

TITLE OF THE INVENTION

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Device having a scanning unit and a mounting aid and method for mounting the scanning unit

TECHNICAL BACKGROUND

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The present invention relates to a device having a scanning unit and a mounting aid according to the preamble of Claim 1.

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Furthermore, the invention relates to a method for mounting a scanning unit according to Claim 10.

PRIOR ART

20 Position-measuring devices are used, in particular, in processing machines for measuring the relative position of a tool with respect to a workpiece which is to be processed, for determining the position and dimensions of test objects in coordinate-measuring machines and also in the semiconductor industry, for example in wafer steppers and bonders. In this context, the scale is directly built onto the drive unit (for example linear motor) or the
25 scale is built onto a component which is driven via the drive unit. A scanning unit of the position-measuring device is arranged in a stationary fashion with respect to the moving scale on another machine part whose position is to be measured.

30 Owing to the ever more stringent requirements made of the resolution or accuracy of the position measurement, during assembly a precise assignment of the scanning unit with respect to the scale is ever more important. Various measures have become known for achieving this required assignment.

A scanning unit of the generic type and position-measuring device are described, for example, in EP 0 397 970 A1. In order to mount the scanning unit, a mounting aid is provided as a component between the object to be measured and the scanning unit. This mounting aid comprises a pin, about
5 which the scanning unit can be rotated or pivoted by means of adjustment screws with eccentric heads. This intermediate connection of a mounting aid requires a relatively large installation space. Furthermore, the requirements made of the manufacturing tolerances are large in order to achieve play-free adjustment.

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SUMMARY OF THE INVENTION

The present invention is based on the object of specifying a device having a scanning unit of a position-measuring device and a mounting aid with which
15 simple mounting is made possible with a high level of accuracy.

This object is achieved by means of a device having the features of Claim 1.

Furthermore, the invention is based on the object of specifying a method for
20 the simplest possible mounting, with which the required accuracy of the assignment between the scanning unit and the scale is made possible.

This object is achieved by means of a method having the features of Claim 10.

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Advantageous embodiments of the device according to the invention and of the method arise from the measures which are specified in the dependent claims.

30 Further details and advantages of the present invention are explained on the basis of the following description of exemplary embodiments in conjunction with the figures.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

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| 5 | Figure 1 | shows a scale and a scanning unit of a length-measuring device; |
| | Figure 2 | shows the scanning unit during a first mounting step; |
| 10 | Figure 3 | shows a mounting aid; |
| | Figure 4 | shows the scanning unit with the mounting aid during a second mounting step; |
| 15 | Figure 5 | shows the scanning unit in the adjusted state; |
| | Figure 6 | shows a further possible way of embodying the first mounting step; |
| 20 | Figure 7 | shows a possible way of adjusting the scanning unit with a tool; |
| | Figure 8 | shows a second exemplary embodiment of a mounting aid; |
| 25 | Figure 9 | shows the scanning unit with the mounting aid according to Figure 8 during the second mounting step, and |
| 30 | Figure 10 | shows the application of the invention in an angle-measuring device. |

DESCRIPTION OF THE EMBODIMENTS

A first exemplary embodiment of the device according to the invention will be explained below on the basis of Figures 1 to 5 and Figure 7.

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The illustrated position-measuring device is embodied as a length-measuring device and comprises a scale 1 and a scanning unit 2 which can move relative thereto in a measuring direction X. The scale 1 has an incremental measuring grating 11, which can be scanned by a detector unit of the scanning unit 2. During the scanning of the measuring grating 11, the detector unit generates position-dependent, electrical periodic measurement signals in a known fashion. In this context, the scanning unit 2 comprises a scanning window 23 which is transparent to the scanning beam and points in the direction of the scale 1 which is to be scanned during the position measurement, and therefore cannot be seen in Figure 1. The views according to Figures 2, 4, 5 and 7 without a scale 1 show the scanning window 23 of the scanning unit 2.

During the mounting of the scanning unit 2 on an object 5 to be measured, predefined attachment dimensions have to be complied with depending on the type of scanning principle and depending on the grating period of the measuring grating 11. These attachment dimensions are predefined by the manufacturer of the position-measuring device and must be complied with by the user when carrying out attachment to the object 5 to be measured. The attachment dimensions in the directions Z and Y which are shown in Figure 1 and are perpendicular to the measuring direction X are to be complied with generally in a relatively simple way by means of stops and spacer elements. However, it has become apparent that the angular assignment of the scanning unit 2 to the scale 1 is relatively difficult to set. This involves the angular position R. This angular position R is a rotation angle about the axis Z, wherein Z is oriented perpendicularly to the plane of the measuring grating 11. The direction Z is therefore the direction in which the scale 1 is scanned by the scanning unit 2. The angle R is also referred to as the yaw angle or Moiré angle, and the setting of this angle is referred to

as Moiré setting. This angular assignment has to be set individually for each combination of the scanning unit 2 and scale 1.

