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(54) Mechanical calculator

(57) A mechanical calculator suitable for use in setting the angle of a tool axis in a universal head milling machine includes two scale bearing components (3, 4) coupled for relative rotation about a spigot (8). One (3) of the components bears a part-circular logarithmic 'Sin' scale (6), the other (4) bears a spiral logarithmic 'tan' scale (7). A transparent cursor disc (5) having a radial cursor line (5a) is also mounted for rotation about spigot (8) to allow radial alignment of the two scales.

The described embodiment enables the value of α to be determined given values of ϕ and ψ in the formula

$$\alpha = \mathrm{Tan}^{-1}\left(\frac{\mathrm{Tan}\,\phi}{\mathrm{Sin}\,\psi}\right)$$

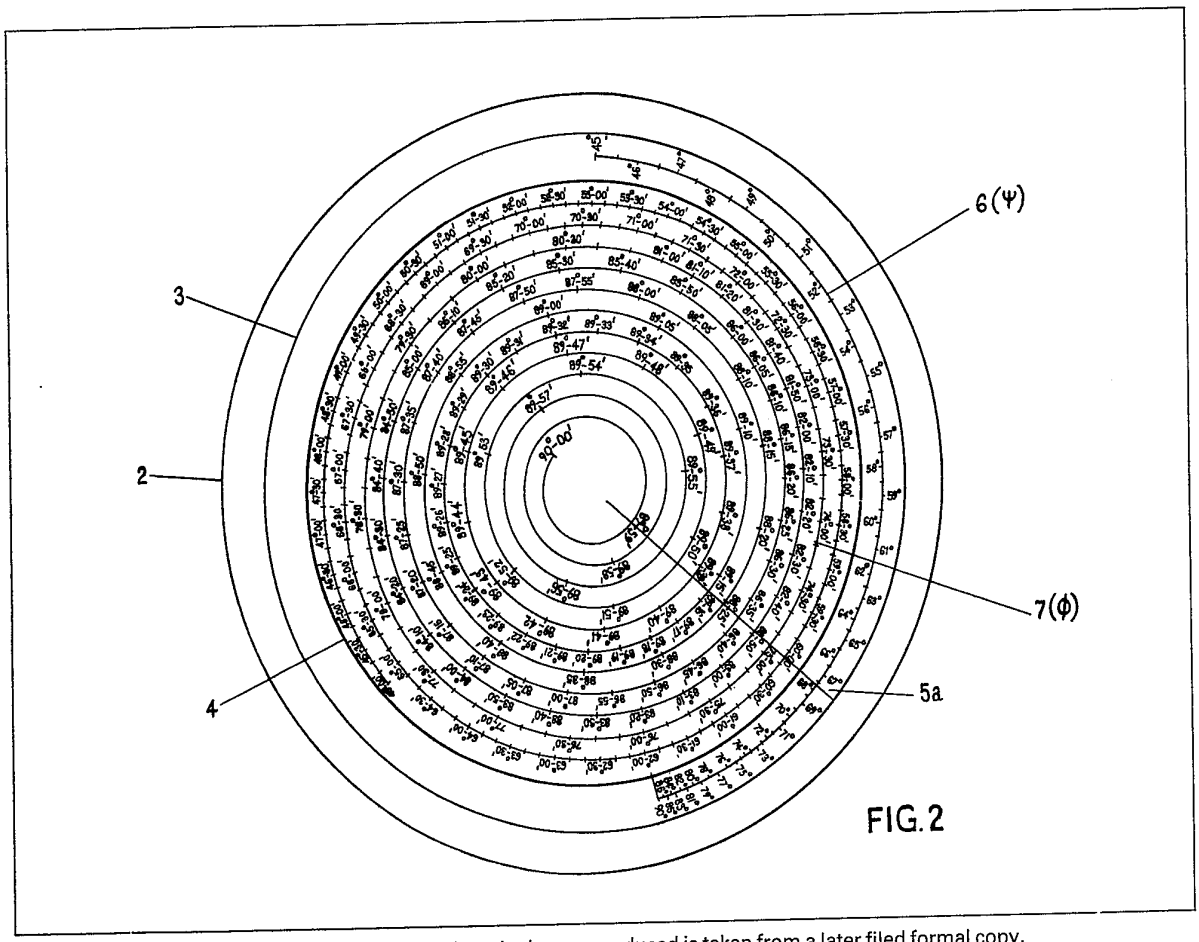

FIG. 2

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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

