

12

EUROPEAN PATENT APPLICATION

21 Application number: 85306359.2

51 Int. Cl.⁴: B 26 D 3/10

22 Date of filing: 06.09.85

A request pursuant to Rule 88 EPC for correction of the description was filed on 17.09.1985.

30 Priority: 28.03.85 JP 64274/85

43 Date of publication of application:
08.10.86 Bulletin 86/41

64 Designated Contracting States:
DE FR GB IT

71 Applicant: Yasuda, Hiroaki
17-go, 9-ban, Kumoi-cho
Nishinomiya Hyogo(JP)

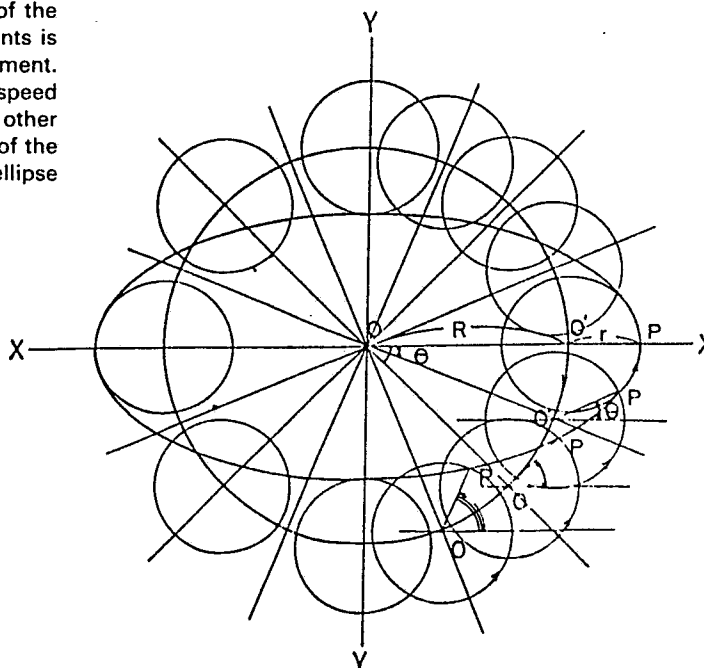
72 Inventor: Yasuda, Hiroaki
17-go, 9-ban, Kumoi-cho
Nishinomiya Hyogo(JP)

74 Representative: Brooke-Smith, Fred et al,
STEVENS, HEWLETT & PERKINS 5 Quality Court
Chancery Lane
London WC2A 1HZ(GB)

54 Method of cutting or marking an ellipse and apparatus therefor.

57 Movement of a cutting blade or a marking element is determined by the combination of two circular movements which determine the major axis and the minor axis of the ellipse, the centre (O') of one of the circular movements is moved on the circumference of the other circular movement. The two circular movements are such that the angular speed of one of the circular movements is twice that of the other and is in a reverse direction. By making the radiuses of the circular movements of the two members variable, the ellipse of the desired angle is cut or marked.

FIG 7



- 1 -

METHOD OF CUTTING OR MARKING
AN ELLIPSE AND APPARATUS THEREFOR

The present invention relates to a method of cutting a plate material, such as a mat for picture frame, a thick sheet of paper, a plywood, a rubber plate, a synthetic resin plate or the like, simply into an ellipse of the desired angle and an apparatus therefor. It is also applicable to a compass for drawing an ellipse by the use of the same principle.

10 Prior art:

Heretofore there have been available as the cutters for cutting a mat for picture frame or thick sheet of paper into an ellipse, those made by Oval and by Keaton, U.S.A. As the elliptical compasses there are those made by Half, West Germany. All these apparatuses are so designed that an ellipse is drawn by the combination of the shifts on the slidable Y-axis and X-axis of the rectangular co-ordinates. This principle will be explained with reference to Fig. 8. In Fig. 8, the co-ordinate of the point P is:

- 2 -

$$(a-b)\cos\theta + b\cos\theta \cdot b\sin\theta$$

$$\frac{\{(a-b)\cos\theta + b\cos\theta\}^2}{a^2} + \frac{(b\sin\theta)^2}{b^2} = 1$$

$$\frac{\{(a-b)\cos\theta + b\cos\theta\}^2 b^2}{a^2 b^2} + \frac{(b\sin\theta)^2 a^2}{a^2 b^2} = 1$$

$$\frac{\{(ab-b^2)\cos\theta + b^2\cos\theta\}^2 + \{ab\sin\theta\}^2}{a^2 b^2} = 1$$

5

$$\frac{(ab\cos\theta)^2 + (ab\sin\theta)^2}{a^2 b^2} = 1$$

$$\frac{a^2 b^2 \cos^2\theta + a^2 b^2 \sin^2\theta}{a^2 b^2} = 1$$

$$\frac{a^2 b^2 (\cos^2\theta + \sin^2\theta)}{a^2 b^2} = 1$$

$$\cos^2\theta + \sin^2\theta = 1 \quad \text{Therefore,} \quad \frac{a^2 b^2}{a^2 b^2} = 1$$

10 Accordingly, the locus drawn by the point P becomes an ellipse. However, when an elliptical cutter is manufactured in accordance with this principle, it is so made that there are provided two rods to form X-axis and Y-axis which are disposed to stride over the base on which an object to be

15 cut, such as a picture frame mat, is placed and which are to be at right angles to each other and by controlling the range of sliding of a sliding member along these rods, the sliding member is

allowed to make an elliptical movement and by pressing a cutter provided on the sliding member onto an object to be cut, cutting of the object into an elliptical profile is made. According to said system, however, it
5 is necessary to keep the two rods to be provided over the base in high precision and to provide them with high strength from structural point of view.

Consequently, the whole cutter must be of large size. Also, since a cutter fitting part to which pressing
10 force is applied is separate from the position of a cutter blade, the cutter fitting part is required to have higher strength. This is because of the fact that an object to be cut is fixed, over which only a cutter is moved.

15 According to a first aspect of the invention, there is provided a method of marking on or cutting in a surface an ellipse, employing a marking or a cutting element comprising producing a relative movement between the element and the surface, said relative
20 movement being constituted by the resultant of first and second circular movements, said first circular movement being centred on the circumference of the second circular movement, and the angular speed of the first circular movement being twice that of the second
25 circular movement and in the opposite direction to the second circular movement.

According to a second aspect of the invention, there is provided apparatus for marking on or cutting in a surface an ellipse, comprising a marking element
30 or a cutting element, and means for producing a relative movement between the element and the surface, said relative movement being constituted by the resultant of first and second circular movements, said first circular movement being centred on the
35 circumference of the second circular movement, and the

angular speed of the first circular movement being twice that of the second circular movement and in the opposite direction to the second circular movement.

