

Electromechanical driving device with a piezoelectric element

Description

The invention concerns an electromechanical driving device, in particular for the exact positioning of an object in the nanometer to centimeter range, with a rotor supported in a bearing device and with at least one piezoelectric element which can be charged by an electric voltage.

From the EP 0 611 485 B2, we know a linear motor with a piezoelectric element which is appropriate to position a tip of a needle-like probe to a range of atomic order on a surface of an object. This known positioning device is characterized in that it can move probes with a high precision in the nanometer range and simultaneously on bigger adjusting distances in the centimeter range. It avoids the disadvantages of traditional devices such as guide backlash, reverse backlash, drift, susceptibility to oscillation or oversizing.

However, the known positioning device is only relatively appropriate for a change of the angular position of an object. To this end, the positioning devices must be used with corresponding coupling elements to the object to be positioned, for example a probe. Moreover, only small angular adjustments can be achieved.

The aim of this invention is to create an electromechanical driving device which can adjust the angular position of objects with a high precision, the expenditure of construction being low.

This aim is achieved with an electromechanical driving device of the above mentioned type in that the bearing device has at least one rotor seat rotatably supported on a bearing block, this rotor seat being restrictedly rotatable by the expansion and/or contraction caused by the electric voltage of the at least one piezoelectric element.

The driving device according to the invention can be produced with very small dimensions so that disorders due to temperature or external mechanical influences, for example due to footfall sound, are only extremely slight.

The at least one piezoelectric element changes its expansion under the influence of the electric voltage only by approximately one micrometer so that the movements of the at least one rotor seat are extremely slight. The rotor can be supported frictionally rotatable in the at least one rotor seat in order to make possible bigger adjustment distances. The friction between the rotor and the at least one rotor seat can preferably be such that the rotor does not follow relatively quick revolutions of the at least one rotor seat but follows relatively slow revolutions of the at least one rotor seat. Thus, if the rotor seat is moved slowly by the piezoelectric element, the rotor follows the movement. On the contrary, if the rotor seat is moved relatively quickly by the piezoelectric element, due to its inertia, the rotor cannot follow the movement any longer. A quasi continuous revolution of the rotor in the rotor seat can be achieved by successive alternately slow and quick movements of the rotor seats. The electrodes of the at least one piezoelectric element can be connected to a saw-tooth generator which generates alternately slow and quick expansions and contractions of the at least one piezoelectric element and thus revolutions of the at least one rotor seat,

whereby the rotor follows the slow revolutions and does not follow the quick revolutions.

Preferably, the at least one rotor seat can be a bearing ring which is supported on the bearing block by several webs. The webs constitute flectors which give the device a high mechanical stability. In traditional arrangements, forces exerted from outside onto the piezoelectric element, in particular forces transversally to its expansion direction, can destroy the fragile piezoelectric crystal. However, the flectors constituted by the webs can absorb here such transverse forces so that there does not come to a destruction of the piezoelectric crystal.

A further advantage of this arrangement consists in that the flectors do not have to guide the parts to be moved and thus generate restoring forces. The restoring forces of the webs act only on the piezoelectric element and are moreover very small since the piezoelectric element expands or contracts by approximately only one micrometer. Since the webs do not act on the rotor, adjustment angles of any size of the rotor can also be achieved.

In a further advantageous configuration, the bearing device can have two bearing rings, supported on bearing blocks by several webs, as rotor seats in which the ends of the rotor are supported, whereby at least one of the bearing rings is rotatable by means of at least one piezoelectric element. Thus, it is also possible to drive the rotor from both sides or from one side, the second bearing ring serving then as a pure counterbearing. The two bearing rings constitute in any case two sliding bearings which are pressed against the rotor so that a rotation free from backlash of the rotor is made possible. Precise adjustments even in the nanometer range can also be achieved.

In another configuration, the bearing device can have a piezoelectrically driven bearing ring for the seat of one end of the rotor and a lower friction counterbearing for the other end of the rotor. Particularly precise movements can be achieved with such a configuration.

