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DD 000301867 A9 **FR 002473932 A1**
JP 2004082249 A **US 4466601 A**
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(54) Title of the Invention: **Trigonometrical angle plate**
Abstract Title: **Trigonometrical angle plate**

(57) A trigonometrical angel / fixture plate arrangement, typically for use with milling or CNC machines, comprises a surface/plate 1 having four dowel holes 4, 5, 6, mounting / support blocks 2 and support strap / strip / stay components 3. At one end of plate 1 dowel locations 4 connect the plate to the two mounting blocks 2, and the two support straps 3 are connected to plate 1 by dowel locations 5 and to mounting blocks 2 by dowel locations 5. All dowel holes are a precise distance apart, so as to create a desired angle between the blocks 2 and the fixture plate via hinged datum (4, Fig 2), creating an angle α (7) in accordance with the trigonometric relationship D = 2C Sin ½ α, where D is strap length (see fig 2), and C is the distance between hinge /dowel location 4 and dowel location 5. The plate 1 and mounting blocks 2 are made from high strength aluminium and the straps 3 are made from strip steel.

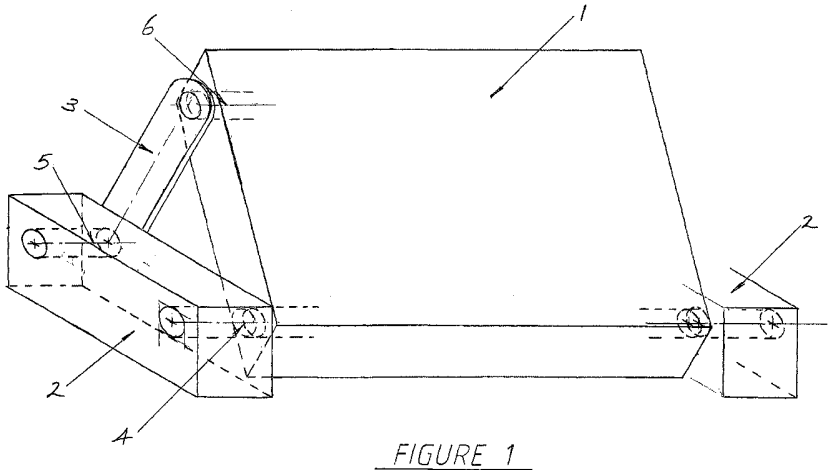

FIGURE 1

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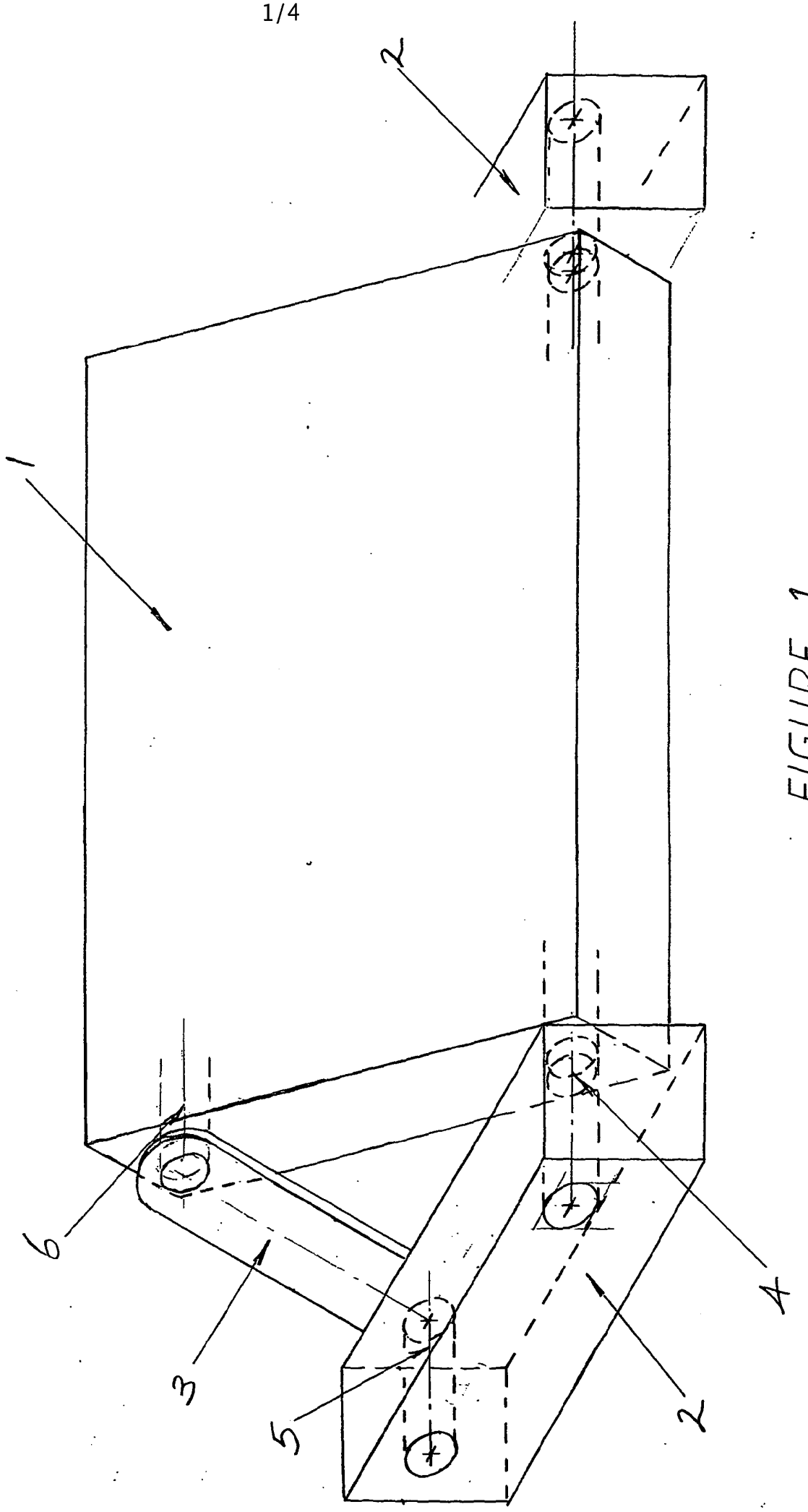