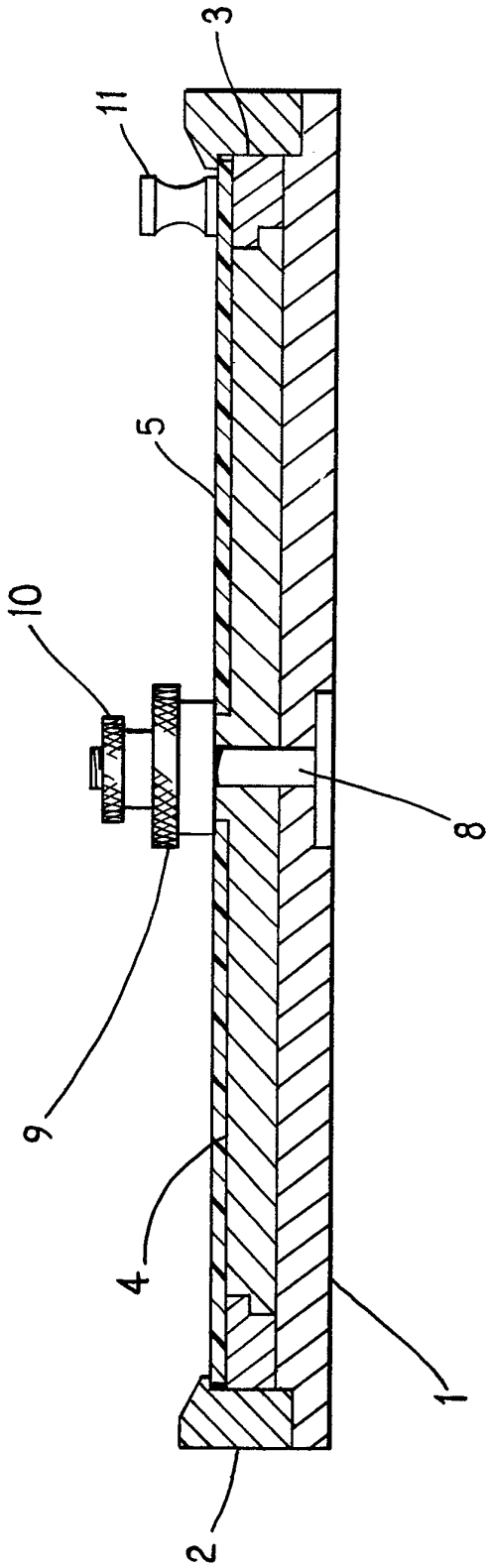

FIG.1

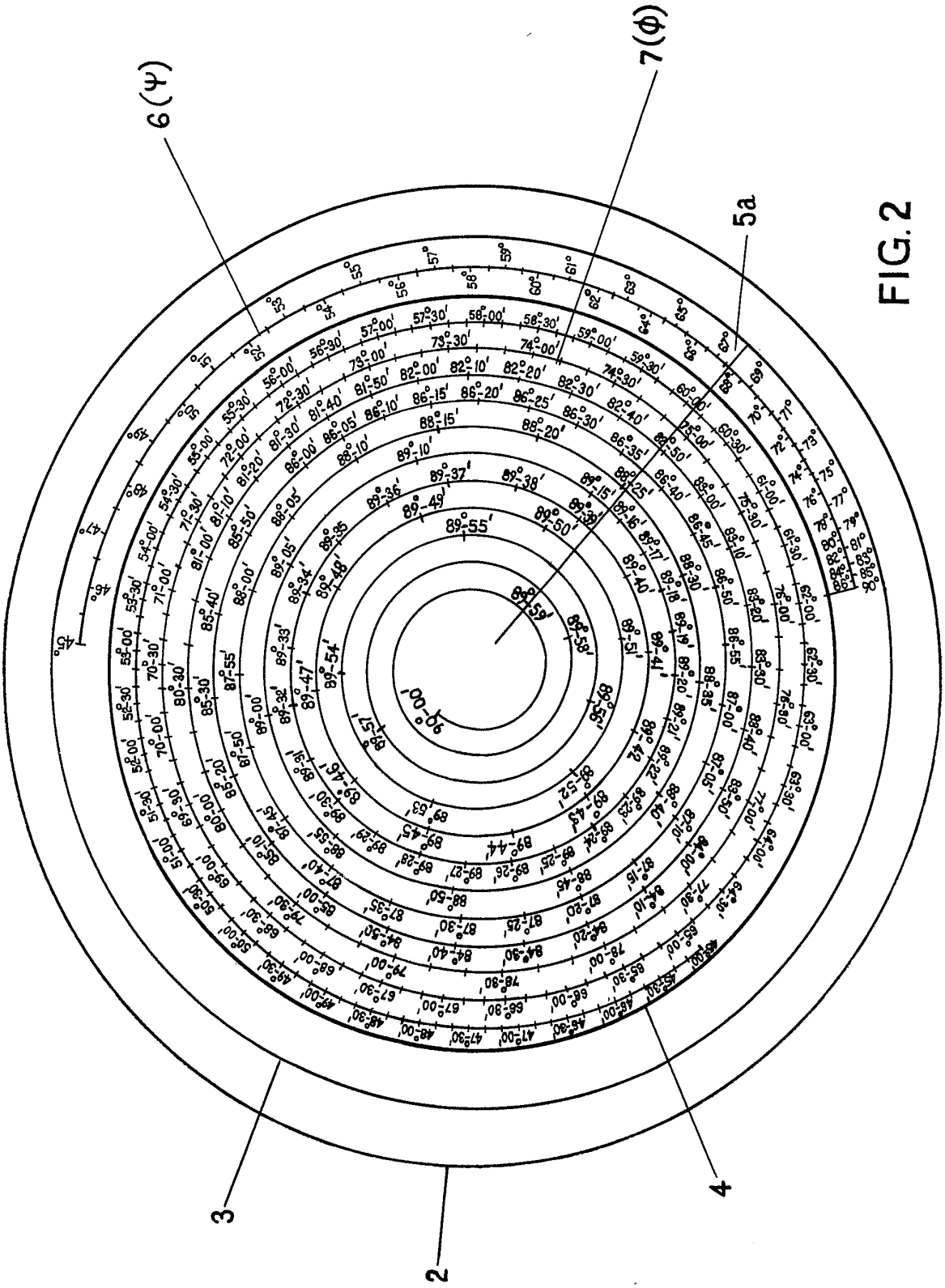

FIG. 2