According to the invention, the required angular position or rotational
5 position of the scanning unit 2, that is to say the angle R , is now set using a mounting aid 3. During the adjustment, the electrical scanning signals of the scanning device 2 are monitored, wherein the amplitude and/or the mutual phase position of a plurality of the scanning signals is a measure of the quality of the scanning signals and therefore also of the required assignment
10 between the scanning unit 2 and the scale 1.

The mounting aid 3 is embodied in such a way that the scanning unit 2 can rotate about a rotational axis D of a reference element 4. The rotational axis D runs parallel here to the axis Z shown in Figure 1.

15 Figure 2 shows the scanning unit 2 during a first mounting step. The reference element 4 is here a pin which is attached in a positionally fixed fashion to the object 5 to be measured. This reference element 4 forms the rotational axis D about which the scanning unit 2 is rotated in order to adjust
20 the Moiré angle. Instead of the pin, a sleeve can also be used.

The scanning unit 2 is designed to form a form fit with the reference element 4 by means of abutment, which form fit locks the scanning unit 2 relative to the reference element 4 in directions X , Y transverse with respect to the rotational axis D . As a result, a rotational movement about the rotational axis D which is unambiguously defined by the form fit is made possible. This form fit is advantageously formed by virtue of the fact that a recess 22 is provided in an outer wall 21 of the scanning unit 2. The recess 22 is embodied in the example as a V-shaped groove or notch into which the outer face of the
25 circular reference element 4 can be inserted and which forms a rotary bearing with the outer face of the circular reference element 4. The recess 22 is arranged as close as possible to the centre of gravity of the scanning,
30 that is to say at the shortest possible distance from the scanning window 23.

According to the invention, the mounting aid 3 illustrated in detail in Figure 3 is then provided and is designed to secure the scanning unit 2 to the mounting aid 3 in such a way that the scanning unit 2 can be pivoted about the rotational axis D of the reference element 4 by means of the mounting aid 3 supporting said scanning unit. This securing is carried out in such a way that the mounting aid 3 forces the scanning unit 2 against the reference element 4. As a result, play-free abutment of the scanning unit 2 against the reference element 4 is ensured. The securing is also carried out in such a way that the mounting aid 3 forms, with the scanning unit 2, a rotationally fixed form fit that ensures that the scanning unit 2 can be rotated about the rotational axis D by means of the mounting aid 3. Figure 4 illustrates this further mounting step in which the mounting aid 3 is fitted onto the scanning unit 2 in the +X direction, and the mounting aid 3 forces the scanning unit 2 against the pin-shaped reference element 4, and the rotationally fixed form fit is brought about between the mounting aid 3 and the scanning unit 2.

The mounting aid 3 has two arms 31, 32 which lie opposite one another and which engage around the scanning unit 2 and between which the scanning unit 2 is held and secured in a clamping fashion. In order to generate the clamping force, at least one of these two arms 31, 32 is embodied elastically spring-loaded, with the result that the scanning unit 2 is forced against the reference element 4. The arms 31 and 32 generate a force F1 and opposing force F2 in such a way that, on the one hand, the scanning unit 2 is secured in a clamping fashion on the mounting aid 3 and, on the other hand, the scanning unit 2 is forced against the reference element 4. As is apparent from Figure 4, it is particularly advantageous if the mounting aid 3 is also fixed in the illustrated mounting position in a positively locking fashion on the reference element 4 such that positionally fixed locking in the directions X, Y, that is to say transversely with respect to the rotational axis D, is ensured. This form fit is formed by the circular outer face of the reference element 4 and a corresponding recess 33 in the mounting aid 3, in particular again in the form of a V-shaped groove or a notch. The scanning unit 2 is therefore clamped in between the reference element 4 and the arm 32 of the mounting

aid 3, and the reference element 4 is clamped in between the scanning unit 2 and the arm 31 of the mounting aid 3.

5 In the illustrated exemplary embodiment, the scanning window 23 and therefore also the recess 22 of the scanning unit 2 are not arranged centrally (viewed in the X direction). In order, in this case, to make it possible for the mounting aid 3 alternatively also to be able to be fitted onto the scanning unit 2 from the -X direction, a further recess 35 is present in the mounting aid 3. If the mounting aid 3 is then fitted on in the -X direction as shown in Figure 4, 10 the recess 35 interacts in a positively locking fashion with the reference element 4.

