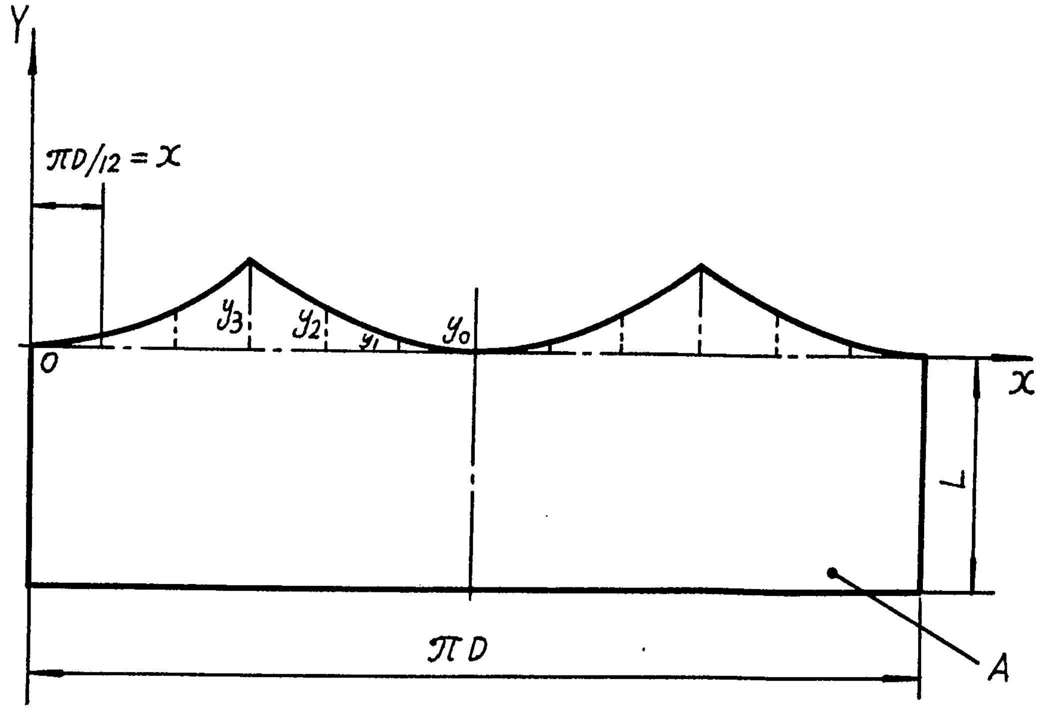

FIG.6b.

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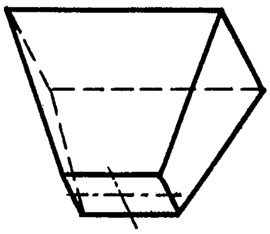


FIG.7a.

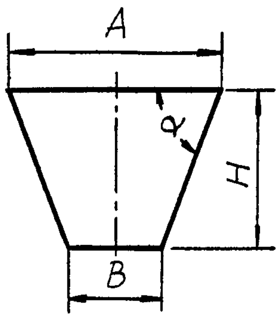


FIG.7b.

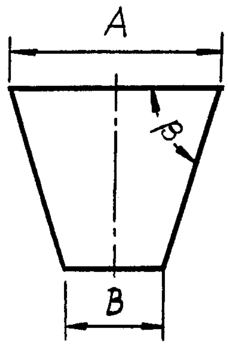


FIG.7c.

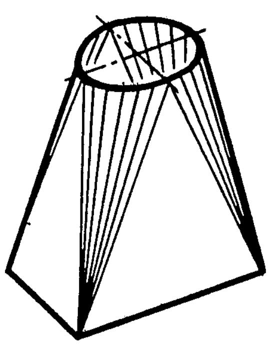


FIG.8a.