FIGURE 1

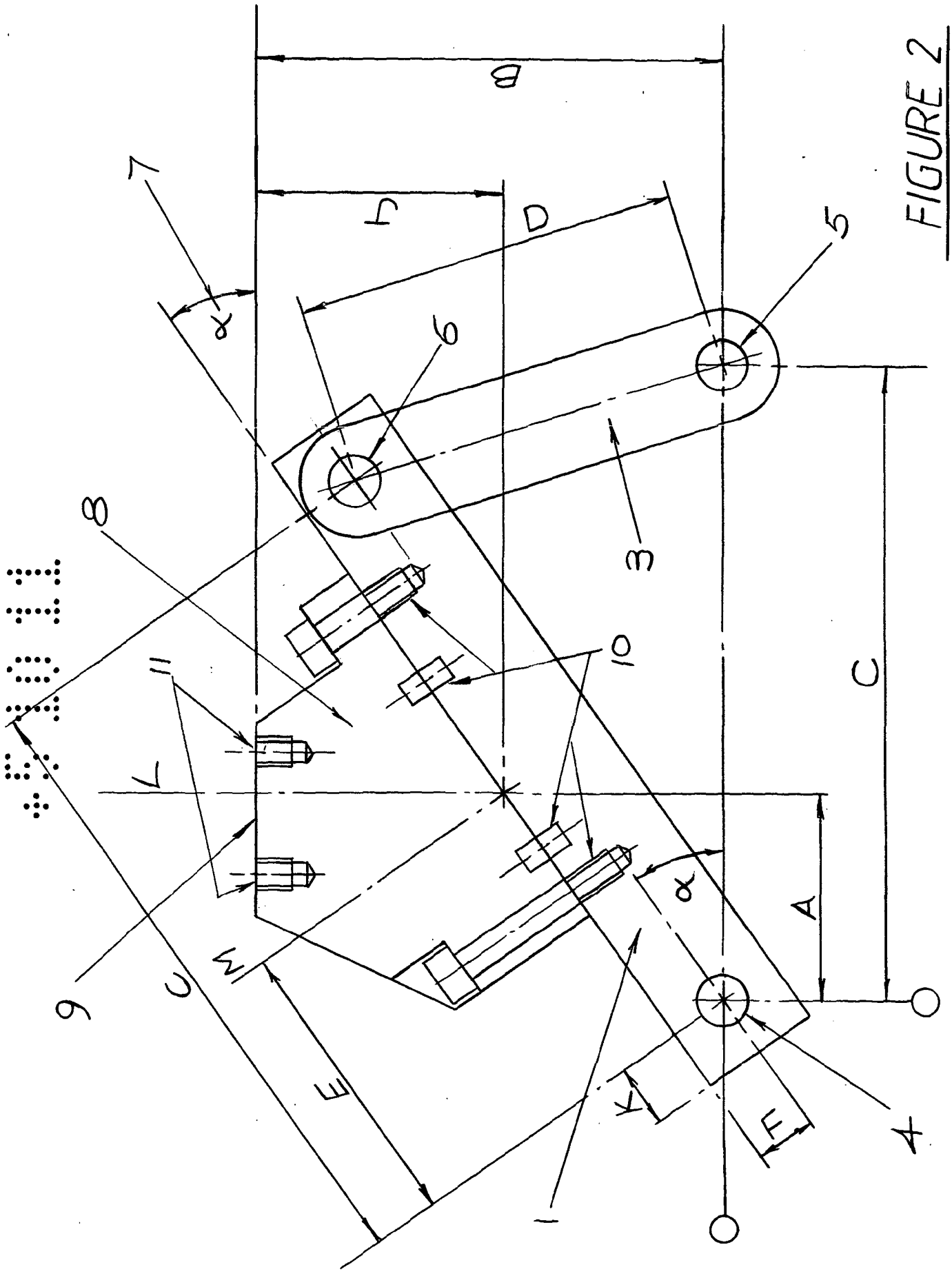


FIGURE 2