The handling capability of the scanning device 2 during the mounting and the adjustment process is already improved merely by providing the 15 mounting aid 3. The handling capability can, however, be improved even further by selective measures. As is illustrated in Figure 3, for this purpose at least one hole 34, which runs transversely with respect to the rotational axis D, can be provided in the mounting aid 3. This hole 34 is dimensioned in such a way that a tool 6, for example a screwdriver, can be plugged in in an 20 as precisely fitting fashion as possible in order to pivot the mounting aid 3, with the scanning unit 2 clamped therein, about the rotational axis D in a particularly sensitive way, as shown in Figure 7. Such an embodiment is particularly suitable for narrow installation conditions. It may be advantageous to provide a plurality of such holes 34 which are accessible 25 from various sides or directions within the X-Y plane.

The mounting aid 3 is embodied in such a way that, after the scanning unit 2 has been adjusted and mounted on the object 5 to be measured, said mounting aid 3 can be removed from the scanning unit 2. The mounting aid 30 3 can be pulled off from the scanning unit 2 and from the reference element 4 in a direction perpendicular to the rotational axis D, advantageously in the measuring direction X, by overcoming the clamping force of the two arms 31, 32. If it should be necessary for reasons of space, the reference element 4 can also be removed from the object 5 to be measured. The scanning unit 2

which, after adjustment has taken place, has been attached in a positionally fixed fashion to the object 5 to be measured is illustrated in Figure 5. The positionally fixed attachment to the object 5 to be measured can be carried out, for example, by means of screws (not illustrated) or by bonding.

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Figure 6 shows a further possible way of forming the reference element. In this example, a reference element 4.1 is provided on the object 7 which is to be measured and to which the scale 1 is attached. This reference element 4.1 can then be used, on the one hand, as a stop for the orientation of the
10 scale 1 and, on the other hand, also for the inventive adjustment of the scanning unit 2.

A further mounting aid 3.1 will be explained below with reference to Figures 8 and 9. In this context, identical acting components are provided
15 with the same reference symbols as in the exemplary embodiment explained above.

This mounting aid 3.1 has in turn two arms 31, 32 which form an intermediate space in which, on the one hand, the scanning unit 2 is held
20 clamped in and, on the other hand, the scanning unit 2 is forced against the reference element 4. In contrast to the mounting aid 3 explained above, in this mounting aid 3.1 a handle 9 is integrally formed on in one piece. This handle 9 is embodied as prolongations of the arms 31, 32. On the one hand, this handle 9 can facilitate the adjustment of the mounting aid 3.1 in that this
25 handle forms a grip and a lever and, on the other hand, in this way the clamping force can also be overcome in order to facilitate the pulling off of the mounting aid 3.1 from the scanning unit 2. The function is comparable here to a clothes peg.

30 The invention can also be used in angle-measuring devices. An exemplary embodiment will be explained in more detail below with reference to Figure 10. The scanning unit 2, which scans a measuring grating 11.3 of a scale 1.3, is again provided for measuring angles. In this case, the scale 1.3 is embodied as a partial plate, and it can alternatively also be embodied in

the form of a drum, wherein the measuring grating can then be provided on the end side or the lateral face. The scanning unit 2 is also to be mounted in these cases during the assembly on an object to be measured with the accuracy predefined by the manufacturer. For this purpose, a mounting aid
5 3.3 is again provided with which the scanning unit 2 can be rotated about the rotational axis D of the reference element 4. An outer wall of the scanning unit 2 has a recess 22 in the form of a notch which forms, as already explained above, a form fit with the circular surface of the reference element 4. In contrast to the examples explained above, the arms 31.1, 32.1, 32.2 of
10 the mounting aid 3.3 for engaging around the scanning unit 2 in a clamping fashion are configured somewhat differently. The force F1, F2 for securing the scanning unit 2 in a clamping fashion on the mounting aid 3.3 and for pressing the scanning unit 2 against the reference element 4 is introduced by the two arm-shaped sections 32.1 and 32.2. In this case, the arm 31.1
15 acts as an opposite support in order, on the one hand, to force the scanning unit 2 without play against a side of the reference element 4 and, on the other hand, to force the mounting aid 3.3 without play against the opposite side of the reference element 4.

20 The clamping force F1, F2 explained above is applied to the mounting aid 3, 3.1, 3.3 by the means specified in Claim 1. These means apply a force which forces the scanning unit 2 against the reference element 4, 4.1, wherein the term forces means pressing against. It is advantageous here if the means are elastic or spring means in order to ensure play-free contact even during
25 the rotation of the scanning unit 2 about the reference element 4, 4.1. It is particularly advantageous if the force is implemented by means of an elastic or spring embodiment of at least one of the arms 31, 32, 31.1, 32.1, 32.2 of the mounting aid 3, 3.1, 3.3 which holds the scanning unit 2 in a clamping fashion against the mounting aid 3, 3.1, 3.3.

