Title: STYLUS COUNTERBALANCING MECHANISM FOR A MEASURING PROBE

Abstract: A probe head (4) has a rotatable mounting (10) for a measurement probe (8) possibly with an extension arm (9). Mechanisms are disclosed for counterbalancing the weight of the probe and extension. The mechanisms provide less counterbalancing torque as the mounting is moved downwardly so that the mechanism provides substantially the correct magnitude of counterbalancing at all positions of the mounting and thus minimises the corrective torque required e.g. supplied by a servo motor.
— of inventorship (Rule 4.17(iv)) for US only

Published:
— with international search report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.
STYLUS COUNTERBALANCING MECHANISM FOR A MEASURING PROBE

The present invention relates to a counterbalanced pivotable probe head, which can counterbalance the weight of a laterally extending probe on the head in particular but not exclusively in the field of coordinate measurement or inspection of workpiece dimensions.

Continually servoing probe heads are known from e.g. US Patent No. 5,088,046 (Renishaw) or European Patent No. 380653 (Renishaw). Conventionally, these are driven by a geared motor with the axis supported by mechanical bearings. A geared motor has limitations in achieving a high servo stiffness and hence a rapid servo response. To achieve a high servo response, a low gear ratio or even direct drive motors may be utilised.

With such a system, there is little resistance to supporting a horizontal arm against the forces of gravity apart from the torque generated by the motor. If the head is held with the arm horizontally, the motor will have to supply torque and there will be heat generated in the head. This heat is undesirable as it causes the head to expand. To avoid the need for the motor to supply torque, counterbalance weights could be added so the arm is statically balanced about its rotation axis. These weights would remove the need for the motor to provide a static holding torque, but add to the inertia of the axis and hence reduce the servo response. A counterbalance spring mechanism with the spring force arranged to provide a counterbalance torque would overcome this problem.

Spring counterbalancing of a probe against the action
of gravity is known. For example United Kingdom Patent No. GB 2275339 (Faro) shows (at its Fig 5) a spring counterbalance 60, for counterbalancing an extended probe arm. Using such a system it is then not necessary to lift the whole weight of the arm with a motor, the spring being used to help. Also US Patent No. 5,208,994 (Renishaw) provides a spring supporting a stylus for counterbalancing. This disclosure is not related to pivotal movement but merely shows a mechanism for carrying the weight of a linearly movable stylus.

GB 2275339 does not address the problem of providing a lower counterbalancing torque to a probe supporting arm when it extends downwardly, than the torque required when the same arm extends horizontally. For GB 2275339 it seems that the spring counterbalancing forces will simply keep increasing as the arm moves from an upward position to a horizontal position and on to a lower position.

This invention provides a probe head which produces a counterbalancing torque for a measurement probe (possibly including an extension arm) attached to the probe head, comprising a probe head body, a measurement probe mounting pivotally supported at the body, the mounting being adapted to support a measurement probe in at least two pivotal positions, a second of the two positions providing more downward measurement probe inclination than a first of the positions, and comprising a counterbalancing mechanism for applying counterbalancing torque to the mounting, the mechanism being adapted to apply a greater torque when the mounting is in the first of the positions than the
torque applied in the second of the positions.

Preferably the mechanism has a resilient member and a lever, the lever being mechanically linked with the mounting and in force conducting communication with the member, the lever and the member being arranged such that in use force is applied to the lever by the member and the said force has a torque component for acting to counterbalance a probe, the torque component being greater when the mounting is in the said first position than in the said second position.

Preferably the mechanism provides a torque which decreases sinusoidally as the mounting is moved to provide a more downward inclination of the probe.

More preferably the lever is pivoted at a pivot point and the resilient member has a line of action along which the said force is directed, the line of action passing through the lever and being movable closer to the pivot point as the mounting approaches the second position from the first position.

The lever may form part of the mounting and may be pivotable therewith.