The nature and advantage of the present
5 invention will become more apparent from the following description made with reference to the accompanying drawings, in which:

Figure 1 is a front view of an elliptical cutter according to the present invention,

10 Figure 2 is a plan view of the elliptical cutter shown in Figure 1,

Figure 3A is an illustrative view to show the engagement between the main link and the sliding plate,

Figure 3B is a cross section of Figure 3A,

15 Figure 4A is a perspective view of the cutter pushing section,

Figure 4B is a cross section of Figure 4A,

Figure 5 is a perspective view of the cutter fitting section,

20 Figure 6 is a bottom view showing the reverse surface of the base,

25

30

35

Fig. 7 is an illustrative view for drawing an ellipse according to the present invention;

Fig. 8 is an illustrative view for drawing an ellipse by the known art, and

5 Figs. 9, 10 and 11 show respectively an embodiment of the elliptical compass using the principle of the present invention, in which Fig. 9 being a front view thereof and Figs. 10 and 11 being the plan views for drawing an ellipse.

10 The elliptical cutter of the present invention will hereinafter be described, based on the embodiments shown in Figs. 1 to 8.

In the drawing, a base 1 has a required size and a shape to be stabilized even when it is placed on a
15 working table. On said base there are provided a bearing 2 for a turntable and bearings 3, 4 for a main shaft and a sub-shaft. The bearing 2 is used to support a turntable shaft 5 for smooth rotation. To the top end of the shaft 5 a turntable 6 of a size suitable for placing
20 and fixing a workpiece, such as a mat, is fixed and at the lower end of the shaft 5 a pulley 7 is provided. As shown in detail in Fig. 2, the bearings 3 comprise a couple of two opposite pieces on the right and left sides. Each bearing 3 supports the main shaft 8 for
25 smooth rotation. To the lower end of the main shaft 8 a pulley 9 is fixed, and to the upper end thereof a horizontally projecting ~~crank arm~~ 10 is provided

0196383

integrally. In the crank arm 10, a dovetail groove 10a is formed in its longitudinal direction. An extension piece is slidably accommodated in said dovetail groove 10a and the upper part of said piece 11 is loosely fitted in a hole 12a made in a sliding plate 12. The lower part of the piece 11 is formed into a fitting piece 11a of a shape to be fitted slidably in the dovetail groove 10a of the crank arm 10 and its upper part is made into an axial form, on the top of which a flange 11b is formed. Said axial form and flange 11b are accommodated into the hole 12a of the sliding plate 12, after which a presser plate 13 is fixed to the sliding plate 12 in a manner to press the top surface of the flange 11b, whereby the piece 11 is made revolvable in relation to the sliding plate 12 but not extractable upward or downward. The piece 11 has a hole 11c made vertically therethrough. At the lower part of the hole 11c, a female screw is threaded. A screw rod 14 having a knob 14a at its top is thrust into the hole 11c and screwed up. The free end of the screw rod 14 is protruded downward from the lower part of the piece 11 to have it oppose to the inner bottom surface of the dovetail groove 10a of the crank arm 10. When the screw rod 14 is strongly turned with the knob 14a, the lower end of the screw rod 14 is brought into pressure contact with the inner bottom surface of the dovetail groove 10a, by which the extension piece is fixed. To the contrary, by loosening the screw rod 14,

the piece 11 becomes optionally slidable in the dovetail groove 10a of the crank arm 10. The main shafts 8 are provided two in opposed state in the base 1 and are similarly supported by the sliding plate 12. Also, a sub-shaft 15 is provided adjacent to the main shaft 8. The sub-shafts 15 are also two, which are provided on the opposite side to the turntable shaft 5 of the main shaft. Each of the sub-shafts is provided at its upper end with a sub-crank 16 and at its lower end with a pulley 17. Into the dovetail groove 16a provided in the sub-crank 16, an extension piece 18 is inserted. The upper part of the piece 18 is engaged with the sliding plate 12 and the piece 18 is also screw-stopped with a screw rod 19. The crank arm 10 is provided with a scale a and by fixing the piece 18 according to the scale, the minor axis of the ellipse is determined. The two crank arms 10 and the sub-cranks 16 are disposed in parallel state and are connected with the sliding plate 12 via the pieces 18. In determining the minor axis of the ellipse, it is necessary to set at least the scales of the two crank arms to the same position. Although there is no scale on the sub-cranks, after setting the scale of the crank arm, the screw rod of the sub-crank may be tightened.

The sliding plate 12 is provided with an arm 20 for determining the major axis of ellipse. The arm 20 is provided in manner to overlies one end of the sliding plate 12. Either one or both of them is/are

provided with a scale b. The arm 20 is provided in its longitudinal direction with a slot 20a and on its lower surface with a protrusion 20b along the slot so as to prevent transverse deflection of the arm. A groove 12b to accommodate the protrusion 20b is provided on the sliding plate 12. At the outer end part of the groove 12b a screw hole 12c is provided. A screw portion 21a of a fixing member 21 inserted into the slot 20a of the arm 20 is screwed in said screw hole 12c. By fastening of the fixing member 21, the arm 20 is fixed or after loosening of the fixing member, the arm is slid. At the free end of the arm 20, a cutter holder as shown in Fig. 4 is provided. The cutter holder 22 accommodates and supports a presser 22b in a bearing 22a in rotatable and slidable manner and also accommodates and supports a shaft 22d in the presser 22b through the medium of a bearing 22c. A cutter stem 23 is fitted to a cutter fitting piece 22e of a shaft 22d projected at the lower end of the holder 22. A presser 23b is provided with a spring 22g between the bearing 22a and a flange 22f provided at the top surface of the presser so as to be forced upward at all times. The cutter fitting piece 22e is provided with a transverse slot 22h, in which the cutter stem 23 is fixed. The cutter stem 23 has a flange 23f at its center, with bolt sections 23b, 23c (each having a bolt-like male screw thread) projected to both ends thereof. On the longitudinal side of

one bolt 23b, a cut groove 23d is provided. A cutter
23a is inserted in the cut groove 23d and is securely
held by a nut 23e screwed into the bolt section 23b
and a flange 23f. The other bolt 23c is inserted in
5 the transverse slot 22h of the cutter fitting piece 22e
and a nut 23g is screwed at the free end thereof. The
cutter fitting piece 22e is held between and fixed by
the nut 23g and the flange 23f. Under this condition,
by turning the bolt 23c, the angle of the cutter in
10 relation to an object to be cut is made adjustable from
a right angle to an optional angle.

In order to place the cutter 23a at a right angle
to an object to be cut, the outside of the bolt part
23c is ground into a plane shape and inserted in the
15 slot 22h, whereby the angle can be simply determined.

