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(54) **Swing-arm device for an optical scanning unit.**

(57) A swinging-arm device (5) for an optical disk player comprises a swinging arm (16), which near one end (17) carries an optical scanning unit (6) and which is electromagnetically pivoted by means of coils (27, 28) arranged on the swinging arm and a permanent magnetic stator (29, 30, 49-52, 54) arranged on a stationary mounting of the device. The centre of mass (Z) of the pivotal assembly comprising, *inter alia* the swinging arm and the optical scanning unit is disposed on the pivotal axis and the two coils are disposed diametrically opposite one another on opposite sides of the pivotal axis and exert equal pivotal forces which act in one plane which is perpendicular to the pivotal axis and which extends through the centre of mass. The centre of mass is disposed midway between two ball-bearings (20, 21).

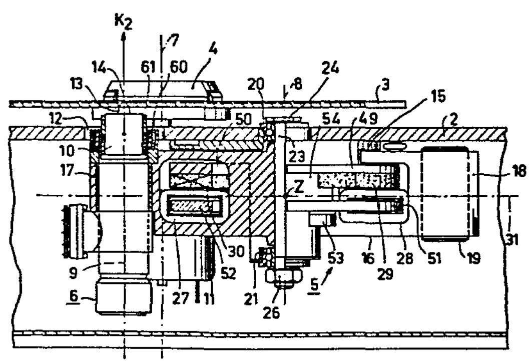

FIG.2

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"Swinging-arm device with an optical scanning unit."

The invention relates to a swinging-arm device for writing and/or reading recording tracks in an optical disk by means of a radiation beam which is concentrated to form a radiation spot, which device comprises: a stationary mounting; an optical scanning unit comprising a lens system which is movable along an optical axis; a swinging arm having a first end provided with means for securing the scanning unit to the swinging arm and a second end opposite the first end; a swinging-arm bearing arrangement which pivotally supports the swinging-arm in the mounting for pivotal movement about a pivotal axis situated between the two ends of the swinging arm; coil means connected to the swinging arm for exerting electromagnetic pivotal forces on the arm in a plane perpendicular to the pivotal axis; and a permanentmagnetic stator comprising permanent stator-magnet means secured to the stationary mounting, which means co-operate with the coil means *via* an air gap.

Devices for moving and positioning optical scanning units for the contactless scanning of rotary optical disks are known in various forms. The optical disks may be video disks, rotating at a speed of 1500 or 1800 revolutions per minute, optical data-storage disks, which also rotate at high speed, or optical audio disks. As is shown, it has been proposed to manufacture optical audio disks having a diameter of approximately 12 cm. The speed of rotation varies between approximately 250 and 500 revolutions per minute.

The known devices for moving and positioning optical scanning units are generally of a type in which the optical scanning unit is moved rectilinearly over the rotating surface of the optical disk. However, it has also been proposed to employ a swinging-arm device in conjunction with an optical scanning unit which performs a limited rotary movement. This limited rotary movement or pivotal movement is effected about a pivotal axis which is parallel to the axis of rotation of the optical disk. Advantages of a swinging-arm device in comparison with a rectilinearly movable device are its simple bearing arrangement and drive system. In general, journalling and driving rotary devices is technically easier. In rectilinearly movable devices it is often necessary to convert rotational into translational movement. The comparatively large dimensions and the comparatively high mass of the moving part of the rotary device may be a disadvantage. As a result of this such devices may become more susceptible to shocks, that is, if an apparatus in which a swinging-arm device is used is subjected to a shock, this may give rise to undesired movements of the optical scanning unit.

Nevertheless, the advantages of a swinging-arm device may outweigh its disadvantages, especially if optical disks of smaller diameter are used which do not rotate too fast, such as the aforementioned optical audio disk. Of particular interest is a swinging-arm device used in conjunction with an optical scanning unit equipped with a movable lens system for automatically focussing and maintaining the focussing of a radiation beam on the information surface of the optical disk, the swinging arm being included in an automatic control circuit for automatically following the track of the optical disk, which control circuit corrects tracking errors by small pivotal movements of the whole swinging arm. Tracking errors may occur as a result of incorrect centring of the optical disk on a drive spindle, an eccentric position of the tracks relative to the central aperture of the disk, oscillations of the tracks when the disk is not perfectly perpendicular to the axis of rotation of the drive spindle, and other random influences. In view of the frequency spectrum of the tracking errors the radial tracking system is required to have a dynamic bandwidth of at least 1000 Hz. Moreover, for the pivotal movement of the swinging arm the required power should not be too high in view of the development of heat and the dimensioning of the servo circuits.