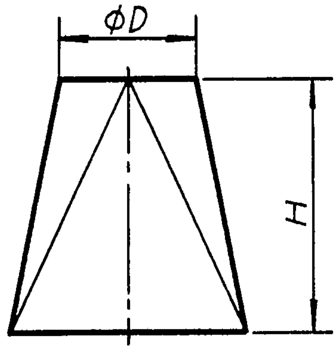


FIG.8b.

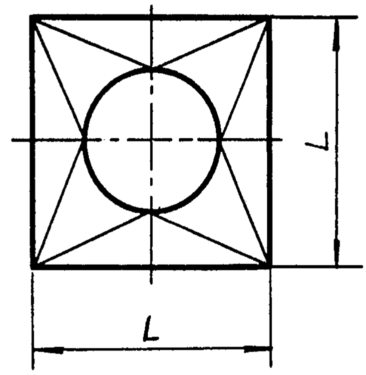


FIG.8c.

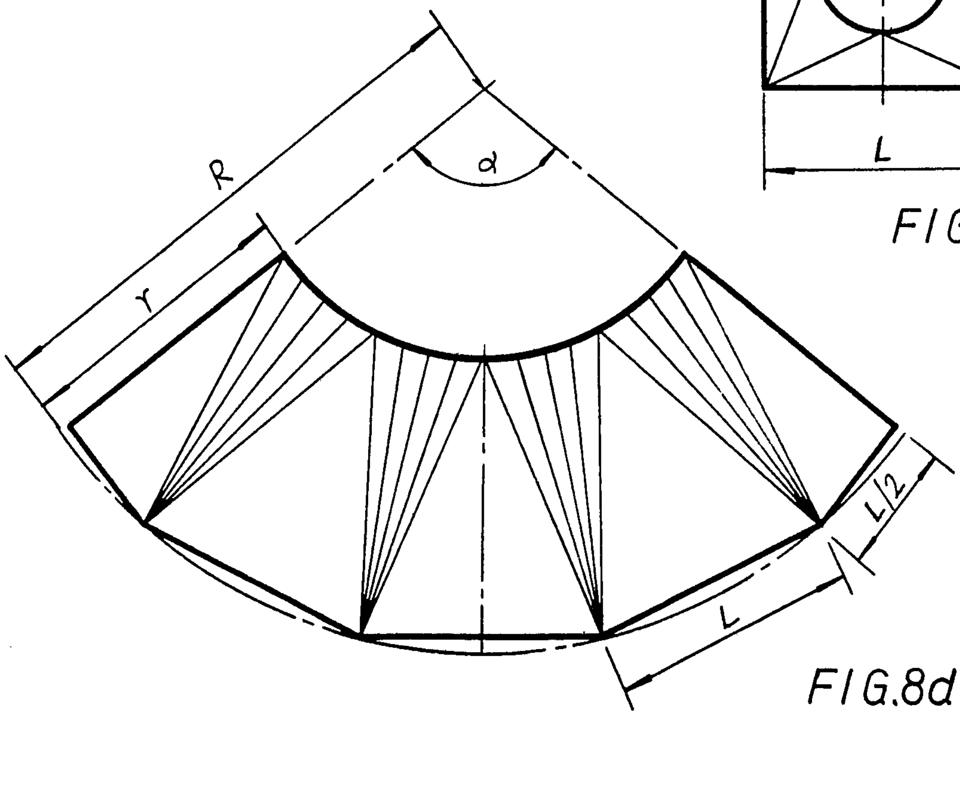


FIG.8d.