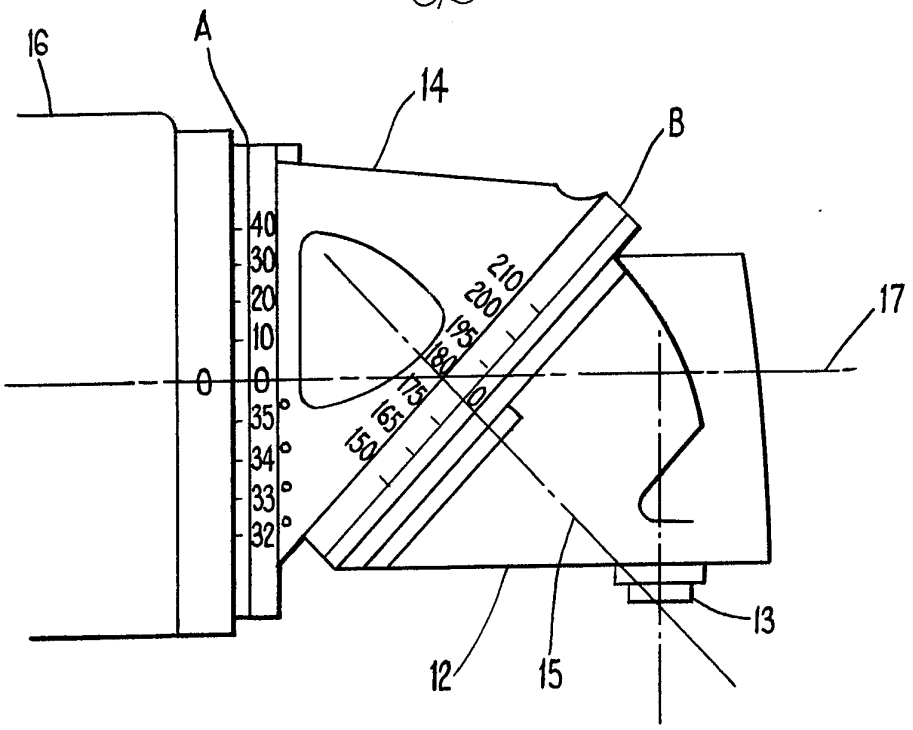
16
A
14
B
17
40
30
20
10
0
35°
34°
33°
32°
210
200
195
180
175
165
150
13
12
15