The invention aims to provide a swinging-arm device of the type mentioned in the opening paragraph having a large dynamic bandwidth for pivotal movements about the pivotal axis and requiring a comparatively low power for effecting the pivotal movements, and is characterized by the application of a number of steps in combination, namely: the centre of mass of the pivotal assembly comprising the swinging arm with the optical scanning unit is disposed on the pivotal axis; the coil means comprise first and second coil means which are disposed diametrically opposite each other on opposite sides of and at equal distances from the pivotal axis and which exert equal first and second pivotal forces on the swinging; and the first and second pivotal forces act in one plane perpendicular to the pivotal axis. Each of these steps in itself serves to prevent undesired forces and moments being exerted on the swinging-arm device. In the absence of undesired forces and moments the arm can be of a less rigid and consequently lighter construction. It has been found that, in comparison with the other parts of the swinging-arm device, the bearing arrangement especially has a low rigidity. Bearing arrangements which meet requirements of freedom from play and low friction can be obtained by the use of axially pre-stressed ball-bearings. The balls are compressed over a very small area so that, at least in the micron range, they are elastically deformable in a comparatively easy manner. In view of the desired large bandwidth it is therefore very important to aim at a minimal bearing load. The smaller the mass of the arm is, the smaller is the bearing load, so that the attainable bandwidth can be larger. Since the centre of mass of the swinging-arm device is disposed on the pivotal axis this also yields the advantage that the orientation of the pivotal axis relative to the direction of the field of gravity is not critical.

Since the coil means exert a perfect moment about the pivotal axis on the swinging arm no undesired transverse forces are exerted on the swinging-arm bearing arrangement during pivotal movements. As already described, this is important in view of the attainable dynamic bandwidth of the swinging-arm device. However, transverse forces are also undesirable for other reasons, because they may give rise to undesired deformations in the swinging-arm device and consequent displacements of the read spot. Moreover, transverse forces in the swinging-arm bearing arrangement give rise to frictional forces; these also have an adverse effect on the bandwidth. Since the pivotal forces exerted by the coil means act in one plane perpendicular to the pivotal axis, no moments are exerted on the swinging arm about an axis perpendicular to the pivotal axis, which moments could give rise to transverse reaction forces in the swinging-arm bearing arrangement.

Also, in one embodiment the centre of mass of the swinging-arm device is arranged in the said one plane in which the two pivotal forces act. The advantage of this is that dynamic torsional deformations about the pivotal axis owing to the moments exerted are minimized.

A further embodiment is characterized in that the swinging-arm bearing arrangement comprises two bearings which are disposed on opposite sides of the swinging arm at substantially equal distances from the centre mass of said pivotal assembly. This ensures that both bearings are subject to substantially equal transverse-force loads, so that neither of the bearings is subjected to a load which is heavier than necessary.

It is also of advantage to employ a further embodiment which is characterized in that: the two bearings comprise ball-bearings; the swinging-arm bearing arrangement comprises a resilient support for one of the two ball-bearings, which supports present a higher resistance to forces perpendicular to the pivotal axis and to moments about the pivotal axis than to forces directed along or parallel to the pivotal axis and to moments about axes perpendicular to the pivotal axis; and the resilient support is secured to the frame in an axial pre-stressed condition, so that the two ball-bearings are urged axially towards one another.

Owing to the resulting absence of play in the bearings the bearings cannot adversely affect the attainable bandwidth. Owing to the flexibility of the resilient bearing support about the said moment axes alignment errors between the two ball-bearings can be compensated for elastically and without play.

