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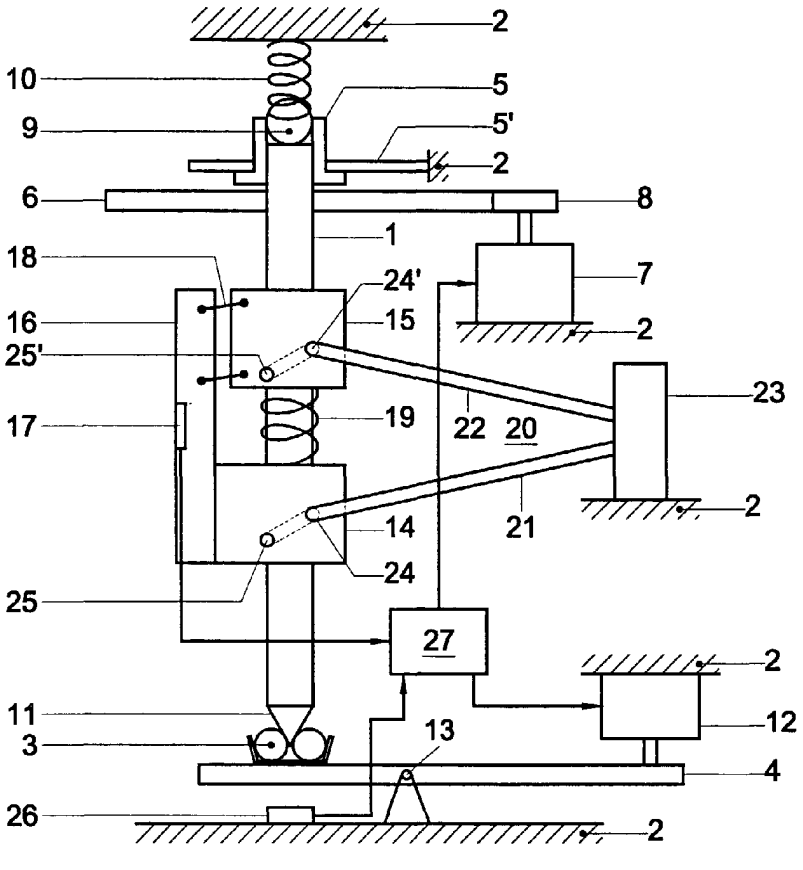
(54) Title: APPARATUS FOR POSITIONING AN OBJECT IN A TWO-STEP CONFIGURATION



(57) Abstract: In an apparatus for positioning an object in a two-step configuration, such as, for instance, a magnetic head, in a recording and/or reproducing device relative to a magnetic tape, the object is coarsely movable by means of a spindle driven by a first motor and finely movable by means of a second motor. The spindle itself is movable in its longitudinal direction by means of the second motor. Not only the motor of the coarse positioning of the spindle, but also that of the fine positioning is fixed in the housing or frame of the apparatus.

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Title: Apparatus for positioning an object in a two-step configuration.

The present invention relates to an apparatus for positioning an object in a two-step configuration, such as, for instance, a magnetic head, in a recording and/or reproducing device relative to a magnetic tape, the object being coarsely movable by means of a spindle driven by a first motor and finely movable by means of a second motor. The apparatus is generally applicable in coarse-fine positioning systems where high positioning accuracies are of great importance.