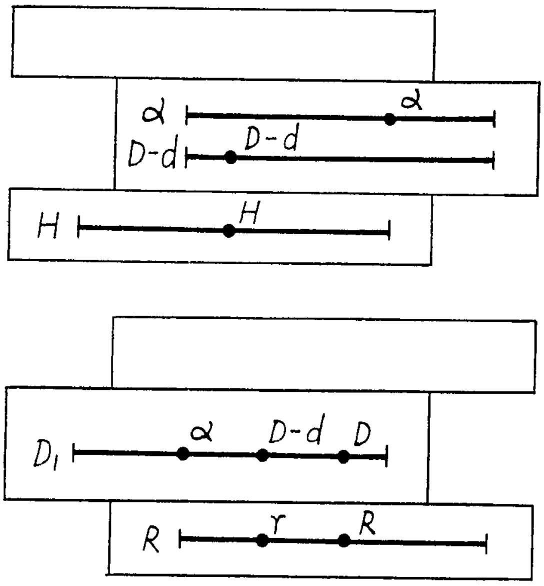


FIG.9.

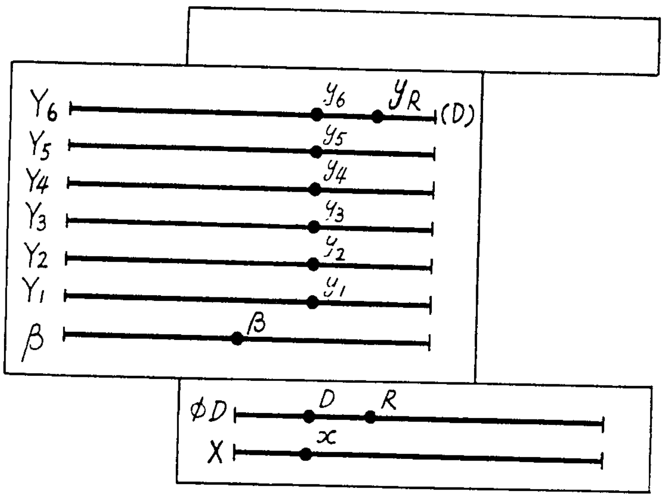


FIG.10.

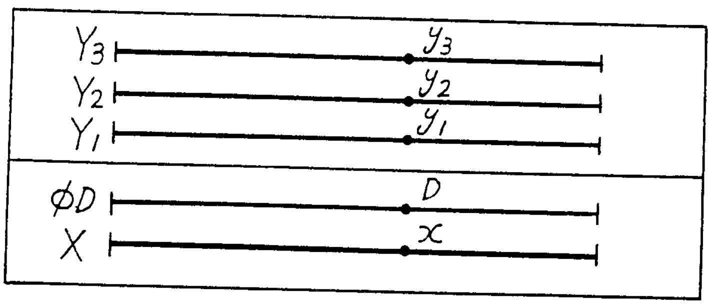


FIG.11.

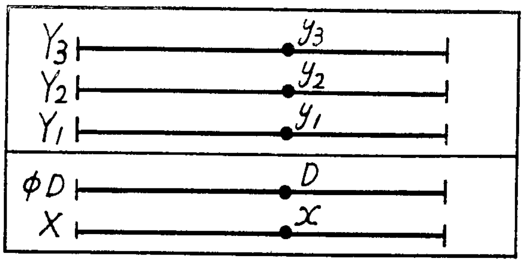


FIG.12.

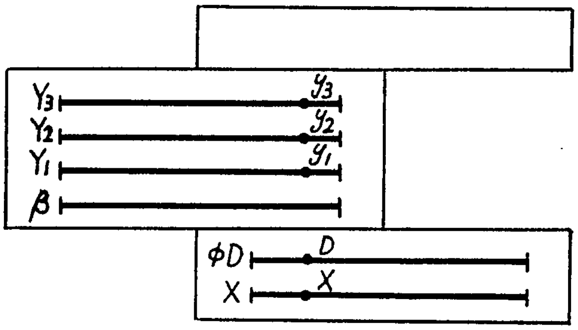


FIG.13.

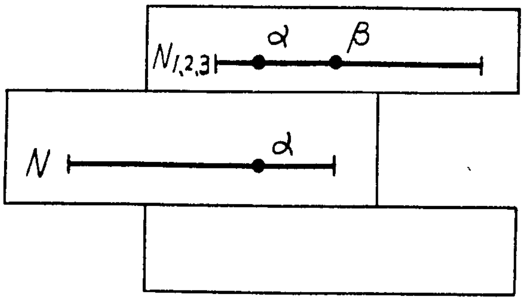


FIG.14.