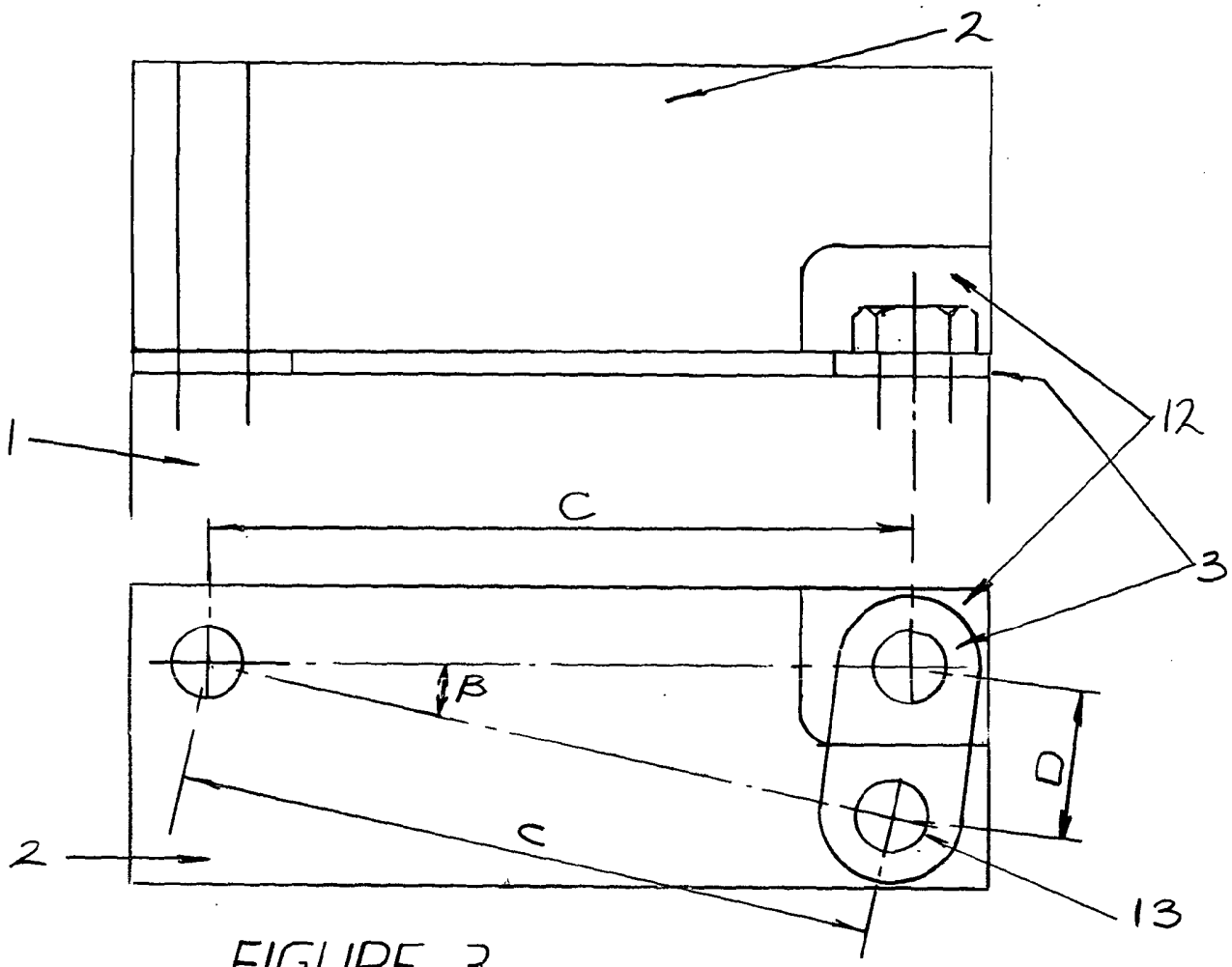
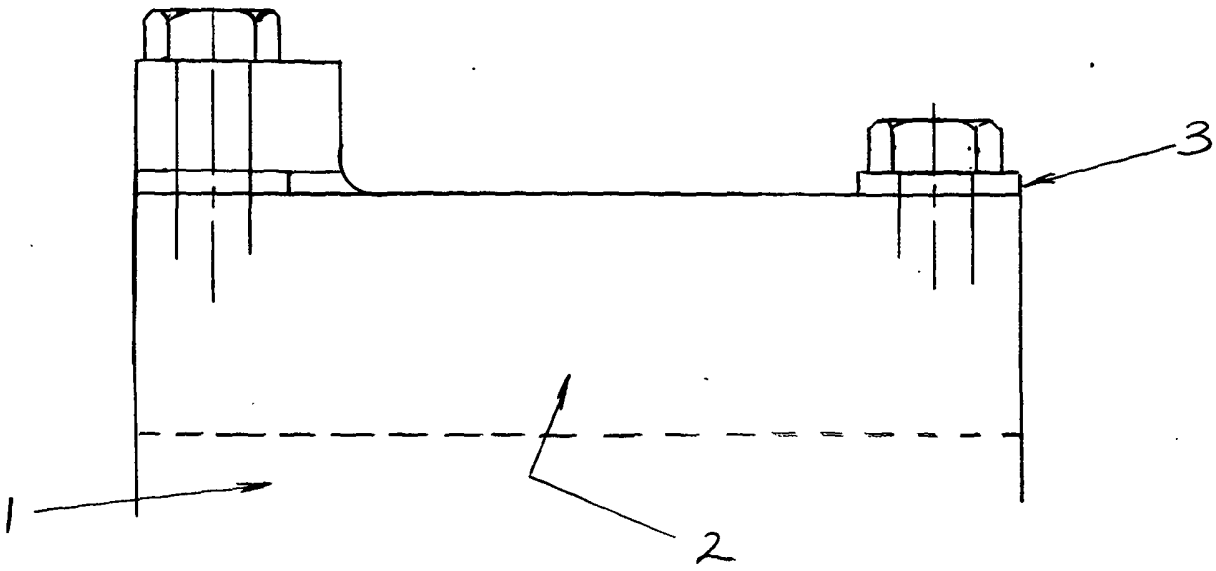