If in a recording and/or reproducing device information is to be written by means of a magnetic head into a large number of tracks on a magnetic tape or is to be read from a magnetic tape, for instance in 192 tracks on a 8 mm wide tape, the magnetic head must be able to be accurately positioned in the width direction of the tape. In practice, such a positioning takes place by means of a servo loop, which, responding to track following signals in the tape, adjusts the magnetic head on the tape. In this regard, the magnetic head must be able to be adjusted both dynamically from one track to the other track and be kept on a track, even if small changes of position occur in the tape. To accurately realize such an adjustment, it is known to make use of a two-step actuator, in which by means of a spindle driven by a first motor a coarse positioning becomes possible so as to, in particular rapidly, move the magnetic head from one track to the other, while by means of a second motor a fine positioning becomes possible so as to keep, in particular, the magnetic head on the relevant track. In this known two-step actuator, the magnetic head with the second motor and the means for moving the magnetic head by means of this second motor are moved together as one whole along a spindle extending in the width direction of the tape, which spindle is controlled by the first

motor. Consequently, this two-step actuator may be regarded as one that is active in series configuration. Within this whole, the means for moving the magnetic head by means of the second motor comprise, for instance, a pivot axis. It is a drawback of this construction that a relatively great mass must be moved along the spindle for the coarse positioning, which implies a limitation to the accuracy attainable in rapid positioning.

It is an object of the invention to remove these drawbacks and further, more in general, to provide an apparatus for positioning an object in a two-step configuration, by which a rapid change of position becomes possible, while yet a very high positioning accuracy can be attained and, in particular, an apparatus for positioning a magnetic head which enables a rapid positioning of the magnetic head from one track to the other, while yet a very high positioning accuracy of the magnetic head can be attained.

According to the invention, the apparatus as described in the opening paragraph is therefore characterized in that the spindle itself is movable in its longitudinal direction by means of the second motor. When used in a recording and/or reproducing device, the magnetic head can be moved with a very small additional mass directly, so as to keep the distance between the above position-determining spindle and the magnetic head as small as possible, and rapidly, driven in its center of gravity, along the spindle in the width direction of the tape, while furthermore, independently thereof, the spindle with the magnetic head can be finely positioned in the width direction of the tape. This two-step actuator can be regarded as one that is active in parallel configuration, the two motors being firmly connected with the housing or a frame in which the object is movably arranged.

In a preferred embodiment, the spindle is, at one end, spring-supported in a housing or frame relative to which the object is movable and at the other end in a bearing movable in the longitudinal direction of the spindle by means of the second motor. To realize the spring support of one end of the spindle as much as possible without friction, this spring support

may comprise a ball resting on this end and a spring located between the ball and the housing or frame. To obtain a good centering and a support of the spindle in the bearing substantially free from play both axially and radially, the bearing may be designed as ball bearing and the end of the spindle supported thereon may be tapered. The bearing, and hence the spindle, is preferably movable in the longitudinal direction of the spindle by means of a lever driven by the second motor. Such a lever construction enables a high adjusting accuracy of the position of the spindle. The lever is tiltable in a hinge under spring pressure to limit the play in the hinge as much as possible, while the lever is balanced around its pivoting point, so that the fine adjustment is less shock sensitive. Furthermore, to determine the position of the lever and thus of the bearing and hence the spindle and the object in the longitudinal direction of the spindle, a sensor is provided.

In a first embodiment, the object may be arranged on a carrier which is firmly connected with a first spindle nut element movable along the spindle, and which is movably connected with a second spindle nut element movable along the spindle, while between the two spindle nut elements a spring element is provided. In this embodiment, the object may be connected with the second spindle nut element by means of a leaf spring parallelogram construction. In this embodiment, play in the spindle movement is inhibited, because in this construction the spring element keeps the first and the second spindle nut element against the groove edges of the spindle, pressed away from each other as far as possible.

In a second embodiment, the object is arranged on a carrier, which is firmly connected with a first and a second spindle nut element movable along the spindle. To inhibit the play in the spindle movement, another measure, referred to below, may be used.

In both embodiments, it is favorable if means are provided to inhibit a rotation of the object around the axis of the spindle. These means may be designed in the form of a spring construction. This spring construction is

preferably in fixed contact with a housing or frame part located behind the spindle relative to the object, while the free ends of the spring construction extend through openings in the first and the second spindle nut element and in the grooves of the spindle. In the second embodiment, this spring construction has yet another function, to wit: ensure that the play in the spindle movement is inhibited. To this end, however, the openings in one of the two spindle nut elements firmly connected with the carrier for the object are formed by slotted holes.