A swinging arm in accordance with the invention may be driven in a manner similar to that known from swinging-arm devices for moving and positioning a magnetic head over the surface of a magnetic storage disk. Such known swinging-arm devices sometimes employ a flat coil which is disposed in the plane of the swinging arm and which moves in an axial permanent-magnetic field between flat permanent magnets arranged at a small distance from the flat coil, parallel to the plane of the swinging arm. The magnetic head is suspended in a system of weak springs so that small flexural deformations of the swinging arm have substantially no influence on the position of the magnetic head above the surface of the magnetic disk. In swinging-arm devices which co-operate with an optical disk flexural deformations in the swinging-arm device give rise to focussing errors of the light spot. The resistance to flexural deformations consequently affects the bandwidth of the automatic focussing control system. An embodiment of the invention which provides a swinging arm having higher bending resistance but which combines all the advantages of the previous embodiments, is characterized in that: the swing arm has at least substantially the shape of a bar of rectangular cross-section, the two long sides of the rectangle being parallel to the pivotal axis, so that the bar comprises two side surfaces, an upper surface to be directed towards the optical disk and a lower surface opposite the last-mentioned surface, the side surfaces having a height greater than the width of the upper and lower surfaces; the swinging arm is formed with first and second apertures which are disposed on opposite sides of the pivotal axis and which extend through the side surfaces;

the first and second coil means are mounted in the first and second apertures respectively, and the stator is provided with first and second permanent stator magnets each having the shape of an arc of a circle, which magnets extend through the first and second apertures respectively. By having the arcuate stator magnets extending through the apertures in the swinging arm a highly compact but nevertheless easy-to-assemble device can be obtained.

In order to obtain a large dynamic bandwidth it is important that, as already stated, the pivotal mass of the swinging-arm device is sufficiently small. However, reducing the dimensions of the swinging arm is only possible to a limited extent, the limits imposed depending on the type of means used for keeping the read spot positioned on the information track to be read. As is known, optical disk players comprise at least two automatic control systems, namely a focussing control system and a tracking control system. The focussing control system serves to keep the light spot automatically focussed on the information surface and to automatically correct possible error. The tracking control system serves for automatically eliminating deviations from the position of the light spot in the plane of the information surface and transverse to the direction of the information track.

For tracking purposes the optical read unit is equipped with an opto-electronic measuring unit, which measures deviations of the read spot in directions transverse to the information track. Since the information tracks are substantially concentric with the axis of rotation of the optical disk, said deviations may be referred to as "radial-position errors" of the light spot. In a swinging-arm device the light spot follows an arcuate scanning track over the information surface of the optical disk. Consequently, the read spot does not move over the information surface in a purely radial direction. The degree of curvature of the scanning path of the read spot increases as the distance between the optical read unit and the pivotal axis of the swinging-arm device decreases. The deviations between the movements of the read spot relative to the track and the desired radial direction of movement will increase as the degree of curvature increases. The measuring device for measuring the radial-position errors has a limited sensitivity, so that the sensitivity of said measuring device imposes a specific limit on the maximum permissible error. In swinging-arm devices for scanning optical disks this leads to a problem which greatly resembles the problems encountered with pick-up arms of record players. In record players this is referred to as a "tracking-angle error", which is the angle formed by the radius and the tangent to the arcuate scanning path followed by the stylus of the pick-up head at the point of scanning of the groove in the gramophone record. A large amount of literature is available on the subject of determining the most suitable scanning path for the stylus of the pick-up head over the gramophone record. Reference may be made, for example to the article "Tracking Angle" by B.B.Bauer in the magazine Electronics, March 1945, pages 110 to 115.

In the case of swinging-arm devices for optical disk players it is also possible to speak of a tracking-angle error. This error may be defined as the angle, at the point where the light spot illuminates the information surface, between the radius and a tangent to the arcuate scanning path. Larger tracking-angle errors are permissible as the sensitivity of the measuring device for measuring the radial-position error of the read spot relative to the track increases. An example of this is an opto-electronic measuring device using a beam splitter which splits a light beam which has been reflected by the information surface into two sub-beams which each co-operate with two photodiodes, the output signals of the photodiodes being added to each other and being subtracted from each other in a suitable manner in order to obtain an output signal which is a measure of displacements of the read spot in a radial direction relative to the information track, a maximum tracking angle error of 20° being regarded as permissible.

When this value is permissible, the most suitable scanning path can be selected by means of the said known theory, that is, that scanning path for which a minimal distance between the read spot and the pivotal axis of the swinging arm is obtained and for which the tracking angle errors never exceed the maximum permissible value.