FIGURE 3



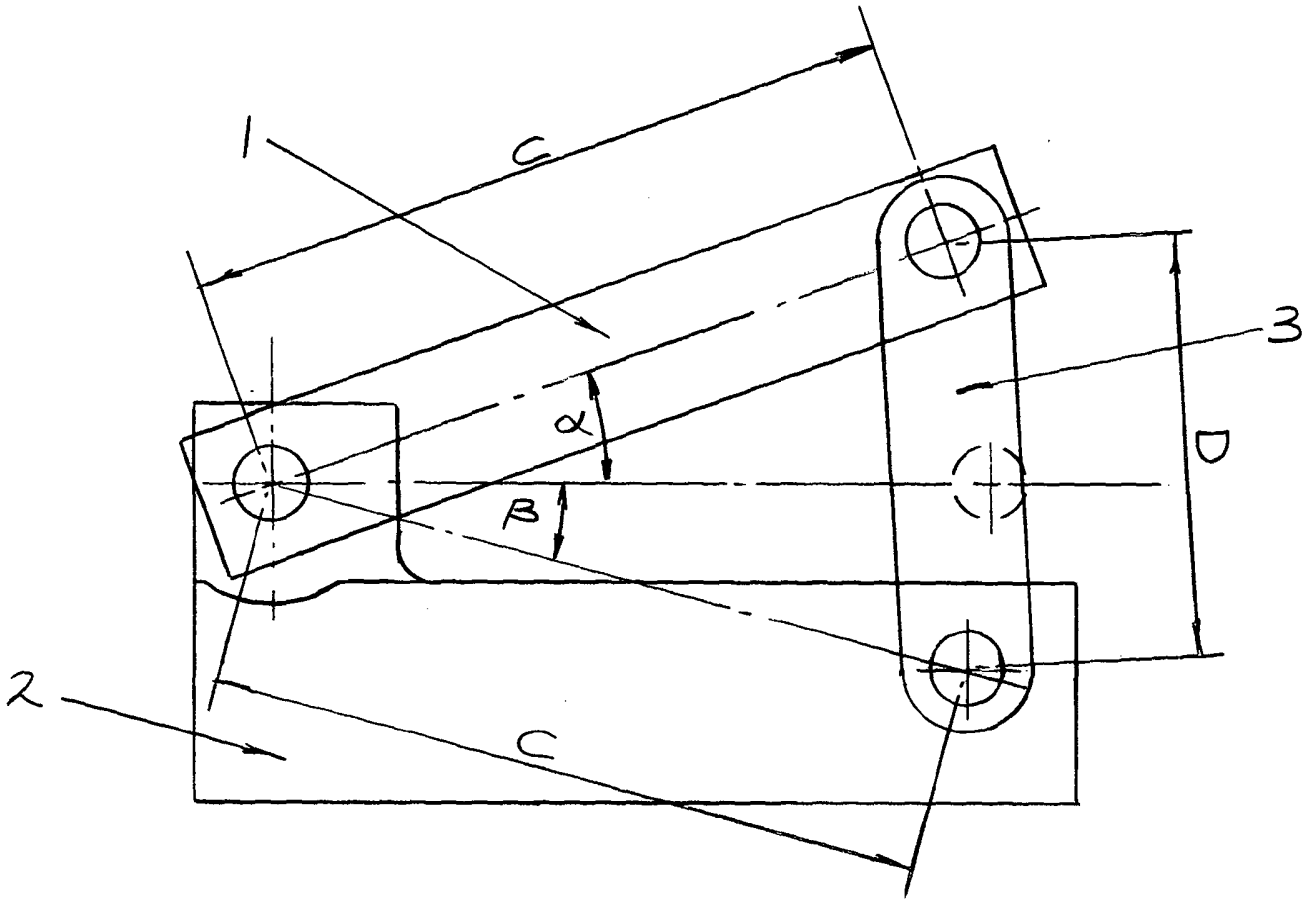


FIGURE 4

TRIGONOMETRICAL ANGLE PLATE

This invention relates to an angle plate as used in an engineering machine shop.

Most milling machines, now generally referred to as CNC machining centres, have a spindle operating either in a fixed vertical axis, or a fixed horizontal axis. However, many machining operations are set at an oblique angle to the primary XYZ axes. In order to achieve this, the workpiece is mounted on either (1) a special purpose fixture which is itself machined at an angle or (2) an adjustable angle plate which is set by the operator to the required angle.

A conventional angle plate has two main components, usually made from cast iron, broadly similar to each other, which are attached to each other by two large close fitting shouldered bolts. In order to adjust the angle plate to the desired setting, the bolts are released and the top surface plate can then be rotated about the horizontal axis. The hinge boss of the base plate is usually calibrated in degrees around its circumference, facilitating an approximate setting. For better accuracy one would use a sine bar, being a precison instrument, comprising a ground rectangular steel bar with two rollers attached to it, a precise dimension apart (e.g. 5.0000'' or 127mm). To create a precise angle, a spacer made of slip gauges is placed under one of the rollers. For example, to create an angle of 27.5 deg, the slip gauge dimension would be 5 x sin27.5 = 2.309" = 58.64mm. The sine bar and slips are then mounted on the angle plate with the aid of a stop to prevent the apparatus sliding off, and finally a dial clock can be traversed over the surface of the sine bar, and the table adjusted until the deflection is zero. Next, the workpiece is clamped to the top plate, and aligned with zero XYZ datums. Finally machining can commence.