Alternatively the lever is separate from the mounting and is pivotable separately from the mounting. Preferably the separate mounting and lever are connected to each other by a flexible link on one side of the pivot point and the resilient member is connected to the lever on the other side of the pivot point, via a further flexible link. Preferably the further flexible link incorporates a pulley.
Illustrative embodiments of the invention will now be described with reference to the drawings. Briefly:

Fig 1 shows a perspective view of a pivoting probe head which incorporates the invention according to one of the embodiments detailed herein;

Fig 2 shows a pictorial view of parts of a first embodiment of the present invention;

Fig 3 shows a side view of the first embodiment;

Fig 4 shows an end view of the first embodiment;

Fig 5 shows a second embodiment of the present invention;

Figs 6a and 6b show a schematic view of the forces involved in the first embodiment;

Figs 7 and 8 show alternative spring adjustment mechanisms; and

Figs 9-13 each show alternative embodiments of the invention.

Fig 1 shows a probe head 4 which includes a body 6 for supporting a pivotable probe mounting 10, shown partially. The head may rotate about a vertical axis in the directions of arrows R, and is rotatably supported on probe head holder 5. A measurement probe 8 is shown attached to the head 4 having a measurement stylus 7. The probe is, in this case, mounted on an extension arm 9. The probe 8 with or without arm 9 will be connected to pivotable probe mounting 10 for movement in the directions indicated at arrows B. In this example the general extent of pivotable movement of probe 8 and mounting 10 is from a slightly upwardly inclined position shown at line 1 to a position denoted by line 2, slightly beyond a straight down position.

In Figures 2, 3 and 4 there is shown the probe mounting
10 attached to a rotatable plate 12 with screws 14 (Fig 4). Rotatable plate 12 is in turn attached to a shaft 16. In this embodiment these components 10,12 and 16 are rotatable directly by a servo motor (11, Fig 4) about axis A. The probe 8 and possibly probe arm 9 will in use be attached to mounting plate 10 and in the position shown in Figs 2,3 and 4, the probe arm will extend laterally. In use the probe arm will move in the directions of arrows B by the action of the servo motor. The extent of movement in this embodiment is shown in Figs 1 and 3. Line 1 indicates the approximate upper extent of pivoting for probe mounting 10 and line 2 indicates the approximate lower extent of movement of mounting 10. There will, of course, be at least two positions at or between these extents 1 and 2, one of these positions providing more downward inclination of probe 8 than another position.

At position 1 the weight of the probe will be counteracted by force from a counterbalancing mechanism and the servo motor 11 may provide little or no additional torque.

The counterbalancing mechanism includes a spring 18 which is held at one end by a support 20 and is attached at the other end to a flexible cable 22. The cable travels around a pulley 24 and on to a lever 26 where it is attached at attachment point 30. The spring 18 and the lever 26 are thus linked. The lever 26 may pivot about point 32. Attached to the opposite end of the lever is a further flexible cable 28. This cable is attached to mounting 10. The lever 26 and mounting 10 are thus linked.
The cable may be wire or non-metallic rope e.g. kevlar™ stranded cord.

In use spring 18 provides a counterbalancing force via lever 26 to the mount 10. Rotation of the mount plate and shaft 10,12 and 16 respectively by a servo motor 11 will cause the counterbalance force provided by the spring to change. The pivot point 32 and support for pulley 24 will remain stationary since they are journalled to body 6. The counterbalance force will be at an approximate maximum when the mounting 10 provides horizontal probe extension and will be at an approximate minimum when the mounting 10 provides vertically downward inclination. Mechanically earthed parts are shown in Fig 4.

The forces involved are shown more clearly in Figs 6a and 6b. Fig 6a shows mounting 10 in an approximately horizontal position. It will carry a load M (the probe mass etc) producing a torque T about axis A on lever 26. This torque will be counterbalanced by a spring force S which is, in this position substantially equal to the torque T applied to lever 26. Fig 6b shows mounting 10 in a lower position, the weight on the mounting is shown again as M. This produces a much lower torque t about pivot 32. This lower torque is counterbalanced again by spring force S. Although the spring force S shown in Fig 6b will be slightly larger than the force S shown in Fig 6a, due to spring extension, the counterbalancing force is reduced. The reduction in torque as the mounting 10 moves downwardly comes about because the line of action of the spring force S moves closer to the pivot point 32 as the mounting 10 moves downwardly. This reduction in torque
is approximately sinusoidal.