The turntable 6 which is rotatably supported by
the bearing 2 is provided with two fixing means 24 for
keeping a workpiece accurately when loaded thereon.
The diameter of a pulley 7 provided at the lower end
20 of the turntable shaft 5 is made larger than the
diameter of pulleys 9, 17 which are provided at the
lower ends of the main shaft 8 and the sub-shaft 15,
the ratio thereof being 2:1, and a belt 25 is stretched
around the pulleys 7, 9 and 17. In place of the
25 pulley belt, a sprocket wheel, a chain or a gear
may be used.

A description will be made below on the process
of cutting a picture frame mat into an elliptical form

with an elliptical cutter of the present invention.

Firstly, a mat is placed on a turntable 6 and is fixed with a fixing means 24. Then, a choice is made whether to make the cut surface perpendicular or

5 angled, depending on which the cutter 23 is fixed. In fixing the cutter shaft 23f to the cutter holding piece 22e, the angle of the cutter to the surface to be cut is adjusted and fixing is made. Next, the major axis and the minor axis of an ellipse are to be determined.

10 In order to obtain the designed ellipse, firstly the major axis is adjusted by sliding the arm 20 provided on the sliding plate 12 after loosening the fixing member 21 to obtain the desired length according to the scale b and then the fixing means 21 is fastened again.

15 By this, a radius R on the major axis side of the ellipse between the turntable axis and the cutter is determined. Then, the minor axis of the ellipse is determined. In order to do this, according to the scale on the crank arm 10, the screw rod 14 provided on the extension piece 11 is loosened to shift the piece 11 and when the piece 11 is stopped at the specified position, the screw rod 14 is fastened again. At this time, the screw rods 14, 19 which are four in total provided on the two crank arms and two sub-cranks

20 respectively are to be set. By this, a minor axis side radius r of the ellipse is obtained. Then, when the turntable 6 is rotated while pressing the presser 22 from above, an elliptical window opening is cut on the

mat with the cutter provided at the lower end of the
 presser 22. In case of $r = 0$, when the distance
 between the free end of the arm 20 and the central
 point of the turntable 6 is assumed to be R and the
 5 distance from the center of the main shaft 8 of the
 crank arm 10 to the center of the fixing position of
 the piece 11 to be r , the point P on the circumference
 of the radius r of the circle drawn by the rotation
 of the crank arm 10 having its center on the
 10 circumference of the circle with the radius R is, when
 on X -axis, on its co-ordinate of $\{\pm(R + r).0\}$.

Assuming the angle of 0.0° with the acute angle
 side of X -axis to be θ , while a straight line connecting
 the point O' on the circumference of radius R and the
 15 point P on the circumference of radius r is kept at the
 same angle to the X -axis, the crank arm is rotated in
 a direction reverse to the direction of rotation of R ,
 i.e., reversely rotated, by which the locus of this
 point P becomes an ellipse. This will be demonstrated
 20 below.

Assuming the co-ordinate of the point P to be
 $(R\cos\theta + r\cos\theta, R\sin\theta - r\sin\theta)$ and the locus of the
 point P to be an ellipse, the data may be held by
 inserting in the elliptical equation: $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$.

25 When $a = R + r$ and $b = R - r$ are applied to the above
 equation,

- 12 -

$$\frac{(R\cos\theta+r\cos\theta)^2}{(R+r)^2} + \frac{(R\sin\theta-r\sin\theta)^2}{(R-r)^2} = 1$$

$$\frac{(R\cos\theta+r\cos\theta)^2(R-r)^2}{(R+r)^2(R-r)^2} + \frac{(R\sin\theta-r\sin\theta)^2(R+r)^2}{(R+r)^2(R-r)^2} = 1$$

$$\frac{\{(R\cos\theta+r\cos\theta)(R-r)\}^2}{\{(R+r)(R-r)\}^2} + \frac{\{(R\sin\theta-r\sin\theta)(R+r)\}^2}{\{(R+r)(R-r)\}^2} = 1$$

$$\frac{(R^2\cos\theta-r^2\cos\theta)^2}{(R^2-r^2)^2} + \frac{(R^2\sin\theta-r^2\sin\theta)^2}{(R^2-r^2)^2} = 1$$

$$5 \quad \frac{R^4\cos^2\theta - 2R^2r^2\cos^2\theta + r^4\cos^2\theta + R^4\sin^2\theta - 2R^2r^2\sin^2\theta + r^4\sin^2\theta}{(R^2 - r^2)^2} = 1$$

$$\frac{R^4(\cos^2\theta + \sin^2\theta) - 2R^2r^2(\cos^2\theta + \sin^2\theta) + r^4(\cos^2\theta + \sin^2\theta)}{R^4 - 2R^2r^2 + r^4} = 1$$

$\cos^2\theta + \sin^2\theta = 1$ Therefore,

$$\frac{R^4 - 2R^2r^2 + r^4}{R^4 - 2R^2r^2 + r^4} = 1$$

10 Accordingly, the line drawn by the above method becomes an ellipse.

By changing the length of the arm 20 and the fixing position of the piece 11 relative to the crank arm the angle and the size of the ellipse may be made optional. When the piece 11 is fixed onto the
15 0 point of the crank arm, i.e. at the center of the main shaft, a true circle having the arm length as a radius can be formed. By furnishing a writing

instrument in place of the cutter to be provided at the lower end of the presser, the apparatus may be used as an elliptic compass.

5 When the cutter is pressed onto the mat while revolving the turntable on which the mat is placed and fixed, it is possible to carry out cutting of the ellipse in a simple construction with accuracy and through adjustment of the eccentricity of the sliding plate by the screw rod and the extension piece and also
10 adjustment of working length of the arm, adjustments of the major axis and the minor axis of the ellipse can be made simply and accurately, and the ellipse of the desired angle can be optionally prepared. Also, due to the simple construction and simple operation, there is
15 a merit of requiring no skill of operators.

Then, an embodiment of the elliptical compass is explained with reference to Figure 9 - Figure 11.

On an arm 30 (a special type arm as shown in Figure 9 and Figure 10) set on a sheet of paper or a
20 plate on which an ellipse is to be drawn, a main shaft 31 is supported revolvably. The arm 30 is made to be supported on the paper at least at three different points. It is used in such a manner that the center of the main shaft 31 supported by the above arm 30 is set
25 at the position which becomes the centre of the ellipse to be drawn.

A handle 32 and a first block 33 is fixed at the upper end and the lower end respectively of the main shaft 31. With the revolution of the handle 32, the first block 33 is revolved via the main shaft 31. A
5 first gear wheel 34 is mounted revolvably on the outer circumference of the main shaft 31 and by a screw 35 provided protrudingly from the arm 30, the first gear wheel 34 is fixed at the desired angle. A crank arm 36 is fitted slidably to the first block 33 by the
10 main shaft 31. A link 37 is fixed to a free end of the crank arm 36 by a second gear wheel shaft. The second gear wheel 38 is provided at the upper end of the second gear wheel shaft in a manner to engage with the first gear wheel 34.