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The invention has been explained by way of example by means of the particularly advantageous photoelectric scanning principle. In this context, the scanning unit 2 comprises the scanning window 23 which is transparent to the scanning beam and points in the direction of the scale 1 which is to be

scanned during the position measurement. However, the invention is not restricted thereto and can also be implemented successfully with inductive, magnetic or capacitive scanning principles.

Claims

1. Device having a scanning unit (2) and a mounting aid (3, 3.1, 3.3) for adjusting the scanning unit (2),
5 **characterized in that**
the mounting aid (3, 3.1, 3.3) is designed to secure the scanning unit (2) to the mounting aid (3, 3.1, 3.3) in such a way that the scanning unit (2) can be pivoted about a rotational axis (D) of a reference element (4, 4.1) by means of the mounting aid (3, 3.1, 3.3) supporting said scanning unit (2), wherein the mounting aid (3, 3.1, 10 3.3) forms a rotationally fixed form fit with the scanning unit (2) and wherein the mounting aid (3, 3.1, 3.3) comprises means (31, 32; 31.1, 32.1, 32.2) which in the process force the scanning unit (2) against the reference element (4, 4.1), and in that the mounting aid (3, 3.1, 3.3) is designed so that it can be removed from the scanning unit (2) after adjustment has taken place.
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2. Device according to Claim 1, wherein the scanning unit (2) is designed to form a form fit with the reference element (4, 4.1), which form fit locks the scanning unit (2) relative to the reference element (4, 4.1) in directions transverse with respect to the rotational axis (D), but permits rotational movements about the rotational axis (D).
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3. Device according to Claim 2, wherein, in order to form the form fit, a recess (22) is provided on an outer wall (21) of the scanning unit (2), against which the reference element (4, 4.1) can be brought to bear.
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4. Device according to Claim 3, wherein the recess (22) is a V-shaped groove.
5. Device according to one of the preceding claims, wherein the mounting aid (3, 3.1, 3.3) has at least two arms (31, 32; 31.1, 32.1, 32.2) which lie opposite one another and which engage around the scanning unit (2) in a clamping fashion on at least two opposite sides, wherein at least one of these arms (31; 31.1, 31.2) is embodied in an elastic fashion in order to clamp the scanning unit (2) to the reference element (4, 4.1).
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- 35 6. Device according to one of the preceding claims, wherein the mounting aid (3, 3.1, 3.3) is designed to form a form fit with the reference element (4, 4.1), which form

fit locks the mounting aid (3, 3.1, 3.3) relative to the reference element (4, 4.1) in directions transverse with respect to the rotational axis (D), but permits rotational movements of the mounting aid (3, 3.1, 3.3) about the rotational axis (D).

- 5 7. Device according to one of the preceding claims, wherein the mounting aid (3, 3.1, 3.3) has at least one opening (34) into which a tool (6) can be plugged in order to thereby pivot the mounting aid (3, 3.1, 3.3) about the rotational axis (D).
- 10 8. Device according to one of the preceding claims, wherein a handle (9) is integrally formed onto the mounting aid (3.1) in order to pivot the mounting aid (3.1) about the rotational axis (D).
- 15 9. Position-measuring device having a scale component (1, 1.3) and a device according to one of the preceding claims.
- 20 10. Method for mounting a scanning unit (2) of a position-measuring device on an object (5) having the following method steps:
 - making available a reference element (4, 4.1) with a rotational axis (D);
 - connecting the scanning unit (2) to a mounting aid (3, 3.1, 3.3) in such a way that the mounting aid (3, 3.1, 3.3) forces the scanning unit (2) against the reference element (4, 4.1), wherein the mounting aid (3, 3.1, 3.3) forms a rotationally fixed form fit with the scanning unit (2);
 - adjusting the scanning unit (2) by pivoting the mounting aid (3, 3.1, 3.3) which supports the scanning unit (2) about the rotational axis (D) of the reference element (4, 4.1);
 - 25 - attaching the scanning unit (2) in a positionally fixed fashion to the object (5) in the adjusted rotational position; and
 - removing the mounting aid (3, 3.1, 3.3) from the scanning unit (2).
- 30 11. Method for mounting a scanning unit (2) according to Claim 10, wherein the reference element (4) is made available by fastening it to the object (5).
- 35 12. Method for mounting a scanning unit (2) according to Claim 10, wherein the reference element (4.1) is made available by fastening it to an object (7) on which the scale component (1) is arranged, said scale component (1) being scanned by the scanning unit (2) during the position measurement.