The embodiment shown in Figs 2, 3 and 4 has the advantage that the counterbalancing force provided by spring 18 increases in an approximately sinusoidal manner as the mounting 10 moves upwardly and thereby follows the theoretical counterbalancing torque requirement for a mass moving in a circular arc against gravity. Therefore the work done by the servo motor is minimised at all positions of mounting 10.

It will be noted also that the length of cable 28 is greater than the distance between axis A and the axis of pivot 32. This means lever 26 is not parallel to a line between axis A and mass M in Figs 6. This arrangement permits the mounting 10 to move to position 2 (Figs 1 and 2) without going over centre. Cable 28 could be shorter or equal in length to the distance between axis A and the axis of pivot 32. It can be seen that the distance between pivot 32 and spring attachment 30 is relatively small. This short distance produces little variation in the extension of the spring 18 and so rotation of lever 26 does not alter significantly the spring forces applied to the lever.

It is possible to make the lever 26 parallel to a line between axis A and mass M at position 1 and not parallel at position 2 (Fig 3). At position 1 the parallel linkage will allow the torque applied to the mass M to be substantially sinusoidal, whereas at position 2 over-centring will be prevented. Such an arrangement may be accomplished by providing radii 11 and 13. As the lever 26 moves downwardly the effective length of cable 28 increases because the cable unwinds.
itself from radii 11 and 13. The action extends the length of cable 28 as the inclination of mounting 10 moves downwardly and thus changes the previously parallel linkage to a divergent one. The radii 11 and 13 may be reversed to reduce the effective lengths of the cable 28, as the lever 26 moves downwardly. The radii may not have a constant radius but may have a cam profile in order to change the length of cable 28 at various inclinations of the probe and thereby fine tune the counterbalancing characteristics of the mechanism.

The embodiment shown in Fig 5 is an alternative mechanism for producing a sinusoidal counterbalancing force which is maximised at lateral positions of mounting 10 and decreases when mounting 10 moves to a lower position. In this embodiment two springs 34 are employed and counterbalancing forces are reduced as the line of action of spring 34 moves closer to pivot axis A. This embodiment has the advantage that 360° rotation of mounting 10 is possible provided that springs 34 are mounted on opposing cranks or the like.

The springs 34 may be any form e.g. coil, torsion or cantilever.

The embodiment shown in Figs 2, 3 and 4 and the embodiment shown in Fig 10 below has the advantage that reaction forces imposed by spring force 18 are not borne by shaft 16 but instead are borne by pivot 32. This means that the pivotal mounting of the probe is not subject to large side loads and therefore improved accuracy results. Likewise the embodiment shown in Fig 5 uses two springs which will cancel any reaction forces through rotational axis A. However if side
loads on axis A are not problematic then only one spring 34 need be used in the embodiment shown in Fig 5.

In order that the counterbalancing torque may be more accurately controlled, the actual applied torque may be variable. There are many ways of varying this torque. One way is to move the support 20 and thereby adjust the counterbalancing force S at the spring 18. This allows use of probes and extensions of varying weight.

The position of pulley 24 could alternatively or additionally be moved, having the effect of varying the spring force S.

This counterbalance force adjustment (in the directions of arrows D) may be effected by, for example, relative rotation of complementary threaded parts to alter the position of support 20 or pulley 24. Another approach is to provide a motor 36 which may be a linear motor, or some rack and pinion device.

The adjustment might be provided alternatively by a mechanism shown in Fig 7. In this drawing support 20 has been replaced by a fixed journal 40. Spring 18 is linked to an adjustment arm 42 which is in turn pivoted about and in frictional engagement with journal 40. Pivotal movement of arm 42 is effected by movement of the probe head relative to a stationary machine bed 46 and adjustment abutment 48. In use, the head will be instructed to move by a machine control and arm 42 will be caused to enter aperture or slot 44 and abut its inner surface in order to pivot the arm 42 and thereby adjust the spring force S. The adjustment angle moved
by the arm will be that required to give the correct
counterbalancing force for a given probe configuration.