15 A second block 40 is fixed to the free end of the link 37 via a shaft 39, to the upper end of which a third gear wheel 41 is fixed. The third gear wheel 41 engages with the second gear wheel 38. A diameter ratio between the first gear wheel 34 and the third
20 gear wheel 41 is set at 2 : 1 but the diameter of the second gear wheel may be determined properly. The second block 40 and the first block 33 are so arranged that both oppose each other at all times, irrespective of the shifting of the crank arm and the link.

25 Between the first block 33 and the second block 40, a major axis scale rod 42 and a screw rod 43 are mounted. The major axis scale rod 42 is graduated and is fixed at its base end side to the first block 32 but is put

in the second block 40 slidably. The screw rod 43 is threaded in the first block 33 but is passed through revolvably the second block. However, in order to make the correlation between the screw rod 43 and the second block 40 uniform at all times, irrespective of the revolution of the screw rod, the screw rod 43 is supported by a set ring 43a. A knob 44 is fixed at the free end of the screw rod 43 and by revolving the knob 44, the screw rod 43 revolves and thus the distance between the first block and the second block varies. At this time, the crank arm and the link are shifted but gears 34, 38, 41 maintain the engagement with each other.

A hanging rod 45 projects from a shaft 39 which projects under the second block 40. The hanging rod 45 is provided with a protractor 46 and a pointer 47 fixed to the second block 40 indicates the angle of the protractor or the angle of an ellipse to be drawn. In order that the angle may be indicated accurately, the screw 35 is loosened, the first gear wheel 34 is revolved and adjustment is made so that the pointer 47 may indicate the specified angle of the protractor 46 at the 0 position, after which the screw 35 is tightened. At the lower end portion of the hanging rod 45, a support rod 48 with a minor axis scale is provided horizontally, namely, in parallel with the major axis scale rod 42, the screw rod 43, the crank arm and the

link. A slider 49 is supported slidably on this support rod 48 and is fixed by a setscrew 50 at the setting scale position. The slider 49 is fitted with a writing tool 51, a lower end of which makes contact with a sheet of paper at a proper pressure by its own weight.

A method of drawing an ellipse by the use of the compass of the present invention is explained below.

Assuming the radius of the second gear wheel 34 to be R and the radius of the third gear wheel to be r , the point P on the circumference of the circle of radius r having its center on the circumference of the circle of the radius R , when on the X -axis, has its co-ordinate on $\{+(R + r).0\}$. Assuming the angle of 0.0° on the X -axis with the acute angle side of the X -axis to be θ , when a straight line connecting the point O' on the circumference of the circle having the radius R and the point P on the circumference of the circle having the radius r reversely rotates while keeping the same angle to the X -axis, the locus of the point P forms an ellipse. When revolution is made with the main shaft 31 as center, because the third gear wheel 41 is engaged with the first gear wheel 34 via the second gear wheel 38, during the revolution of the third gear wheel 41 the second gear wheel 38 is to make normal rotation and the third gear wheel is to make rotation on its axis in a reverse direction.

Accordingly, the line to be drawn by this method

becomes an ellipse.

5 The major axis of an ellipse to be drawn may be
set to the prescribed scale by moving the second block
40 by revolving the knob of the screw rod. In the case
of the minor axis, the slider 49 is slid along the
support rod 48 to set to the prescribed scale. By the
shifting of the second block 40, the crank arm and the
link which support the second gear wheel 38 and the
third gear wheel 41 respectively are shifted, centering
10 on the main shaft 31, to drawn an ellipse having the
major axis and the minor axis.

15 According to the present invention, the system
is constituted by the combination of the circular
movements of the three gear wheels and the crank arm
and the link which move, centering on the main shaft
which supports these gear wheels. Accordingly, by a
simple mechanism and a simple operation, accurate
ellipse can be drawn.

CLAIMS

1. A method of marking on or cutting in a surface an ellipse, employing a marking or a cutting element, comprising producing a relative movement between the
5 element and the surface, said relative movement being constituted by the resultant of first and second circular movements, said first circular movement being centred on the circumference of the second circular movement, and the angular speed of the first circular
10 movement being twice that of the second circular movement and in the opposite direction to the second circular movement.
2. Apparatus for marking on or cutting in a surface an ellipse, comprising a marking element or a cutting
15 element, and means for producing a relative movement between the element and the surface, said relative movement being constituted by the resultant of first and second circular movements, said first circular movement being centred on the circumference of the
20 second circular movement, and the angular speed of the first circular movement being twice that of the second circular movement and in the opposite direction to the second circular movement.
3. A cutter for cutting an elliptical shape
25 comprising a base, a turntable rotatably mounted on the base for supporting a laminar object to be cut, pair of spaced, parallel main shafts rotatably mounted with respect to the base the axes of rotation of the main shafts being parallel to the axis of rotation of the
30 turntable, drive means for rotating the turntable and the main shafts, each main shaft having a crank arm mounted thereon, an extension piece mounted on the crank arm and selectively movable towards or away from the axis of rotation of the main shaft, a slider plate
35 pivotally mounted on the extension pieces for circular

movement as the main shafts rotate, an arm mounted on and extending from the slider plate, the length of the arm being selectively adjustable, and a cutting element mounted on the end of the arm remote from the slider
5 plate and overlying the turntable, rotation of the main shafts with the two crank arms in synchronism with each other causing the cutting element to move in a circular path having a radius equal to each of the distances between the axes of rotation of the main shafts and the
10 pivotal mountings of the slider plate on the extension pieces, which distances are equal and determine the minor axis of the ellipse, the distance between the axis of rotation of the turntable and the centre of the circular path of the cutting element determining the
15 major axis of the ellipse, and the drive means being adapted to rotate the turntable at half the angular speed of the cutting element and in the opposite direction to the cutting element.

4. A compass for marking an ellipse comprising a
20 frame, a main shaft rotatably mounted on the frame, means to effect rotation of the main shaft, a first gear wheel freely mounted on the main shaft, a crank arm having one end secured to the main shaft and its other end rotatably connected to and carrying a second
25 shaft on which is secured gear wheel meshing with the first gear wheel, a link having one of its ends rotatably connected to the second shaft and its other end rotatably connected to a third shaft on which is secured a third gear wheel meshing with the second gear
30 wheel, means for selectively altering the distance between the third shaft and the main shaft which distance determines the major axis of the ellipse, and a carriage fixed to the third shaft and carrying a marking element the distance of which from the axis of
35 rotation of the third shaft is selectively adjustable

thereby to determine the minor axis of the ellipse, the
diameter of the first gear wheel being twice that of
the third gear wheel so that the angular speed of the
marking element about the axis of the third shaft is
5 twice that of, and is in the reverse direction to, that
of the third shaft about the axis of the main shaft.