FIG.3

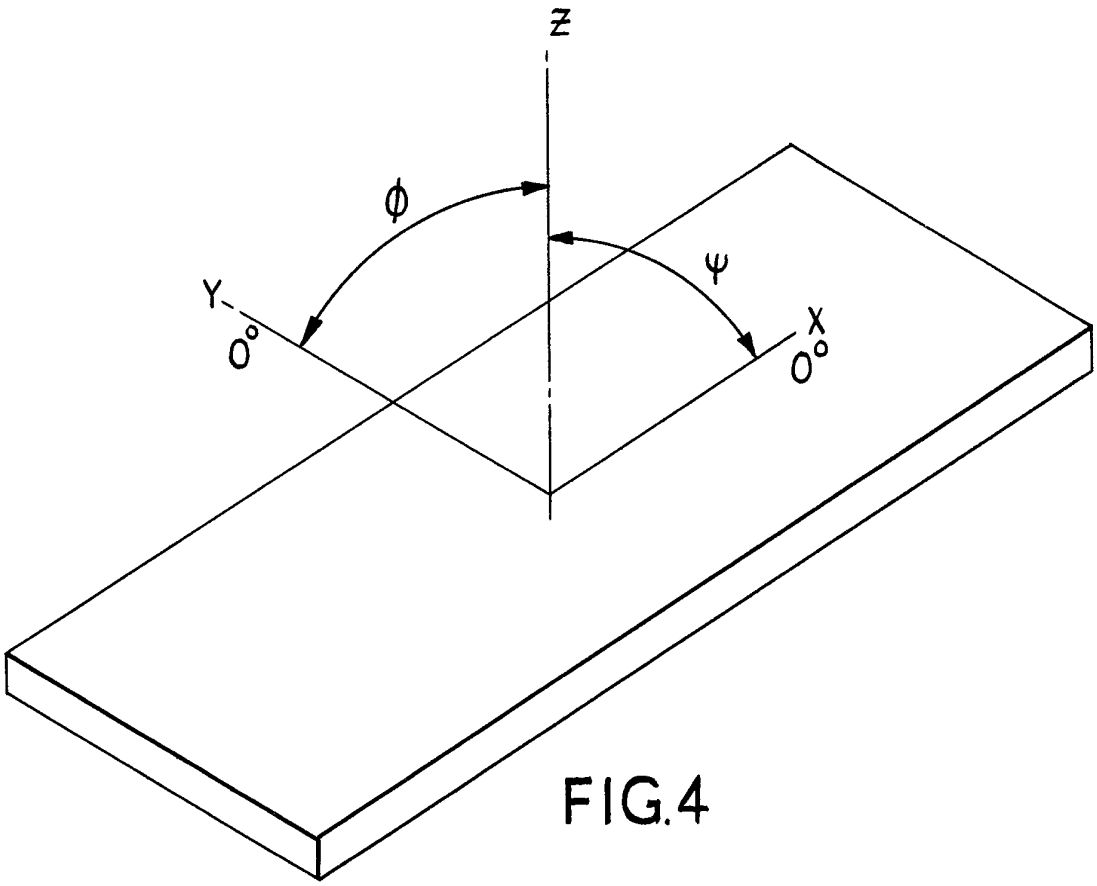
Z
ϕ
ψ
Y
0°
X
0°

FIG.4

SPECIFICATION

Mechanical calculator

The invention relates to a mechanical calculator for use in setting the angle of the tool in a universal head milling machine. The head assembly of the type of machine concerned comprises a first head portion housing the chuck, this first head portion being mounted for rotation with respect to a second head portion about an axis initially at 45° to the horizontal, the second head portion itself being rotatably mounted on a fixed headstock of the machine such that the first and second head portions may be rotated as a unit about a horizontal axis. To set the head at a compound angle, that is where the required tool axis is neither vertical nor horizontal, the first and second head portions must be rotated about the forementioned horizontal axis and the first head portion must be rotated relative to the second head portion, the machine being provided with dials for the purpose. Given the required axis of the tool it is however necessary to perform a trigonometrical calculation to derive the necessary dial settings. The operator may therefore derive the dial settings by trial and error which is time consuming and inaccurate or he may refer the trigonometrical calculation to more technically qualified staff.

An object of the invention is to enable the operator to derive setting angle for the machine dials without reference to technical staff while at the same time retaining the necessary setting accuracy.

This could be achieved either by deriving tables by calculation, which would involve a prohibitive amount of calculation time or by computer programme which would result in large volumes of computer printout for the operator to consult.

According to this invention, there is provided a mechanical calculator which includes two scale-bearing components coupled for relative rotation about a centre, one component having thereon a part circular logarithmic 'Sin' scale, the other having thereon a spiral logarithmic 'Tan' scale, and cursor line means arranged for angular movement about said centre to allow radial alignment of the two scales.