In practice this may mean that the scanning path extends from a point on the outer diameter of the information surface to a point on the inner diameter of the information surface, which points are shifted tangentially relative to each other, that is the relevant points are disposed on different radii which enclose a certain angle. This is also customary in record players.

A preferred embodiment of the invention will now be described in more detail, by way of example, with reference to the drawing, in which:

Figure 1 is a plan view of an optical audio disk player drawn to substantially full scale,

Figure 2 is a sectional view, taken on the line II-II in Figure 1 and drawn to a larger scale, of a part of the optical disk player of Figure 1, the swinging-arm device being partly shown in elevation,

Figure 3 is a plan view of the swinging-arm device as shown in Figure 2,

Figure 4 is a cross-sectional view of the swinging-arm device, taken on the line IV-IV in Figure 3,

Figure 5 is a side view of the actual swinging-arm of the device,

Figure 6 is an underneath view of the swinging arm of Figure 5,

Figure 7 is an underneath view of a main portion of the mounting of the swinging-arm device,

Figure 8 is a sectional view taken on the line VIII-VIII in Figure 7,

Figure 9 is a sectional view taken on the line IX-IX in Figure 7,

Figures 10, 11 and 12 are a transverse sectional view, a plan view and a side elevation respectively of a coil for the swinging-arm drive,

Figures 13 and 14 are a plan view and a side elevation of an arcuate permanent magnet arranged on a semi-circular iron yoke portion of a permanent magnetic stator of the swinging arm device, and

Figures 15 and 16 show a resilient bearing support in plan and sectional views respectively.

The optical audio-disk player shown in Figure 1 comprises a lower cabinet section 1 with a deck 2. An optical audio disk 3 having a diameter of approximately 120 mm rotates on a spindle 4 in a plane of rotation which is parallel to the deck 2. The disk is read in the reflection mode by an optical scanning unit <u>6</u> with the aid of a swinging-arm devicd 5. The axis of rotation 7 of the spindle 4, the pivotal axis 8 of the swinging-arm device 5 and the optical axis 9 of a movable lens system 10 of the optical scanning unit <u>6</u> are parallel to each other and extend substantially perpendicularly to the deck 2. The spindle 4 is driven by an electric motor 11. The lens system 10 projects slightly from the deck 2 through a slot 12. The scanning unit <u>6</u> comprises a semiconductor laser as a light source and all the optical and opto-electronic means required for reading and processing the optical information on the disk 3. As the nature and construction of the scanning unit are irrelevant to the present invention, the scanning unit will not be described in more detail. The lens system 10 concentrates a laser beam 13 to form a read spot 14 on the information surface disposed on the upper side of the optical disk 3, which is transparent except for said information surface.

The swinging-arm device comprises a stationary mounting with a disc-shaped main portion 15. A swinging arm 16 has a first end 17 with clamping means for the optical scanning unit 6 and a second end 18 carrying a counterweight 19. A swinging-arm bearing arrangement for the pivotal movement of the swinging arm 16 about the pivotal axis 8 comprises two ball-bearings 20 and 21 arranged above and below the swinging arm. The ball-bearing 20 is mounted in the main mounting portion 15 and the ball-bearing 21 is mounted in a resilient support 22. Further, the bearing arrangement comprises a bearing bolt 23 having a head 24 and a threaded portion 25 onto which a nut 26 is fitted. The inner races of the ball-bearings 20 and 21 and the swinging arm 16 are retained between the nut 26 and the head 24.