10

15

20

25

30

35

FIG 1

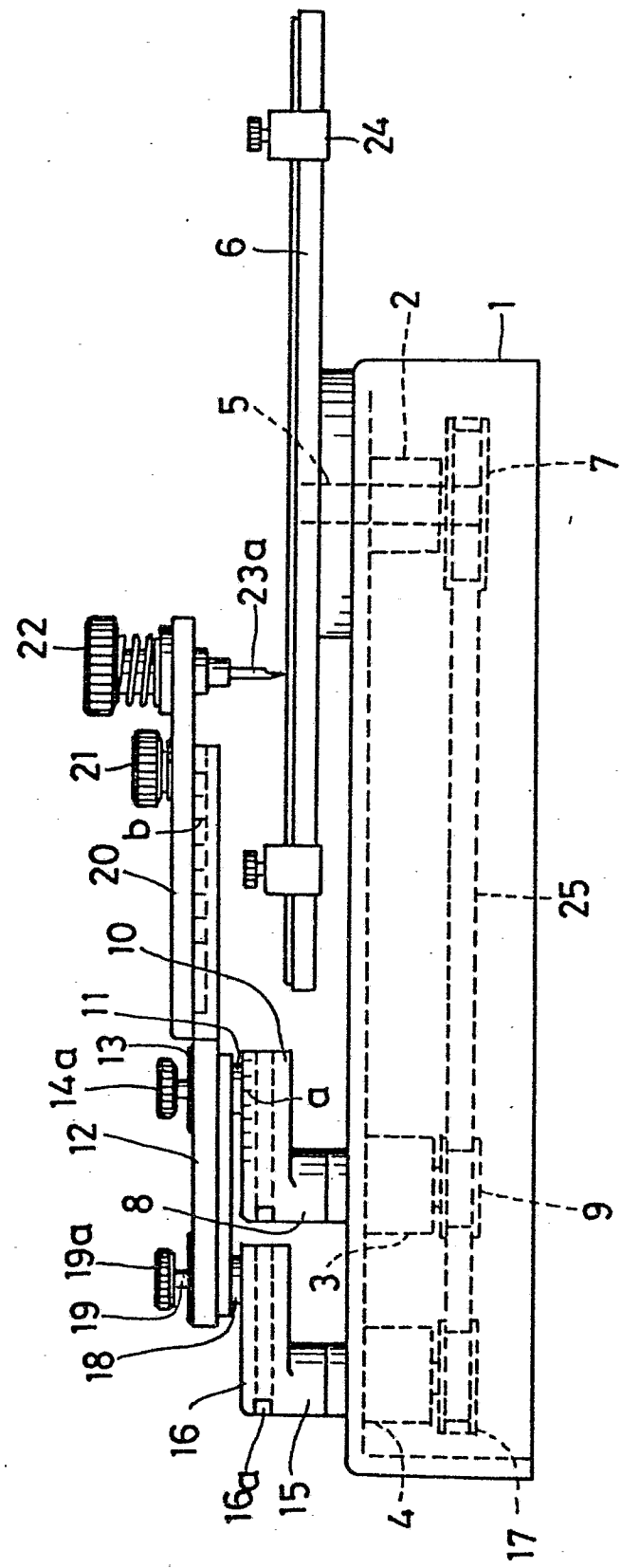


FIG 2

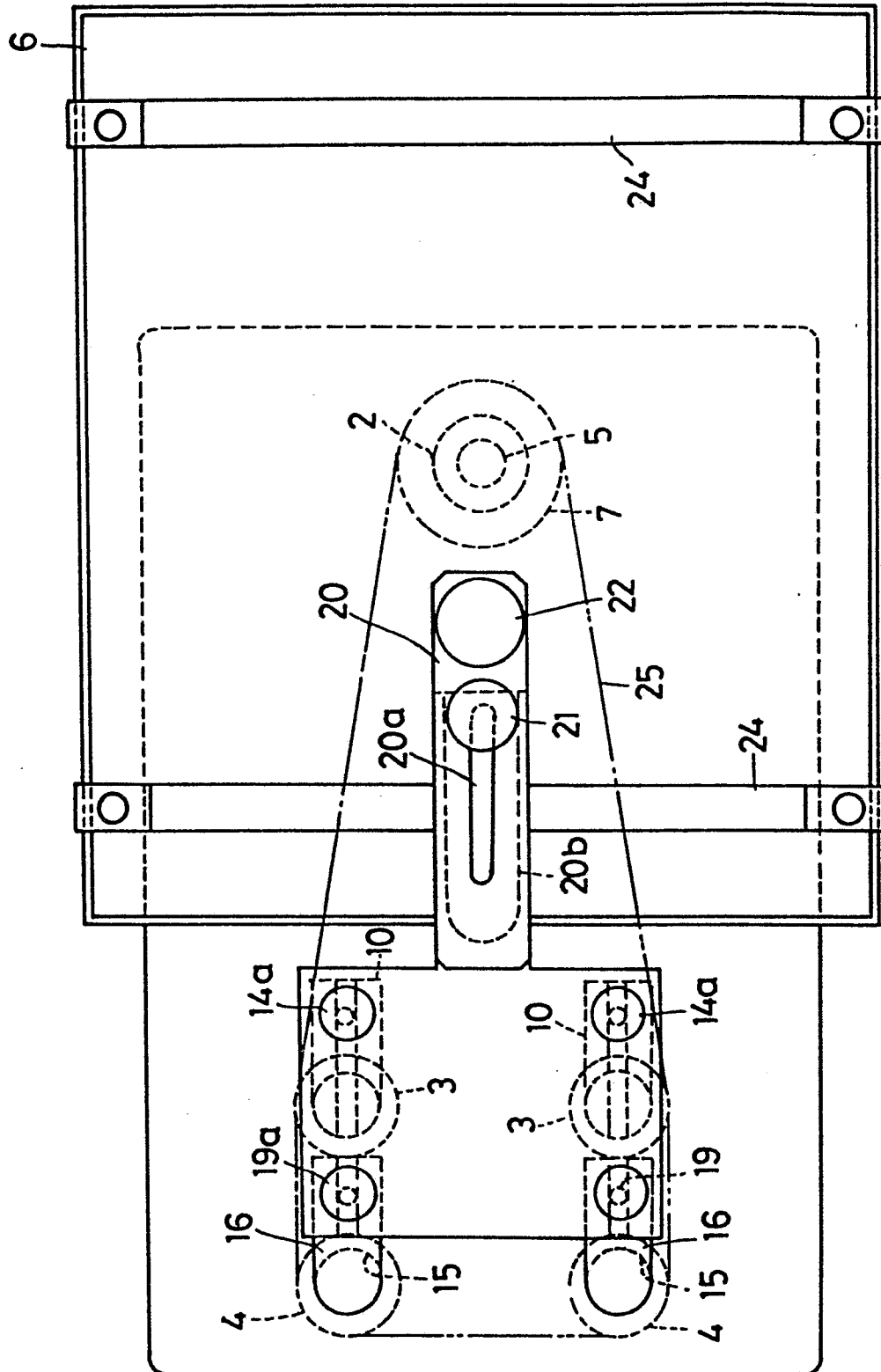


FIG 3A

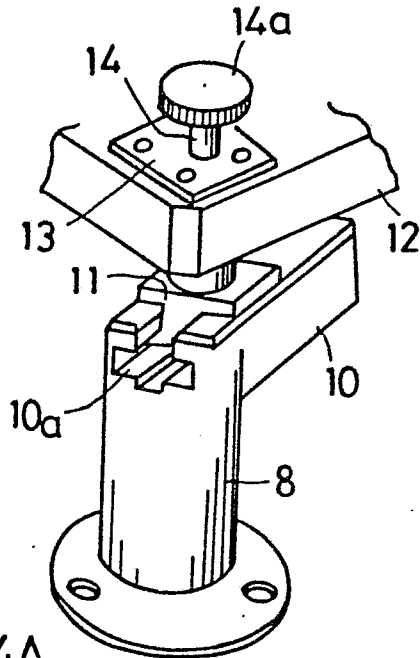


FIG 3B

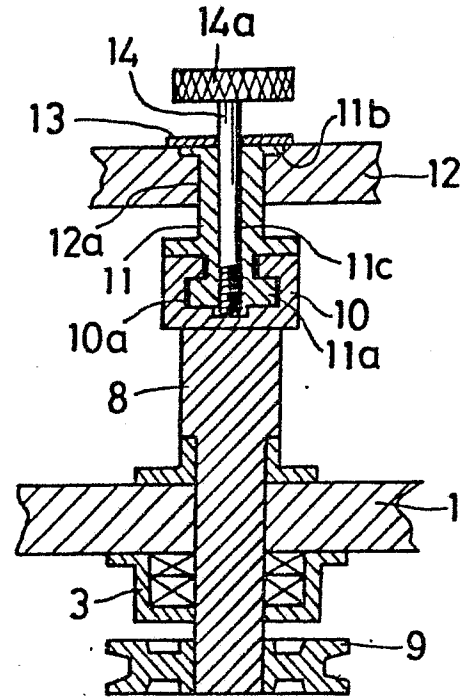