In order to reduce the friction, the rotor can also have tapering ends. These ends can be configured, for example, as spherical caps. In case the rotor is driven only on one side, it is advantageous if the spherical cap on the counterbearing has a lower diameter.

A preferred embodiment of a driving device according to the invention will be described below in more detail with reference to the drawings.

Fig. 1 shows a side view of a driving device according to the invention.

Fig. 2 shows an inside view of a bearing device of the driving device of figure 1.

The driving device 10 of fig. 1 has a rotor 11 with tapering ends 11.1 and 11.2 which are supported in two bearing elements 12 and 13. The two bearing elements 12 and 13 are connected with each other by webs 14 and constitute together the bearing device for the rotor 11. The bearing elements 12 and 13 are elastically pressed against the rotor.

In the inside view of the bearing element 12 of fig. 2, we can see that this element is made of a bearing block 15 on which a bearing ring 16 is fixed as a rotor seat by three webs 17. The rotor 11 which is not represented in fig. 2 is then inserted into

the bearing ring 16. The bearing ring 16 can be set into rotation by the expansion and contraction of the piezoelectric element 18 by a piezoelectric element 18, the electrodes of which are connected with, for example, a sawtooth generator in a manner which is not represented more precisely, whereby the webs 17 act as flectors. The rotor 11 is frictionally supported in the bearing ring 16 in such a way that it can follow slow rotations of the bearing ring 16 but, because of its inertia, no longer any quick movements. The rotor can thus be adjusted by very small adjustment angles by slow movements of the bearing ring 16, while big adjustment angles or even a continuous rotation movement of the rotor 11 can be achieved by alternately quick and slow movements of the bearing ring 16.

The represented driving device 10 is thus appropriate for the positioning of an object by very small adjustment angles as well as by large adjustment angles.

The second bearing element 13 can be configured exactly like the bearing element 12, however it can also constitute a simple counterbearing for the rotor, whereby the friction between the rotor 11 and the counterbearing 13 is appropriately lower than between the rotor 11 and the bearing ring 16.



Claims

1. An electromechanical driving device, in particular for the exact positioning of an object in the nanometer to centimeter range, with a rotor (11) supported in a bearing device and with at least one piezoelectric element (18) which can be charged by an electric voltage, characterized in that the bearing device (12, 13, 14) has at least one rotor seat (16) supported on a bearing block (15) in a restricted rotatable manner which is rotatable by the expansion and/or contraction of the at least one piezoelectric element (18) caused by the electrical voltage.
2. A driving device according to claim 1, characterized in that the rotor (11) is rotatably supported with friction in the at least one rotor seat (16).
3. A driving device according to claim 1 or 2, characterized in that the at least one rotor seat is a bearing ring (16) which is supported on the bearing block (15) by several webs (17).
4. A driving device according to any of the claims 1 to 3, characterized in that the bearing device (12, 13, 14) has two bearing rings (16), supported by several webs (17) on bearing blocks (15), as rotor seats in which the ends (11.1, 11.2) of the rotor (11) are supported, whereby at least one of the bearing rings (16) is rotatable by means of the at least one piezoelectric element (18).
5. A driving device according to any of the claims 1 to 3, characterized in that the bearing device (12, 13, 14) has a piezoelectrically driven bearing ring (16) for receiving one end (11.1) of the rotor (11) and a lower friction counterbearing for the other end (11.2) of the rotor (11).



6. A driving device according to any of the claims 2 to 5, characterized in that the friction between the rotor (11) and the at least one rotor seat (16) is such that the rotor does not follow relatively quick rotations of the at least one rotor seat (16) but follows relatively slow rotations of the at least one rotor seat (16).
7. A driving device according to claim 6, characterized in that the electrodes of the at least one piezoelectric element (18) are connected with a sawtooth generator which generates alternately slow and quick expansions and contractions of the at least one piezoelectric element (18) and thus rotations of the at least one rotor seat (16), whereby the rotor (11) follows the slow rotations and does not follow the quick rotations.
8. A driving device according to any of the claims 1 to 7, characterized in that the rotor (11) has tapering ends.
9. A driving device according to claim 8, characterized in that the rotor (11) has ends in form of spherical caps.