The DISADVANTAGES with this system are as follows :-

1. Cast iron angle plates are heavy, cumbersome and unwieldy.

2. The height between the base and the top is considerable, resulting in a massive loss of available spindle travel in a vertical machine.

3. On a turret type mill, where the table overhangs the saddle on either side, as the C of G of the table + angle plate + workpiece moves outside the saddle, the table tips by the amount of the clearance in the slideways, and the height of the angle plate + workpiece creates large positioning errors.

4. Setting up the angle plate with the sine bar is slow and laborious. Once the workpiece is attached, it is often impossible to recheck the setting, and since the setting is only held by clamping friction, there is no guarantee that movement will not take place under machining loads or vibration.

5. Allignment to XYZ datums is invariably difficult, because the datum of the workpiece is likely to refer to the base, from which the portion being machined at an angle is dimensioned. However, the base is now itself at an angle, and out of sight, making for considerable difficulties for the operator in establishing where the datums are in relation to the workpiece as he now sees it.

6. If a number of operations are required at various different angles, the aforementioned procedure has to be carried out for each setting.

STATEMENT OF INVENTION

To overcome this, the present invention proposes an aluminium plate with four dowel holes, two at each end, accurately positioned about the centreline of the plate and a precise distance apart = C .

To this plate are attached two aluminium blocks with matching dowel holes, but offset from the block centreline vertically upwards. The plate is dowelled and bolted to the blocks at the front. At the rear are attached two steel strips with holes accurately machined at either end of a precise diameter to fit the dowels at a precise distance apart = D . One end of each strip is bolted and dowelled to the rear of each block, and the other end is bolted and dowelled to the rear of the plate.

Thus the angle of the plate now = α

Where $\sin \frac{1}{2} \alpha = \frac{1}{2} D/C$

Or $D = 2C \sin \frac{1}{2} \alpha$

The blocks are now bolted at each end direct to the machine table.

The ADVANTAGES of this system are :-

1. For any given angle of the plate, α , there exists a unique centre distance for the dowel holes in the stays. By the same argument, a pair of stays set for a specific angle will always create that angle. For example, a pair of 35 deg stays will always create a 35 deg angle, without further adjustment or inspection. Therefore, if machining a component calls for a number of different angles to be set up, the stays applicable to the required angles can be prepared in advance, and then the plate can be rapidly set to the exact angle by simply attaching the correct stay.

2. This process is repeatable with the same accuracy over and again for an indefinite number of times.

3. Given a set of coordinates in the plane of the base of a component, another set of coordinates dimensioned from an oblique axis can be accurately and quickly established and repeated.

4. Once the base blocks are bolted to a machine table, the entire structure is rigid.

5. The structure employs the minimum number of components to achieve rigidity.

6. The structure is light in weight by comparison to its strength.

7. Preferably the plate and base blocks are made of high strength aluminium.

8. Preferably the support straps are made of steel strip.

INTRODUCTION to DRAWINGS

Figure 1 shows the fixture plate at an inclined angle. The plate (1) is attached at its front edge with hollow dowels and bolts to support blocks (2). It is supported at the rear by straps (3), which are also attached with hollow dowels and bolts.

Figure 2 shows a typical application for the trigonometrical plate.

Figure 3 shows how it is possible to utilise the system for shallow angles. Here the length of strap (3) is so short that interference occurs between the bolt (4) and block (2), or the bolt (5) and plate (1). In these circumstances a lower dowel location (10) solves the problem.

Figure 4 shows an alternative layout where there is no discontinuity from $\alpha = 0$ deg upwards to 90 deg and beyond. In this example the strap is accessible from the outside.

DETAILED DESCRIPTION

Use Figure 1.

A machine fixture plate (1) with dowel holes precision machined in each end at a precise distance apart. A pair of mounting blocks(2), with dowel holes(4) & (5) at the same precise distance apart.
A pair of stays (3) with dowel holes (5) & (6) at each end at a precise distance apart. When assembled and attached to a machine table, a rigid structure whose surface is at a precise angle to the table.