For the radial movement of the read spot 14 over the information surface of the optical disk there are provided two coils 27 and 28 and permanent magnets 29 and 30. These magnets co-operate with the two coils _via_ an air gap. The coils are so wound and the magnets are so magnetized that each coil exerts an electromagnetic pivotal force on the swinging arm in a plane perpendicular to the pivotal axis 8 (see Figs. 10-14). The centre of mass Z of the pivotal assembly comprising mainly the swinging arm 16 with the optical scanning unit _6_, the counterweight 19 and the two coils 27 and 28, is disposed on the pivotal axis 8. For pivotal movements about the pivotal axis 8 the mass moment of inertia of that part of the pivotal assembly which extends in the direction of the first end 17 of the swinging arm is equal to the mass moment of inertia of the part which extends in the direction of the second end 18. The coils 27 and 28 are disposed diametrically opposite each other on opposite sides of and at equal distances from the pivotal axis 8. They exert equal variable pivotal forces K_1 on the swinging arm (see Figure 3). These pivotal forces act in a plane passing through the centre of mass Z and perpendicular to the pivotal axis 8. This plane intersects the plane of the drawing along a line 31 in Figure 2 and along a line 32 in Figure 4. In the embodiment shown the two forces K_1 are equal to each other and act tangentially relative to the pivotal axis 8, so that substantially no transverse force components are exerted on the bearings. The two forces are applied at equal distances from the pivotal axis 8, so that they produce pivoting moments of equal magnitude and direction. The points of application of the forces are disposed close to the parts of the swinging-arm device having the largest mass, that is, the scanning unit 6 and the counterweight 19. This has the advantage of a low dynamic flexural deformation of the swinging arm 16. In the ideal case the pivotal forces would act in the centres of gravity of the principal masses, that is, in the centres of gravity of the scanning unit 6 and of the counterweight 19. However, this is difficult to achieve in practice.

The two ball-bearings 20 and 21 are disposed at equal axial distances from the centre of mass Z. The optical axis 9 of the movable lens system 10 is disposed in a plane of symmetry of the swinging arm 16 which contains the pivotal axis 8. This plane of symmetry intersects the plane of the drawing along a line 33 in Figure 3. A variable focussing force K_2 (see Figure 2) which is exerted on the lens system 10 for focussing purposes by means to be described hereinafter, consequently acts in the said plane of symmetry. The focussing force therefore does not produce any undesired dynamic torsional moments in the swinging arm 16, the swinging arm being subjected only to a bending load by the force K_2. The variable reaction forces occurring in the ball-bearings 20 and 21 are equal to each other because, as already stated, the centre of mass Z of the pivotal assembly is disposed midway between the two ball-bearings.

The ball-bearing 21 is mounted in the resilient support 22. This support comprises an extruded hollow cylindrical portion 34 for receiving the outer race of the ball-bearing 21, which cylindrical portion is connected to four radially extending strip-shaped members 35. This ensures that the resilient support presents a higher resistance to forces perpendicular to the pivotal axis 8 and moments about the pivotal axis 8 that to forces directed along or parallel to the pivotal axis 8 and moments acting about axes perpendicular to the pivotal axis. By means of two screws 36 the bearing support is secured in an axially pre-stressed condition to two portions 37 of the swinging-arm mounting which extend downwardly from the main portion

15. When the bearing arrangement is mounted the bracket 22 is shifted until the optical axis of the lens system is exactly perpendicular to the mounting face 38 on the upper side of the swinging-arm mounting(see Figures 4, 8 and 9). Possible alignment errors of the two bearings 20 and 21 relative to each other are compensated for by the resilient action of the support 22 and the axial pre-stress in the support, which pre-stress urges the bearings 20 and 21 axially towards one another, eliminates any bearing play.

As can be seen in Figures 5 and 6, the swinging arm 16 has substantially the form of a bar of rectangular cross-section, the two long sides of the rectangle being parallel to the pivotal axis 8, so that the bar comprises two side surfaces 39 and 40, an upper surface 41 to be directed towards the optical disk 3, and a lower surface 42 opposite the last-mentioned surface. The side surfaces 39 and 40 have a height which is greater than the width of the upper and lower surfaces. The swinging arm is formed with two apertures 43 and 44 which are disposed on opposite sides of and at equal distances from the pivotal axis 8 and which extend through the side surfaces 39 and 40. The coils 27 and 28 are accommodated in these two apertures. Figures 10to 12 show only one of the coils, namely the coil 27, the coil 28 being identical to the coil 27. Each coil comprises a coil former with end flanges 46 and 47. The turns of the coil lie between the flanges. The width of the coil is such that it fits exactly in the aperture in the swinging arm, the arm being locally recessed on both sides to receive the flanges 46 and 47.