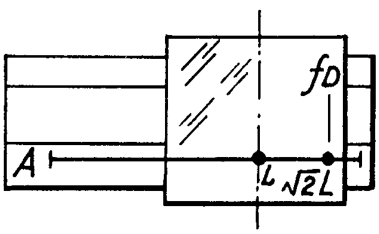


FIG.15.

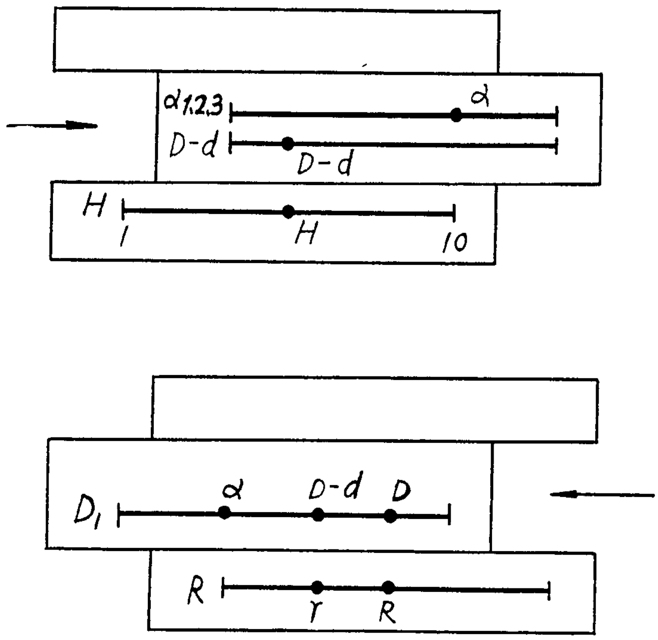
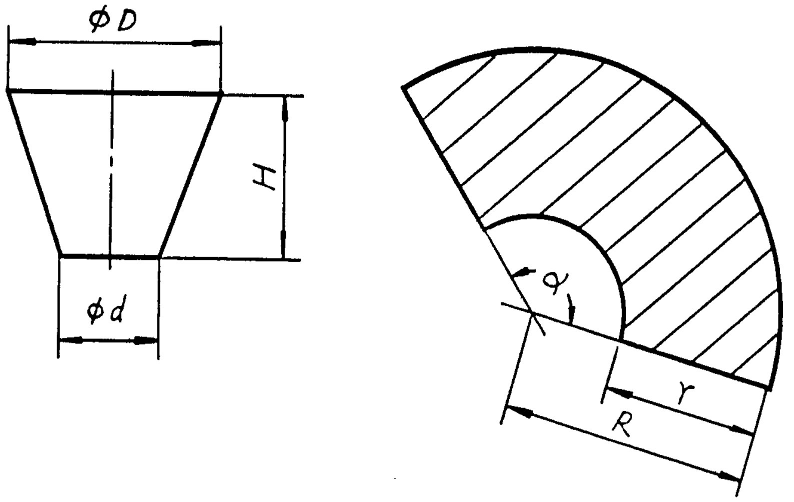


FIG.16.



SPECIFICATION

Slide rule

The invention relates to apparatus for forming a three dimensional object from two dimensional sheet material, more particularly for determining the dimensions of the development of the three dimensional article, i.e. the two dimensional blank.

It has long been known that there are two conventional methods for constructing a three dimensional plate-formed member from metal or non-metal sheet material, the laying-out method, a primitive method that necessitates the preparation of the a drawing according to which the member can then be developed and relevant dimensions obtained and further, involves the use of cumbersome and complicated processes and the presence of non-negligible errors in the dimensions of the developed material; the calculating method, co-existent with the former method, in accordance with which solution of complicated mathematical equations is necessary and heavy work is thereby involved. Both these methods require skilful technicians having specialised knowledge.