Preferably, the one component is an annular plate and the other component is a disc fitting within said annular plate.

Conveniently, the cursor line means comprises a transparent cursor disc having inscribed thereon a radial cursor line and mounted for rotation about said centre.

An embodiment of the invention will now be described by way of example with reference to the accompanying drawings:-

Figure 1 is a diametral section of the calculator,

Figure 2 is a plan view of the scales of the calculator and also of the cursor but omitting the centre boss for clarity,

Figure 3 is an elevation of the head of the milling machine, and

Figure 4 is a diagram of reference axes shown in relation to the table of the milling machine.

Referring to Figure 3, a first head portion 12 housing a chuck 13 is mounted for rotation on a second head portion 14 about an axis 15 initially at 45° to the horizontal. The second head portion 14 is itself mounted for rotation on a fixed headstock part 16 of the machine about a horizontal axis 17. To mill a compound angle the operator must derive the necessary settings on dials A and B from the required tool angle.

Referring to Figure 4, the reference axis Z corresponds to the axis of the tool in a vertical position when the centre of the table lies under the machine head. The Y-axis shown is parallel to the aforementioned horizontal axis 17. The operator is required to ascertain the angles of inclination of the required cutter axis, with respect to the X and Y axes shown (angles ψ and ϕ respectively). From study of the geometry of the adjustment of the dials A and B it can be shown that:-

$$\alpha = \text{Tan}^{-1}\left(\frac{\text{Tan}\,\phi}{\text{Sin}\,\psi}\right)$$

where α is a reference angle given in tables issued by the manufacturer from which the settings of dials A and B can be derived by simple addition or subtraction. For tolerances to be met the value of α is required to an accuracy of $\pm$ 5'.