The permanent magnets 29 and 30 each have the shape of an arc of a circle and extend through the apertures 43 and 44 respectively. Figures 13 and 14 show the permanent stator magnet 29. This magnet is glued onto a semicircular iron yoke member 49. The permanent magnet 30, which is identical to the magnet 29, is glued onto a similar yoke member 50. Identical semicircular yoke members 51 and 52 extend through the coils 27 and 28. In the present embodiment the stator magnets are axially magnetized. The yokes 49 to 52 are secured to the swinging-arm mounting by means of bolts 53, with iron spacing elements 54 interposed between the yokes of each pair of associated yokes. The field of the permanent magnet 29 extends axially towards the iron yoke member 51, via the air gap in which the turns of the coil 28 are disposed. The field is closed via the iron spacing element 54 and the iron yoke member 49. The field of the permanent magnet 30 extends in a similar way.

Near its end 17 the swinging arm 16 comprises a clamping device for mounting the scanning unit 6. This ensures easy and rapid exchangeability of said unit. The swinging arm has a cylindrical bore 55 in which the scanning unit can be mounted. The bore 55 is formed in a clamping ring 56 which can be tightened around the scanning unit by means of a screw 57.

The lens system 10 is movable along the optical axis 9 and is suspended in two leaf springs 58, of which the lower one is visible in Figure 3. These leaf springs are secured to the body of of the scanning unit by screws 59 and always remain parallel to each other, so that the optical axis 9 is not subject to pivotal movements during the focussing movements of the lens system. The leaf springs extend substantially tangentially relative to the pivotal axis 8 of the swing arm. Pivotal movements of the swinging arm conseauently subject the leaf springs to tensile and compressive loads. The leaf springs present a particularly high resistance to tensile and compressive loads, so that the pivotal movements hardly influence a correct operation. For driving the lens system there is provided an annular focussing coil 60, which co-operates with a permanent magnet system 61 which is coaxially mounted on the lens system.

As is shown in Figure 1, the scanning path T of the read spot is an arc of circle, which extends between an outer point B_1 and an inner point B_2 situated on a radius R_1 and a radius R_2 respectively, each of which has its origin on the axis of rotation 7 of the spindle 4. The angle α between the radii R_1 and R_2 is approximately 18°. In comparison with a scanning path between the point B_1 and a point B_3 situated on the radius R_1 the distance between the optical axis 9 of the scanning unit and the pivotal axis 8 is then reduced by a factor $1\frac{1}{2}$.

The reference signs in the claims, relating to the drawings, are not limiting the interpretention of the claims, but are only included with intention of clarification.

CLAIMS

1. A swinging-arm device for writing and/or reading recording tracks in a recording surface of a rotary optical disk by means of a radiation beam (13) which is concentrated to form a radiation spot (14), which device comprises:

- a stationary mounting (15),
- an optical scanning unit (6) comprising a lens system (10) which is movable along an optical axis (9),
- a swinging arm (16) having a first end provided with means for securing the scanning unit (6) to the swinging arm and a second end opposite the first end,
- a swinging arm bearing arrangement (20-26) which pivotally supports the swinging arm in the mounting for pivotal movement about a pivotal axis (8) situated between the two ends (16, 17) of the swinging arm,
- coil means (27, 28) connected to the swinging arm for exerting electromagnetic pivotal forces on the arm in a plane perpendicular to the pivotal axis (8), and
- a permanent-magnetic stator comprising permanent stator-magnet means (29, 30) secured to the stationary mounting, which means co-operate with the coil means <u>via</u> an air gap,

characterized in that

- the centre of mass (Z) of the pivotal assembly comprising the swinging arm (16) with the optical scanning unit (6) is disposed on the pivotal axis (8),
- the coil means (27, 28) comprise first and second coil means which are disposed diametrically opposite each other on opposite sides of and at equal distances from the pivotal axis (8) and which exert equal first and second pivotal forces (K_1) on the swinging arm, and
- the first and second pivotal forces (K_1) act in one plane perpendicular to the pivotal axis.

2. A swinging-arm device as claimed in Claim 1,

characterized in that the centre of mass (Z) of said pivotal assembly is disposed in the said one plane.

3. A swinging-arm device as claimed in Claim 1, characterized in that the swinging-arm bearing arrangement comprises two bearings which are disposed on opposite sides of the swinging arm (16) at substantially equal distances from the centre of mass (Z) of said pivotal assembly.