FIG4A

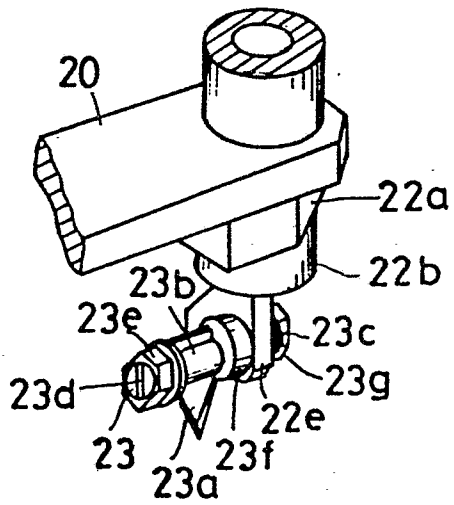
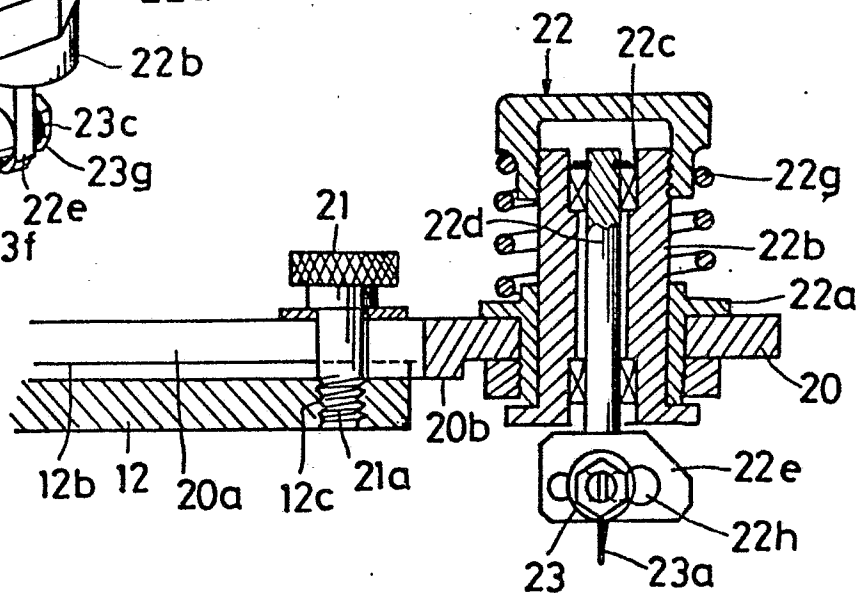


FIG4B



4/7

FIG 5

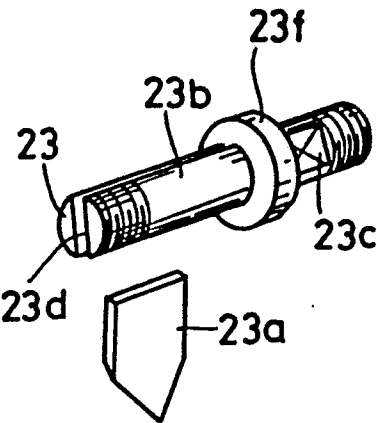
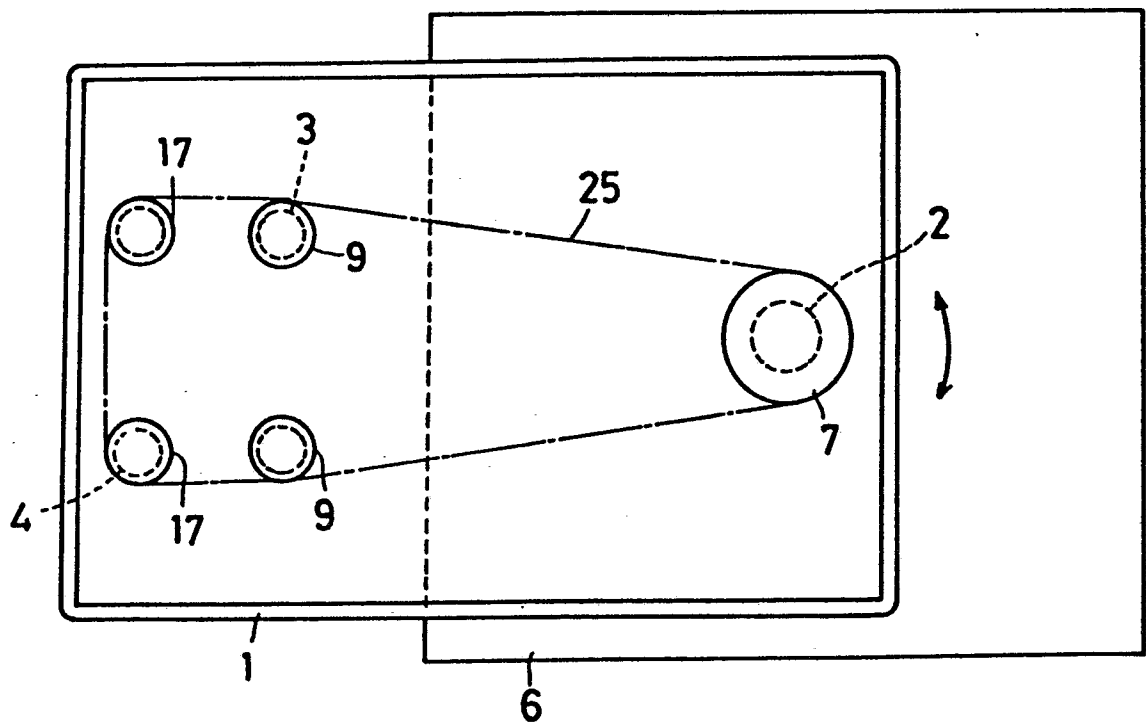