Another method, known as the table method and mentioned in an article entitled "Development of a Symmetrical Cone" carried in the American periodical "Design News" (No. 10, May 1976), aims to provide the development dimensions of a cone body by referring to a table. It is however, limited in use as it is only applicable to conical bodies and only one development angle for a cone can be obtained from the table, while the other parameters remain to be obtained by calculation.

A great variety of calculating rules have been developed for different uses, yet there is still a need for a calculating rule suitable for obtaining the development dimensions of members to be made from sheet material.

The object of this invention is to provide a rule which has none of the disadvantages inherent in the methods mentioned above.

The invention will be further described by ways of example with reference to the accompanying drawings in which:

Figures 1a and 1b show a linear slide rule forming an embodiment of the present invention;

Figures 2a, 2b and 2c show a truncated cone in perspective and side views and its two dimensional development respectively;

Figures 3a, 3b and 3c show a mitre elbow in perspective and side views and its two dimensional development respectively;

Figures 4a and 4b shows perspective and side views of a T connection and Figs. 4c and 4d show the development of the side tube and the main tube respectively;

Figure 5a shows a plan view of a four way tube connection and Fig. 5b shows a development of one tube member;

Figure 6a shows a plan view of a Y-shaped equiangular tube connection and Fig. 6b shows a development of one tube member;

Figures 7a and 7b show perspective and side views of a square pyramid and Fig. 7c shows one side in plan or development;

Figure 8a and 8b and 8c show perspective, side and plan views respectively of a tube having a round end and a square end and Fig. 8d shows a two dimensional development of the tube;

Figures 9 to 15 illustrate the positions of the scales for the objects of Figs. 2 to 8 respectively;

Figure 16 shows the use of the slide rule in calculating the dimensions of a blank for a frustocone.

With reference to Fig. 1, the slide rule, which is simple in construction and so easy to handle that even a non-professional person can master its application with a minimum of labour while obtaining high manufacturing precision, allows the "direct development" for a plate-formed member and can be used to obtain development dimensions for almost all of the common members formed with metal or non-metal plates.

The slide rule is composed of two fixed rules, a movable rule which slides between the two parallel fixed rules and a slider and provided with scales respectively marked on the front and reverse sides of the fixed and movable rules according to the following arrangement:

Front side Fig 1a	Reverse side Fig 1b
N1 N2 N3: Development angle for pyramid	*S: Sine, cosine
C D: Common to multiplication & division	*ST: Radian
N: Projection angle for pyramid	*A: Square
Y1, Y2, Y3, Y4, Y5: Y axis for development of mitre elbow	*L: Logarithm
β Pitch angle of the end of mitre elbow	*L: "
ØD: Caliber of mitre elbow	*DI: Reciprocal
X: X axis for development of mitre elbow (Note: Scales mentioned above also applicable to development of 3-way, 4-way and Y tubes.)	*α1α2α3: Development angle for cone
	*D-d: Difference between two ends of a cone (pyramid)
	D1: Caliber of cone
	*H: Height of cone (pyramid)
	*R: Development radius and development width of cone (mm)
	*RS: Area of development
	*G: Development weight (Kg)
	*fD: Dimensions for round-square tube (graduated on the slider)

The Mechanical Principle of the Scales

1. Scales $\alpha 1$, $\alpha 2$, $\alpha 3$, (D–d), D, H and R

These scales are used for calculating the development dimensions for a cone or truncated cone member and are calibrated and marked according to the following procedure. The projection and development drawings of the cone or truncated cone member as shown in Figs. 2a, 2b and 2c, establish mathematical relationships for the parameters shown on the figs, as follows:

$$\alpha = 360 \frac{D-d}{\sqrt{(D-d)^2 + 4H^2}}$$

$$R = \sqrt{H^2 + \frac{(D-d)^2}{4} \cdot \frac{D}{D-d}} \qquad (A)$$

$$\gamma = \sqrt{H^2 + \frac{(D-d)^2}{4}}$$

The above expressions may be transformed into a set of logarithmic equations:

$$1g\frac{D-d}{2} - 1gH = 1gtg\left[\ M.\alpha\right]$$

$$1gR = 2.25 + 1gD - 1g\alpha \qquad (B)$$
$$1g\gamma = 2.25 + 1g\ (D-d) - 1g\alpha$$