4. A swinging-arm device as claimed in Claim 3, characterized in that

- the two bearings comprise ball-bearings (20, 21),
- the swinging-arm bearing arrangement comprises a resilient support (22) for one of the two ball-bearings (21) which support presents a higher resistance to forces perpendicular to the pivotal axis (8) and to moments about the pivotal axis than to forces directed along or parallel to the pivotal axis and to moments about axes perpendicular to the pivotal axis, and
- the resilient support is secured to the frame in an axially pre-stressed condition, so that the two ball-bearings are urged axially towards one another.

5. A swinging-arm device as claimed in Claim 1, characterized in that

- the swinging-arm (16) has at least substantially the shape of a bar of rectangular cross-section, the two long sides of the rectangle being parallel to the pivotal axis (8), so that the bar comprises two side surfaces (39, 40) an upper surface (41) to be directed towards the optical disk (3), and a lower surface (42) opposite the last-mentioned surface, the side surfaces having a height which is greater than the width of the upper and lower surfaces,
- the swinging arm is formed with first and second apertures (43, 44) which are disposed on opposite sides of the pivotal axis (8) and which extend through the side surfaces (39, 40),
- the first and second coil means (27, 28) are mounted in the first and second apertures (43, 44) respectively, and
- the stator is provided with first and second permanent

stator magnets (29, 30) each having the shape of an arc of a circle which magnets extend through the first and second apertures (43, 44) respectively.

6. A swinging-arm device as claimed in Claim 1, characterized in that the optical axis (9) of the movable lens system is disposed in a plane of symmetry of the swinging arm (16) which contains the pivotal axis (8) of the swinging arm.

7. A swinging-arm device as claimed in Claim 1, in which the movable lens system is suspended in parallel leaf springs, characterized in that the leaf springs extend substantially tangentially relative to the pivotal axis.