FIG 6



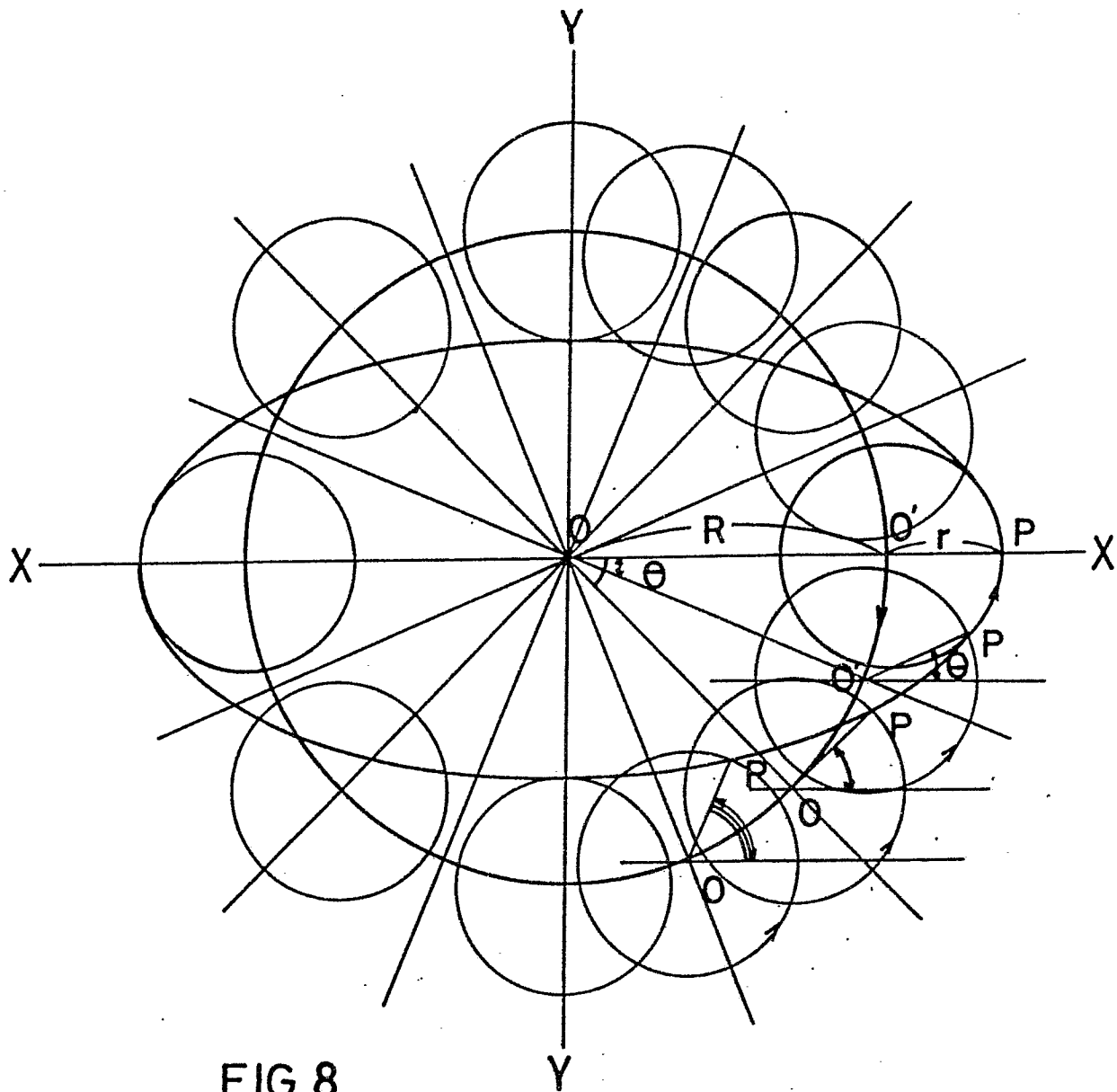
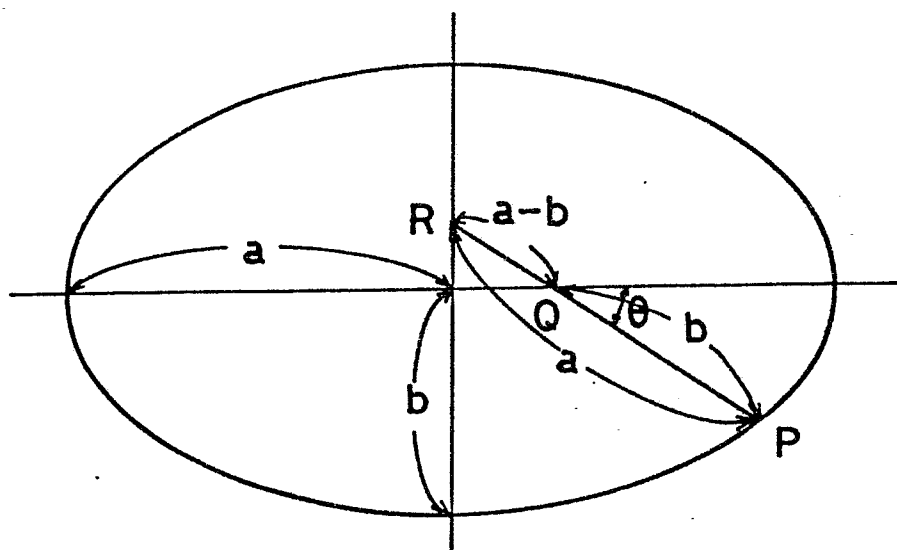
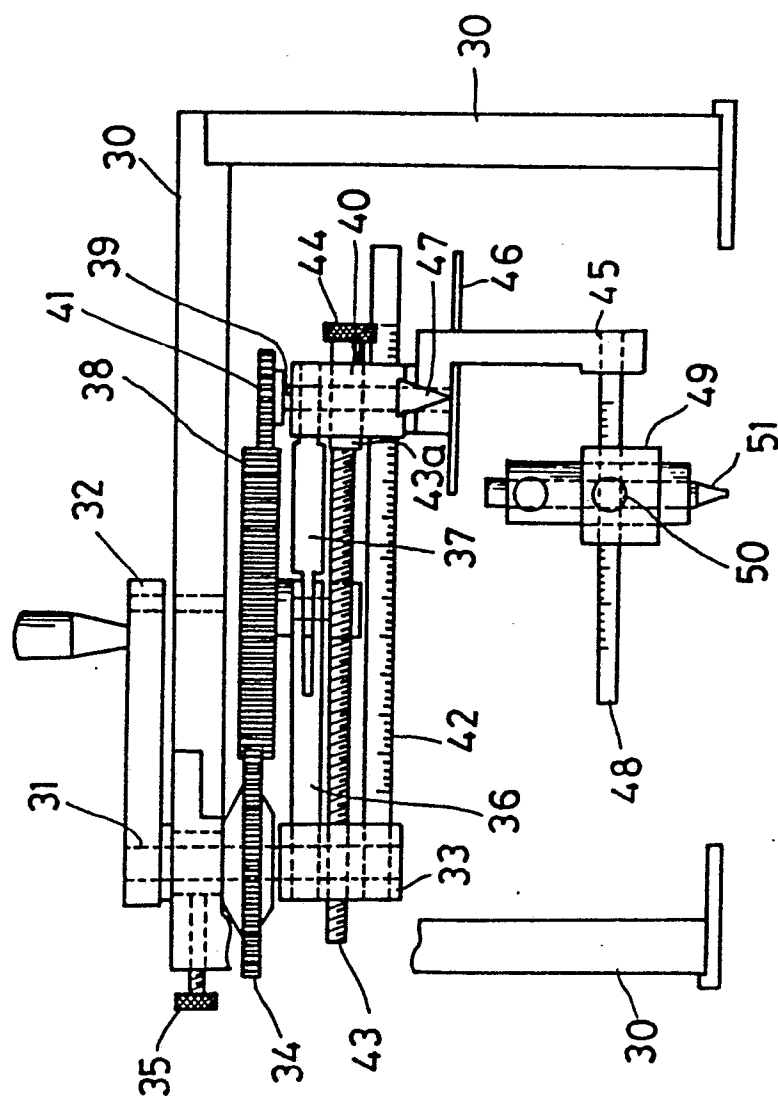