The invention will now be explained in more detail with reference to the accompanying drawing. In this drawing:

Fig. 1 diagrammatically shows the apparatus according to the invention in a first embodiment; and

Fig. 2 shows a detail thereof in a second embodiment.

The embodiment of the apparatus according to the invention shown in Fig. 1 is used in a recording and/or reproducing device, in which, in a two-step configuration, a magnetic head can be positioned relative to a magnetic tape, and comprises a spindle 1, which, at the upper end, is spring-supported in a housing or frame 2 and, at the lower end, is supported in a bearing 3 provided at one end of a lever 4. At the upper end, a bush 5 is provided around the spindle 1, and around this bush a leaf spring 5' mounted to the housing or frame 2 is provided. A toothed wheel 6 is connected with the spindle 1. The spindle 1 is driven by means of a first motor 7 with a toothed wheel 8 engaging with the toothed wheel 6. The spring support of the spindle comprises a ball 9 resting on the upper end of the spindle and surrounded by the bush 5 and a spring 10 arranged between the ball 9 and the housing or frame 2. The support of the spindle 1 in the bearing 3 is realized by designing the bearing as ball bearing and by giving the spindle a tapered end 11 and allowing this tapered end 11 to rest centrally in the ball bearing. The lever 4 is tiltably arranged in the housing

or frame 2 and is driven by a second motor 12 with a spindle adjustment. The motor 12 can move the ball bearing 3 in the longitudinal direction of the spindle 1, while the motor 7 can rotate the spindle 1. The place of the pivoting point 13 of the lever 4 is selected mainly in the center of gravity of the lever 4. The pivoting point 13 is of flexible design to avoid play in the lever.

Along the spindle two spindle nut elements 14 and 15 are movable. The spindle nut element 14 is provided with a carrier 16 for a magnetic head 17. The carrier 16 is coupled with the spindle nut element 15 by means of a leaf spring parallelogram construction 18. To enable compensation for play in the movement of the spindle nut elements 14 and 15 in the longitudinal direction of the spindle 1, a spring element 19 is provided between the two spindle nut elements 14 and 15 and around the spindle 1. Furthermore, a spring construction 20 is provided to inhibit a rotation of the spindle nut elements 14 and 15 and hence of the carrier 16 with the magnetic head 17 relative to the spindle 1. In the embodiment shown, the spring construction 20 consists of two rods 21 and 22 which, at one end, are secured to a housing or frame part 23 located behind the spindle 1 relative to the magnetic head 17, while the free ends of these rods 21 and 22 are put through openings 24 and 24', respectively, in the spindle nut elements 14 and 15, passed around a part of the grooves of the spindle 1 and passed outwards again through openings 25 and 25', respectively.

To determine the position of the spindle in the vertical direction, a reflection sensor 26 is provided on the housing or frame 2, that is to say directly below the part of the lever 4 on which the bearing 3 is located. On the basis of track following signals read from a magnetic tape passed along the magnetic head 17 and of output signals from the sensor 26, control signals for the motors 7 and 12 are derived in the control unit 27. In this regard, it holds that for relatively coarse positioning steps, for instance to pass the magnetic head from a first track on the magnetic tape to a second

track thereon, only the motor 7 is energized, while for a fine positioning, for instance to keep the magnetic head on a track to be followed, only the motor 12 is energized.

In the embodiment shown in Fig. 2, the two spindle nut elements 14 and 15' and the carrier 16 with the magnetic head 17 form one whole. Consequently, the spring element 19 and the leaf spring parallelogram construction 18 are not necessary herein. To compensate for play in the movement of the above whole relative to the spindle 1, the openings in the spindle nut element 15' are formed by slotted holes 28, and a force pushing these rods apart is provided between the two rods 21 and 22, so that the whole of spindle nut elements, carrier and magnetic head is always pushed against the lower edge of a groove in the spindle. In this embodiment, the spring construction 20 therefore has both the function of inhibiting rotation of the above whole around the spindle and the function of compensating for play in the movement in the longitudinal direction of the whole relative to the spindle.