An embodiment of the invention designed to carry out the above calculation will now be described with reference to Figures 1 and 2.

A disc shaped base member 1 is rigidly fixed to an annular member 3 on whose upward facing surface a part-circular scale 6 is printed. Scale 6 is a logarithmic 'Sin' scale. A fixed spigot 8 is centrally fixedly mounted on base member 1 and a rotary disc member 4 is mounted for rotation about the spigot, sliding on the upper surface of base member 1. On the upper surface of the disc member 4 is printed a scale 7 which is a spiral, logarithmic 'Tan' scale. A transparent cursor disc 5 is mounted for rotation about an upstanding central boss of the disc member 4. A radial cursor line 5a is scribed onto the cursor disc 5. The disc 5 is retained by a retaining ring 2 rigidly fixed to the base member. Rotation of the disc 4 and hence the scale 7 is performed by rotating a nut 9 which is fixed to the disc 4 and rotation of the cursor 5 is performed by means of a knob 11 fixed to the cursor disc. The scale 7 may be locked relative to scale 6 by rotation of a lock nut 10

mounted on an upper screw threaded part of the spigot 8.

The steps required to calculate the reference angle α conform to simple slide rule principles. The first step, given angles ϕ and ψ is to divide Tan ϕ by Sin ψ. Both ϕ and ψ scales range from 45° to 90° and are logarithmic as previously described. To divide Tan ϕ by Sin ψ would normally necessitate the substraction of Log (Sin ψ) from Log (Tan ϕ), but since the value of Log (Sin ψ) is always zero or negative, Log (Sin ψ) will be added to Log (Tan ϕ). This is carried out on the calculator by rotating scale 7 and the cursor line 5a such that the angle ϕ on scale 7 is aligned with angle ψ on scale 6. The lock nut 10 is then tightened to fix scale 7 relative to scale 6. The cursor is then rotated until the cursor line registers with the 90° mark on scale 6. If there were a simple non-trigonometric logarithmic version of scale 7 then the solution of tan ϕ divided by sin ψ could be read off. But the inverse tangent of this solution is required, and, as scale 7 is already a tangent scale, the value of α can simply be read off scale 7, the required angle being read off at the first intersection of the cursor line 5a and the sprial scale 7 occurring when following the spiral clockwise from the original value of ϕ.

Thus, in three simple moves the average operator can derive the reference angle α necessary for setting the machine head. The calculation could of course be performed using a linear slide rule but to do so to the required accuracy while still allowing easy ready of the scale would require a slide rule several feet long. The spiral scale 7 effectively condenses the calculator to a compact and manageable form whilst still retaining the required accuracy of $\pm$ 5'.

The limitation of both scales 6 and 7 to the range 45° to 90° is found to be practical as very rarely are setting angles required for which ϕ and ψ fall outside this range.

CLAIMS

1. A mechanical calculator which includes two scale-bearing components coupled for relative rotation about a centre, one component having thereon a part circular logarithmic 'Sin' scale, the other having thereon a spiral logarithmic 'Tan' scale, and cursor line means arranged for angular movement about said centre to allow radial alignment of the two scales.

2. A mechanical calculator according to Claim 1, wherein the one component is an annular plate and the other component is a disc fitting within said annular plate.

3. A mechanical calculator according to Claim 1 or Claim 2, wherein the cursor line means comprises a transparent cursor disc having inscribed thereon a radial cursor line and mounted for rotation about said centre.

4. A mechanical calculator according to any of the preceding claims, wherein the part circular logarithmic 'sin' scale reads from 45° to 90°.

5. A mechanical calculator according to any of the preceding claims, wherein the spiral logarithmic 'tan' scale reads from 45° to approximately 90°, in increments of 10' or less.

6. A mechanical calculator substantially as hereinbefore described, with reference to Figures 1 and 2 of the accompanying drawings.

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