This set of logarithmic equations (B) is called the characterist equation of dimensions for this set of scales, where M is a characteristic coefficient (from $\frac{1}{3.6}$ to $\frac{1}{360.}$)

The moduli of the characteristic equation of scale dimension (B) are regulated according to the type of rule, e.g. circular or linear.

$$m1gtg\left[Sin^{-1}\ (\frac{\alpha}{360})\right] = m1g\ \frac{D-d}{2}\ - m1gH$$

$$mlgR = m.2.25 + mlgD - mlg\alpha$$
$$mlg\gamma = m.2.25 + mlg\ (D-d) - mlg\alpha$$

m for a linear type rule will be determined according to the length of rule say 125 to 500 m.m.

The rule is then calibrated with precision graduations after having obtained the calibration data according to the above parameters.

2. Scales D, Y1, Y2, Y3, Y4, Y5, β ϕD and X.

These scales are used for calculating the development dimensions for a mitre elbow, three-way tube, four-way tube and Y-tube shaped as shown in figures 3, 4, 5 and 6 and are calibrated and marked according to the following procedures:

From the projection and development drawings of the mitre elbow Figs. 3b and 3c the following mathematical expressions may be established for the respective parameters shown in Figs. 3, 4 and 5:

$$Y = (\frac{D}{2}\cos\alpha + c)\ tg\ \beta\ .D. \qquad (C)$$

$$X = \frac{\pi D}{n}$$

where: Y and X = Y axis and X axis respectively,
n = number of scales of perimeter
C = coefficient.

The expressions (C) are transformed into a set of logarithmic equations:

$$1gY = 1g\,(\frac{D}{2}\cos\alpha + 1gD + 1gtg\beta \qquad (D)$$

$$1gX = 1g\,\pi + 1gD - 1gn$$

This set of logarithmic equations (D) is called the characteristic equation of dimension for this set of scales.

The moduli are regulated as before and the scales marked.

$$mlgy = mlg(\frac{D}{2}\cos\alpha + c) + mlgtg\beta + mlgD$$

$$mlgX = mlg\pi + mlgD - mlgn$$

m for linear type rule will be determined by the length of rule for example 125–500 mm.

3. Scales N, N1, N2, N3, (D – d) and H.

These scales, used for calculating the development dimensions for a pyramid as shown in Fig. 7 and are calibrated and marked according to the following procedures:

From the projection and development drawings Figs. 7b, 7c of the pyramid, the mathematical expressions for the development angle β are established.

$$tg\,\beta = \frac{\frac{2H}{A-B}}{\mathrm{Sin}\left[tg^{-1}\left(\frac{2H}{A-B}\right)\right]} \qquad (E)$$

The above expressions are transformed into a logarithmic equation:

$$1gtg\beta = 1g2H - 1g\,(A-B) - 1gSin\ N \quad (F)$$

This logarithmic equation is the characteristic equation of dimension for this set of scales where: N is a characteristic coefficient, (from 6° to 90°).

The moduli are regulated and the scales marked.

$$mlgtg\beta = mlg2H - mlg\,(A-B) - mlgsin\ N$$

m for a linear type rule will be determined by the length of rule e.g. 125 to 500 mm.