The invention is not limited to the embodiments described herein with reference to the drawing, but comprises all kinds of modifications thereof, of course as far as falling within the scope of protection of the appended claims.

CLAIMS

1. An apparatus for positioning an object in a two-step configuration, such as, for instance, a magnetic head, in a recording and/or reproducing device relative to a magnetic tape, the object being coarsely movable by means of a spindle driven by a first motor and finely movable by means of a second motor, characterized in that the spindle itself is movable in its longitudinal direction by means of the second motor.

2. An apparatus according to claim 1, characterized in that the spindle, at one end, is spring-supported in a housing or frame relative to which the object is movable and, at the other end, is supported in a bearing movable in the longitudinal direction of the spindle by means of the second motor.

3. An apparatus according to claim 2, characterized in that the spring support of one end of the spindle comprises a ball resting on this end and a spring located between the ball and the housing or frame.

4. An apparatus according to claim 2 or 3, characterized in that the bearing is a ball bearing and the end of the spindle supported thereon is tapered.

5. An apparatus according to claims 2–4, characterized in that the bearing and hence the spindle is movable in the longitudinal direction of the spindle by means of a lever driven by the second motor.

6. An apparatus according to claim 5, characterized in that a sensor is provided to determine the position of the bearing in the longitudinal direction of the spindle.

7. An apparatus according to any one of the preceding claims, characterized in that the object is arranged on a carrier which is firmly connected with a first spindle nut element movable along the spindle, and which is movably connected with a second spindle nut element movable

along the spindle, while between the two spindle nut elements a spring element is provided.

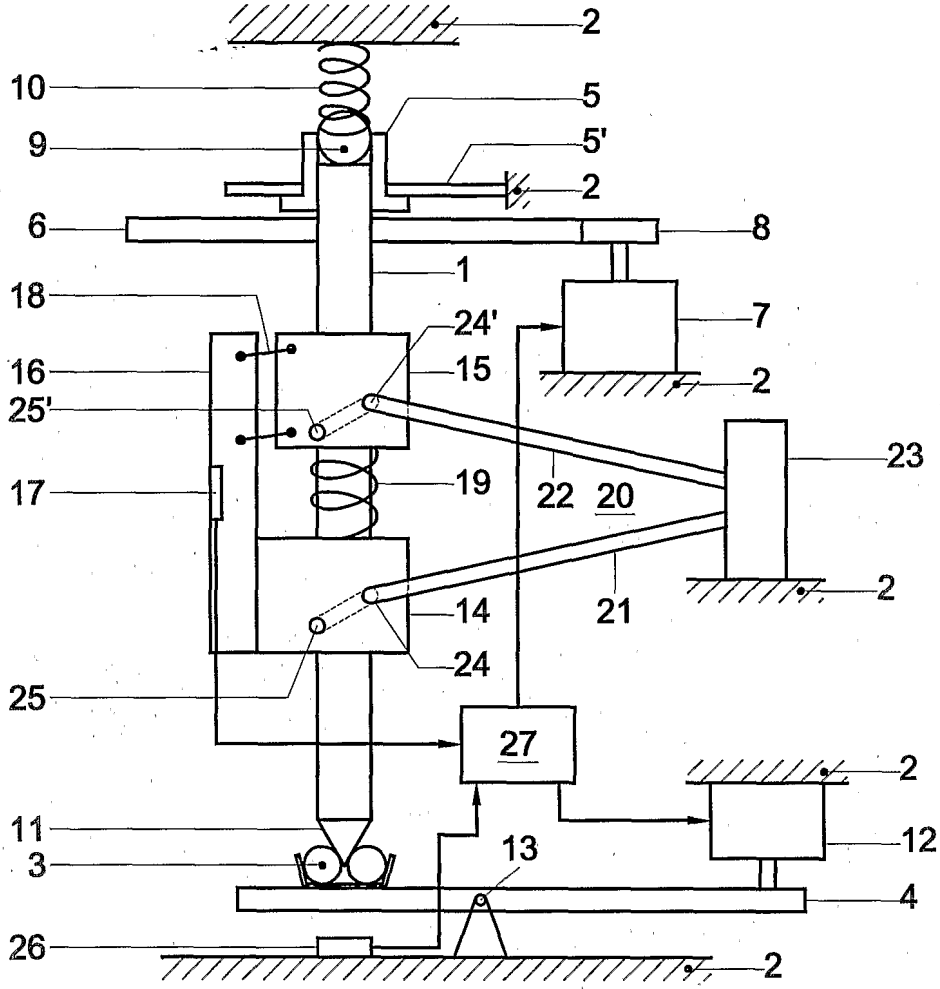
8. An apparatus according to claim 7, characterized in that the magnetic head is connected with the second spindle nut element by means of a leaf spring parallelogram construction.