FIG 8



6/7

FIG 9



717
FIG 10

0196383

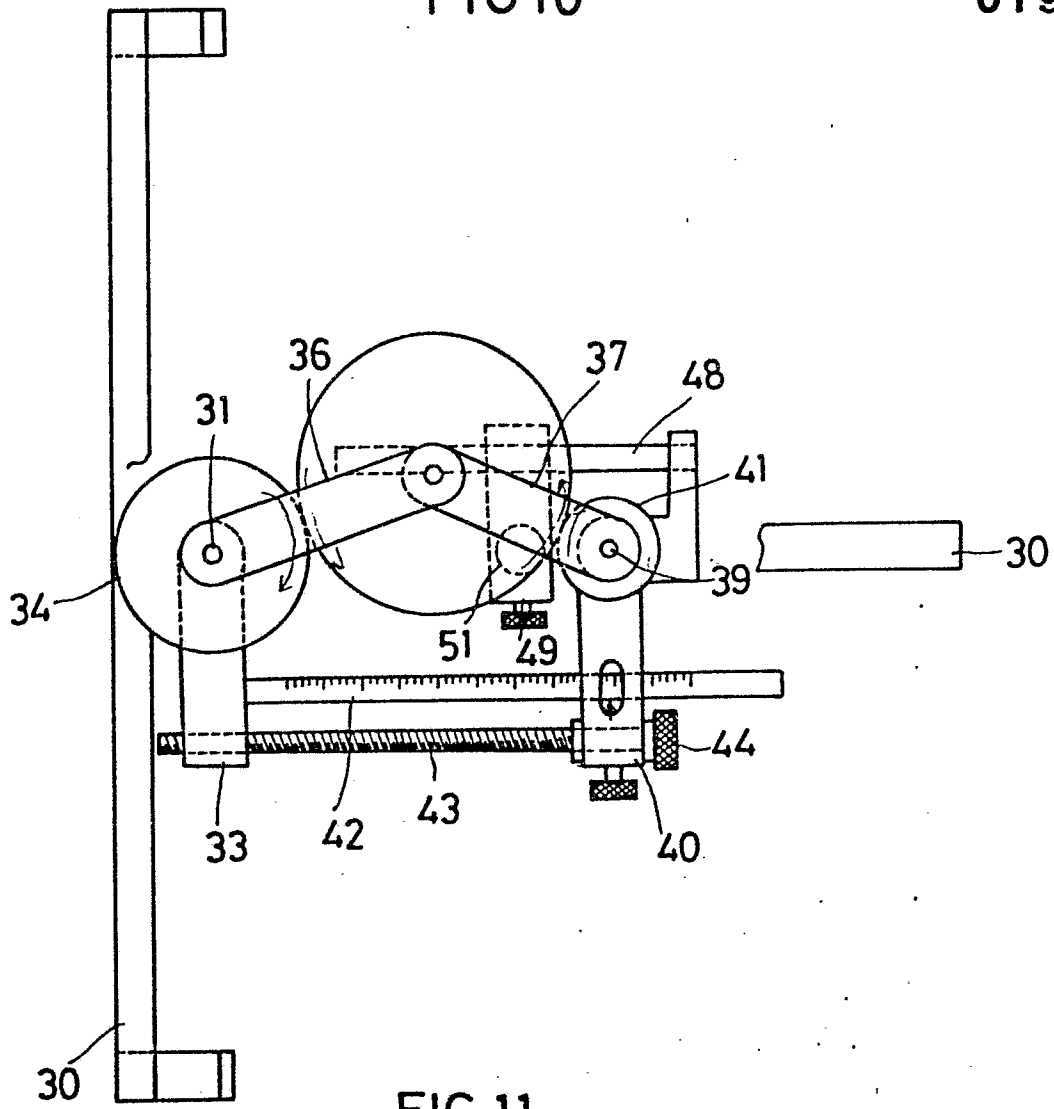


FIG 11