Fig 8 shows a variation of the mechanism shown in Fig
7. This variation is shown in detail in US 5,208,994,
but in summary comprises an adjustment arm 120 again
movable by abutment with a static machine part
analogous to abutment 48 in Fig 7. A plate 112 holds
spring 18 and is adjustable up and down rod 110. The
force of the spring 18 holds plate 112 at an angle to
rod 110 and in so doing twists and jams itself on the
rod to prevent further movement. Adjustment arm 120
will release the plate 112 from its locked state when
the arm is moved in either upwardly or downwardly due
to machine instructed movement of the probe head.
Release of the plate 112 allows the plate to be
repositioned on the rod 110 and thereby the
counterbalance force can be altered.

Another alternative for adjusting the torque is to vary
the distance between pivot 32 (Fig 3) and attachment
30. In this way the force S will not change but the
applied counterbalance torque will be varied.

Such force or torque adjustment might be continuous for
example when threaded parts can be continually moved
during probe use. Alternatively adjustment might be
periodic for example in the case of arm 42 being moved
by a machine movement. It is envisaged that one
adjustment will be made when a change in probe, stylus
or probe extension is made, i.e. periodic adjustment.
The amount of adjustment may be determined in a number
of ways for example an algorithm may be used. In this
procedure a look-up table may be used to determine best
counterbalance torque for any given probe configuration. Alternatively adjustment may take place by varying the counterbalance torque and monitoring the servo motor current requirement (positive and negative currents) for keeping the probe static. A minimum or zero current requirement will indicate the desired counterbalancing torque requirement. In a refinement of this technique the servo motor may be oscillated as well as varying the counterbalance force. In this way stick-friction in the probe mounting is eliminated and a minimum point for servo motor current requirement can be determined in order to establish the most suitable counterbalance torque.

In Fig 6a it can be observed that lever 26 is not parallel to an imaginary line between axis A and the centre of mass M as mentioned previously. This has the result that the counterbalancing force exerted by lever 26 on mass M does not follow exactly the desired counterbalance torque for all angles of inclination of a probe. However, at some angle of inclination the actual and desired torques will coincide and advantageously it is at this angle that the spring adjustment may be made.

Periodic manual adjustment is possible also for example grub screw positional adjustment of the spring support 20.

Many further modifications will be apparent to the skilled addressee. For example with reference to Figures 2-4, the spring 18 may take the form of an elasticated cable and need not have a pulley 24. Whilst spring 18 is shown as a singular tension spring,
it is possible that a plurality of springs may be used. The spring could be alternatively a compression spring, torsion spring, cantilever spring, or any stored mechanical energy device. The spring may act directly on lever 26. The cable 28 may be replaced by a rigid link and the spring 18 may be connected directly to the lever 26 with a line of action towards the pulley 24 (the pulley and cable 22) may then be dispensed with. The direction of counter force applied to the lever 26 by the spring 18 may be other than as shown, for example a bell crank might replace the straight lever 26 and the force applied to this bell crank may be at 90° to that shown in the figures.

Another modification of the adjustment mechanism is shown in Fig 9. This drawing shows an alternative mechanism for altering the torque when changing the probe/stylus configuration. Spring 18 has a fixed support 58 but can have increased tension by changing the effective length of cable 28. An adjustment lever 54 is pivoted on plate 12 at pivot 56. A projection 50 associated with probe 8 will abut lever 54 and govern its position. Various projections 50 will be provided for each probe and stylus configuration used. The longer the projection the greater the counterbalance torque will be. So a heavy probe will require a long projection 50. Cable 28 is attached at one end to lever 26, is routed around a pulley 52, and is attached at its other end to lever 54. Since the position of lever 54 is governed by its abutment with projection 50, then the effective length of the link between lever 26 and mounting 10 will vary with the length of the projection 50 used. This variation in length will change the counterbalance force exerted by spring 18.
because its tension will change with each length of projection 50.