4. Scales (D – d) H, R, and fD.

These scales are used for calculating the development dimensions for a round-square tube as shown in Fig. 8 and are calibrated and marked according to the following procedures:

From the projection and development drawings Fig. 8b, 8c and 8d, of the round-square tube, the mathematical expressions for the parameters shown in Fig. 8 are established.

$$\alpha = 360\,\frac{1.4L - D}{\sqrt{(1.4L - D)^2 + 4H^2}}$$

$$R = \sqrt{H^2 + \frac{(1.4L - D)^2}{4}} \cdot \frac{1.4L}{1.4L - D} \qquad (G)$$

$$\gamma = \sqrt{H^2 + \frac{(1.4L - D)^2}{4}}$$

The mathematical expressions (G) are transformed into a set of logarithmic equations:

$$1g(0.7L - \frac{D}{2}) - 1gH = 1gtg\left[\ P.\alpha\right]$$

$$1gR = 2.25 + 1g1.4L - 1g\alpha \qquad (H)$$

$$1g\gamma = 2.25 + 1g(1.4L - D)1g\alpha$$

This set of logarithmic equations (H) is the characteristic equation of dimension for this set of scales, where, P is a characteristic coefficient

$$(\text{from} \frac{1}{3.6} \text{to} \frac{1}{360}.$$

The moduli of the logarithmic equation set (H) are regulated and scales marked

$$mlg\ (0.7L - \frac{D}{2}) - mlgH = mlgtg \left[P\alpha\right]$$

$$mlgR = m.2.25 + mlg1.4L - mlg\alpha$$

$$mlg\gamma = m.2.25 + mlg(1.4L - D) - mlg\alpha$$

m for linear type rule will be determined by the length of rule e.g. 125 to 500 mm.

Fig. 16 shows the calculation of the angle and depth and radius of curvature, γ and R, for the two dimensional blank corresponding to a frustocone of height H and diameters d and D. As the drawings show the dimensions D and H are used to calculate the angle α, the angle is then used to determine the radii γ and R using the D_1 and R scales.

D − d rule is moved to align the (D − d) value with the value of H on the H rule, and the vernier is then moved to the end line of the H rule. The various rule readings under α_1, α_2, α_3 give the development angle α.

Note: when $\frac{D-d}{2H}$ is 0.1 to 1 read α_1

when $\frac{D-d}{2H}$ is 1 to 10 read α_2

when $\frac{D-d}{2H}$ is 10 to 1000 read α_3

The α value on the D_1 rule is placed at the end of the R rule, then the value of D on the D rule and the readings of the corresponding R rule under the D and D − d values are γ and R respectively.

CLAIMS

1. A slide rule having a movable member slidable between two fixed members having scales provided on the movable and fixed members for calculating directly the development dimensions of a three-dimensional member to be formed from sheet material.

2. A slide rule according to claim 1 wherein the scales $\alpha1$, $\alpha2$, $\alpha3$, (D − d), D, H and R are marked as hereinbefore defined for calculating the development dimensions of a cone or truncated cone.

3. A slide rule according to claim 1 or 2, wherein the scales D1, Y1, Y2, Y3, Y4, Y5, β, ϕD and X are marked as hereinbefore defined for calculating the development dimensions of a mitre elbow, three-way tube, four-way tube or Y tube.

4. A slide rule according to claim 1, 2 or 3, wherein the scales N1, N2, N3, N, (D − d) and H are marked as hereinbefore defined for calculating the development dimennsions of a pyramid.

5. A slide rule according to claim 1, 2, 3, or 4, wherein the scales (D − d), H, R and fD are marked as hereinbefore defined for calculating the development dimensions of a round-square

tube.

6. A slide rule as claimed in any one of claims 1 to 5, comprising a single movable member movable between two fixed members, said scales being distributed on both faces of the fixed and movable members.

7. A slide rule as claimed in any one of claims 1 to 6, which is a linear slide rule.

8. A slide rule substantially as hereinbefore described with reference to the accompanying drawings.

Printed in the United Kingdom for Her Majesty's Stationery Office, Dd 8818935, 1985, 4235.
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.