EXAMPLE 1

Use Figure 2

A block (8) requires to have a surface (9) machined at an angle α (7), distance J from the base along axis L. Holes (11) are required to be drilled and tapped to coordinates which are relative to axis L.

The coordinates of the base of the block are relative to axis M.

The trigonometrical plate is initially set up horizontally. Holes (10) are drilled, reamed and tapped, such that axis M will lie a distance E from the hinge datum (4).

The hinge datum (4) lies a distance F below the plate surface and a distance K from the plate edge. Preferably, for ease of set up, K = F.

Two straps (3) are selected to create angle α (7). In order to achieve this, the pitch of the dowel holes (5) & (6) is dimension D where $D = 2C \sin \frac{1}{2} \alpha$

The block can now be attached to the plate in position using dowels and bolts (10).

The top surface can now be machined according to height dimension B and holes drilled and tapped according to horizontal offset dimension A.

Dimensions A and B are relative to hinge datum (4) where :-

$A = E \cos \alpha - F \sin \alpha$

$B = E \sin \alpha + F \cos \alpha + J$

EXAMPLE 2

Use Figure 3

The invention as described will not work at very small angles due to interference of components. To overcome this, the mounting blocks are machined with a cutout (12), and the lower strap attachment point is relocated at position (12), such that $\alpha = 0$ deg is obtained by strap length D where $D = 2C \sin \frac{1}{2} \beta$

Therefore, to create a shallow angle α,

$$D = 2C \sin \tfrac{1}{2}(\alpha + \beta)$$

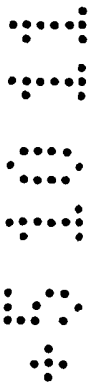
For example, if C = 127mm β = 10 deg α = 5 deg

$$D = 2 \times 127 \sin \tfrac{1}{2}(10 + 5) = 33.154 \text{ mm}$$

EXAMPLE 3

Use Figure 4

Figure 4 depicts an alternative layout where the calculation to arrive at length D in order to achieve angle α is again as in Example 2 : $D = 2C \sin \frac{1}{2} (\alpha + \beta)$.
This remains true at any angle. In this example the straps and the bolts securing them are accessible from the outside.



CLAIMS

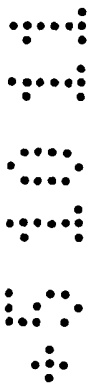
1. A trigonometrical plate, with dowel holes in each end, mounting blocks with dowel holes, stays with dowel holes, such that, when assembled, the angle of the plate is set at a precise angle to the base.

2. A trigonometrical plate as in claim 1, in which the dowel holes are offset, but the coordinates known, enabling an accurate prediction of the angle of the plate.

3. A trigonometrical plate constructed from any material.

4. A trigonometrical plate where the dowel holes lie outside the cross-section of the plate.

5. A trigonometrical plate where the dowel holes lie outside the cross-section of the base mounting blocks.



Application No: GB1011538.4 **Examiner:** David J Evans

Claims searched: 1-5 **Date of search:** 18 October 2011

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1-5	FR 2473932 A1 (FLORANGE GUILLIOT) refer to figs 1 and 2 and WPI Abstract Accession Number 1981-J2630D[36].
X	1-5	DD 301867 A9 (MAGDEBURG BAUSTOFFMASCH GMBH) see fig 2 and WPI Abstract Accession Number 1994-218699[27].
X	1-5	JP 2004082249 A (HONDA MOTOR CO LTD) refer to figs 1, 2, 3 & 9 and WPI Abstract Accession Number 2004-233676[22].
X	1-5	US 4466601 A (RAINES) whole document of interest, especially see fig 1.
X	1-5	KR 20100012423 A (SIK) see figs 1, 2 & 4 and WPI Abstract Accession Number 2010-B95383[15].

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

B23Q

The following online and other databases have been used in the preparation of this search report

EPODOC & WPI

International Classification:

Subclass	Subgroup	Valid From
B23Q	0016/00	01/01/2006
B23Q	0001/25	01/01/2006
B23Q	0001/26	01/01/2006
B23Q	0003/04	01/01/2006
B23Q	0003/10	01/01/2006