9. An apparatus according to any one of the preceding claims, characterized in that the object is arranged on a carrier, which is firmly connected with a first and a second spindle nut element movable along the spindle.

10. An apparatus according to any one of claims 7–9, characterized in that means, such as a spring construction, are provided to inhibit a rotation of the object around the axis of the spindle.

11. An apparatus according to claim 10, characterized in that the spring construction is connected without play with a housing or frame part located behind the spindle relative to the object, and that the free ends of the spring construction extend through openings in the first and the second spindle nut element and in the grooves of the spindle.

12. An apparatus according to claim 11, characterized in that the openings in one of the two spindle nut elements firmly connected with the carrier for the object are formed by slotted holes.


2
10
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8
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25'
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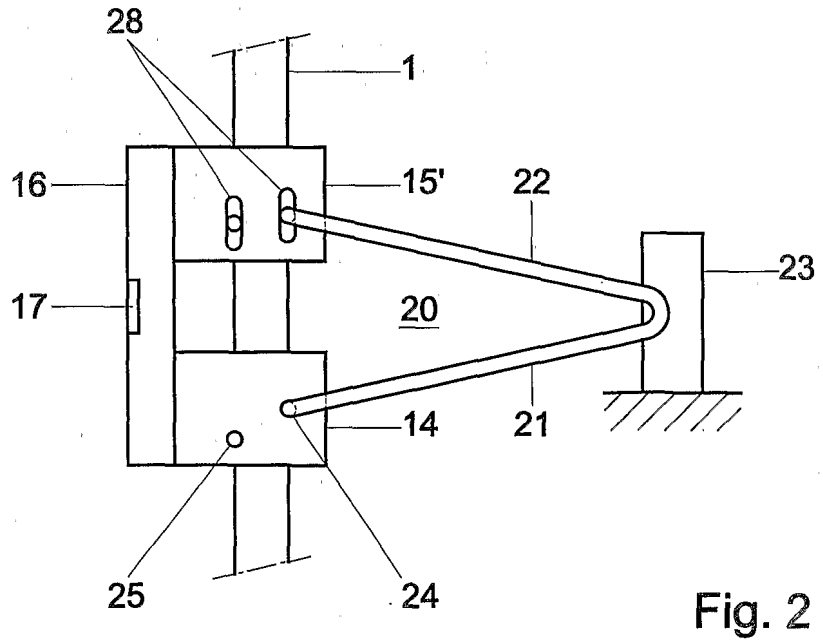
26
2

Fig. 1


28
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15'
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25
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Fig. 2

INTERNATIONAL SEARCH REPORT

Int'l Application No
PCT/NL 01/00633

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G11B5/584

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G11B

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

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
9 January 2002	17/01/2002

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INTERNATIONAL SEARCH REPORT

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