Cables 28 and 22 may be combined as one, in this case, the cable must be arranged to grip lever 26 as the axis moves from position 2.

The embodiments shown in Figs 9-13 operate in a similar manner to the embodiments described above. So the embodiments of Figs 9-13 each show a mechanism which provides a greater counterbalancing torque to a probe 7,8 when the probe extends laterally than the torque provided when the probe is inclined downwardly.

These embodiments have the common feature of a fusee 50 which is recognised as a device for changing the varying force output of spring 18, in this case spring into a constant force or a force varying at a different rate to that of spring 18 during extension of that spring.

Thus in Fig 9 there is shown a rotatable plate 12 and its probe mounting 10, all pivotable about axis A in the direction of arrows B e.g. by means of a servo motor. A counterbalance force is provided by spring 18 via fusee 50 rotating about axis E. A cable 23 joins the spring 18 to the fusee and is wrapped around the fusee, whereas a further cable 22 attaches the fusee to the plate 12 and is likewise wrapped in a counter direction around the fusee 50.

As plate 12 pivots to provide a more downward inclination of the probe mounting 10 so the cable is unravelled and increases the diameter at which it
provides its tension. At the same time cable 23 remains at the same diameter but the force of the extending spring gives this cable an increasing tension. The force exerted on plate 12 by cable 22 attached to the fusee in this instance is approximately constant even though the spring 18 is increasing in tension.

The further embodiment shown in Figs 10,11,12 and 13 operate in a manner similar to that described for Fig 9. In each case the tapering profile of the fusee 50 can be matched to the counterbalancing force required of cable 22.

In Fig 10 a lever 26 is used to apply a counterbalancing torque to the plate 12. The mechanism of Fig 10 operates in a manner similar to that of Figs 2-4, except that the geometry of the mechanism in Fig 10 is arranged differently. However, the result is the same i.e. the torque reduces as probe mounting 10 is inclined downwardly.

The cable 22 in Fig 11 is wrapped around a circular support 60 attached to plate 12. The profile of the fusee 50 is adapted so that its taper provides a reducing tension on cable 22 and thereby a reduction in torque is applied to the support 60 when the probe mount 10 is rotated downwardly.

Fig 12 shows a mechanism whereby a constant tension is provided in cable 22 and a cam 62 converts this tension into a decreasing torque as probe mounting 10 is rotated downwardly.
The spring 18' shown in Fig 13 is a flat spiral spring which provides constant tension to cable 23 as it unravels. In turn fusee 50 provides a reducing tension to cable 22 as plate 12 moves to incline further the probe mounting 10.

As described previously the counterbalancing force provided by springs 18, in the embodiments of Figs 9-13 may be adjusted by altering the position of the spring's support 20.

All the embodiments shown are merely illustrative of the invention and many other variants of the mechanisms shown will be apparent to the skilled addressee.
CLAIMS

1. A probe head which produces a counterbalancing torque for a measurement probe attached to the probe head, comprising a probe head body, a measurement probe mounting pivotally supported at the body, the mounting being adapted to support a measurement probe in at least two pivotal positions, a second of the two positions providing more downward measurement probe inclination than a first of the positions, and comprising a counterbalancing mechanism for applying counterbalancing torque to the mounting, wherein the mechanism is adapted to apply a greater torque when the mounting is in the first of the positions than the torque applied in the second of the positions.

2. A probe head as claimed in claim 1 wherein the mechanism has a resilient member and a lever, the lever being mechanically linked with the mounting and in force conducting communication with the member, the lever and the member being arranged such that in use force is applied to the lever by the member and the said force has a torque component for acting to counterbalance a probe, the torque component being greater when the mounting is in the said first position than in the said second position.

3. A probe head as claimed in claim 1 wherein the mechanism provides a torque which decreases sinusoidally as the mounting is moved to provide a more downward inclination of the probe.

4. A probe head as claimed in claim 2 wherein the lever is pivoted at a pivot point and the resilient
member has a line of action along which the said force is directed, the line of action passing through the lever and being movable closer to the pivot point as the mounting approaches the second position from the first position.

5. A probe head as claimed in claim 2 wherein the lever forms part of the mounting and is pivotable therewith.

6. A probe head as claimed in claim 2 wherein the lever is separate from the mounting and is pivotable separately from the mounting.

7. A probe head as claimed in claim 6 wherein the separate mounting and lever are connected to each other by a flexible link on one side of the pivot point and the resilient member is connected to the lever on the other side of the pivot point, via a further flexible link.

8. A probe head as claimed in claim 7 wherein the further flexible link incorporates a pulley.

9. A probe head as claimed in claim 1 wherein the mechanism includes a fusee and a resilient element.

10. A probe head as claimed in claim 9 wherein the fusee is adapted to alter the torque applied in use to the mounting.
Fig. 1.
Fig. 3.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B25J19/00 601B5/00 601B5/008

According to International Patent Classification (IPC) or to national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B25J 601B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category *</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>WO 99 27320 A (RENISHAW PLC ; MCMURTRY DAVID ROBERTS (GB)) 3 June 1999 (1999-06-03) the whole document</td>
<td>1,2,9,10</td>
</tr>
<tr>
<td>X</td>
<td>WO 92 05016 A (UNIV PENNSYLVANIA) 2 April 1992 (1992-04-02) the whole document</td>
<td>1-5</td>
</tr>
<tr>
<td>X</td>
<td>FR 2 608 959 A (SERVO CONTACT SA) 1 July 1988 (1988-07-01) abstract</td>
<td>1,2</td>
</tr>
<tr>
<td>X</td>
<td>US 4 592 697 A (TUDA GORO ET AL) 3 June 1986 (1986-06-03) abstract</td>
<td>1,2</td>
</tr>
</tbody>
</table>

Further documents are listed in the continuation of box C.

* Special categories of cited documents:
  * Document referring to an oral disclosure, use, exhibition or other means
  * Document published prior to the international filing date but later than the priority date claimed
  * Document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle of the invention
  * Document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
  * Document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

Date of the actual completion of the international search 8 August 2001
Date of mailing of the international search report 21/08/2001

Name and mailing address of the ISA
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epos nl
Fax (+31-70) 340-3016
Authorized officer
Arca, G
<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>US 4 728 247 A (NAKASHIMA SEIICHIRO ET AL) 1 March 1988 (1988-03-01) the whole document</td>
<td>1-4, 6-8</td>
</tr>
<tr>
<td>X</td>
<td>WO 80 01774 A (KOBE STEEL LTD; TSUDA G; MIZUGUCHI O) 4 September 1980 (1980-09-04) abstract</td>
<td>1, 2, 6-8</td>
</tr>
<tr>
<td>P, X</td>
<td>WO 00 34733 A (FARO TECH INC) 15 June 2000 (2000-06-15) abstract</td>
<td>1, 2</td>
</tr>
<tr>
<td>Patent document cited in search report</td>
<td>Publication date</td>
<td>Patent family member(s)</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>-----------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>WO 9927320 A</td>
<td>03-06-1999</td>
<td>CN 1244252 T</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 1073875 A</td>
</tr>
<tr>
<td>WO 9205016 A</td>
<td>02-04-1992</td>
<td>NONE</td>
</tr>
<tr>
<td>FR 2608959 A</td>
<td>01-07-1988</td>
<td>NONE</td>
</tr>
<tr>
<td>US 4592697 A</td>
<td>03-06-1986</td>
<td>DE 3316460 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 3573088 D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 0195085 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WO 8600255 A</td>
</tr>
<tr>
<td>WO 8001774 A</td>
<td>04-09-1980</td>
<td>DE 2965974 D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 0024433 A</td>
</tr>
<tr>
<td>US 4883249 A</td>
<td>28-11-1989</td>
<td>NONE</td>
</tr>
</tbody>
</table>