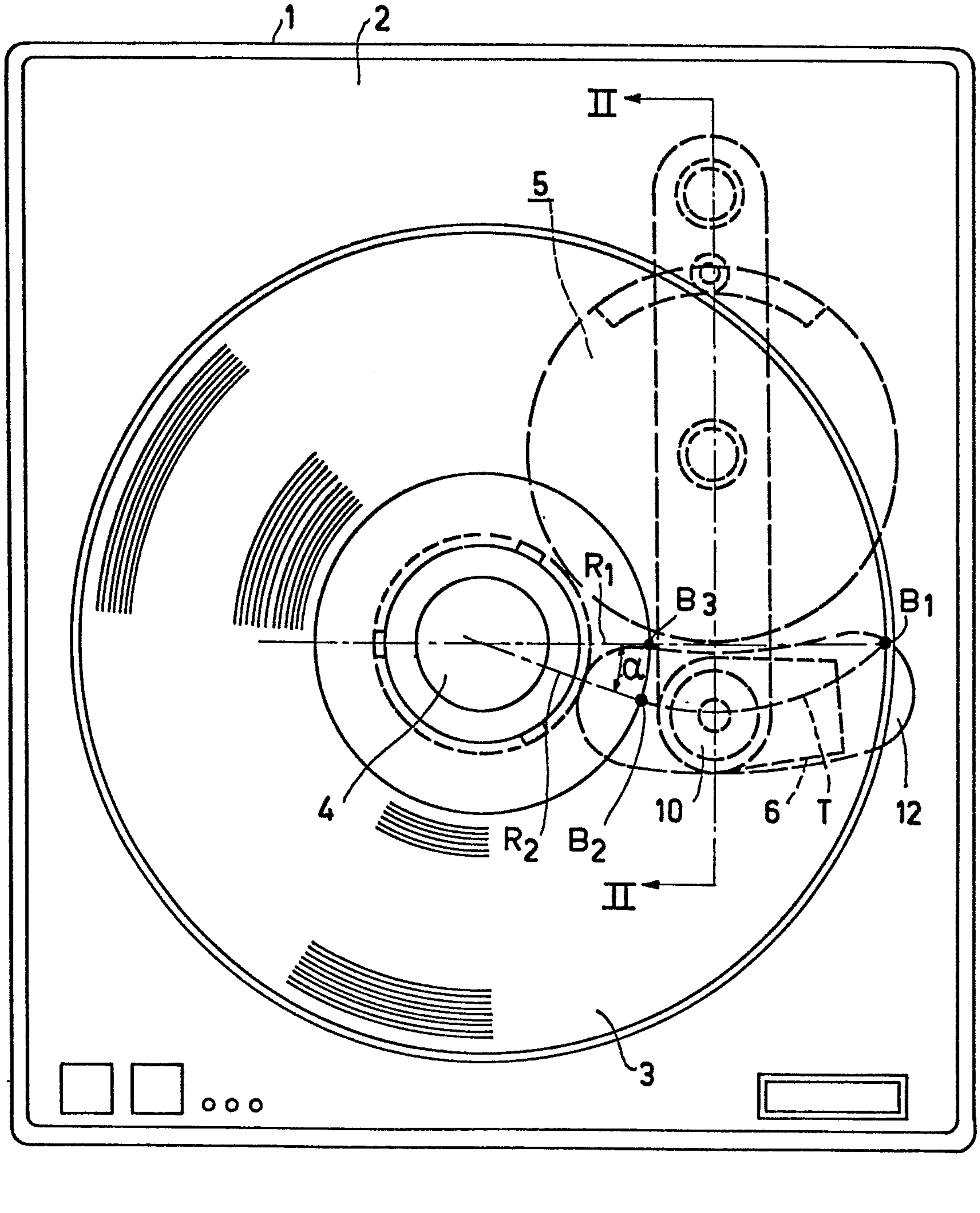

FIG.1

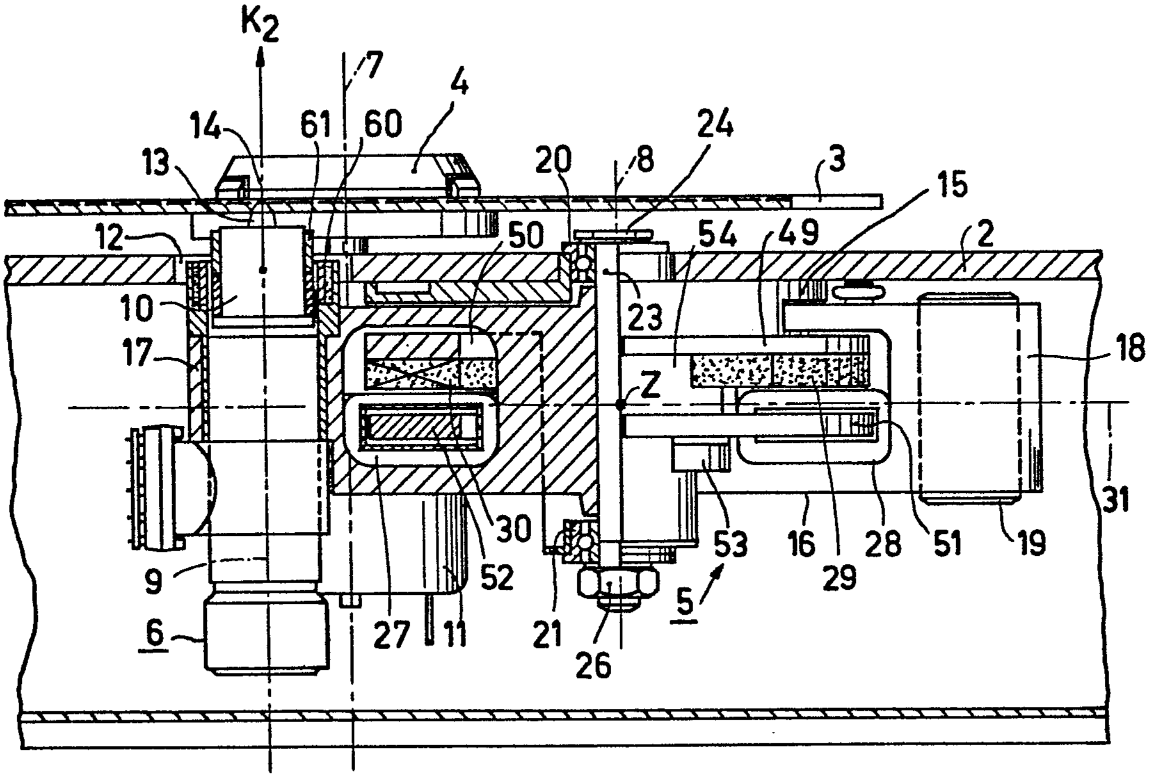
K2
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FIG.2

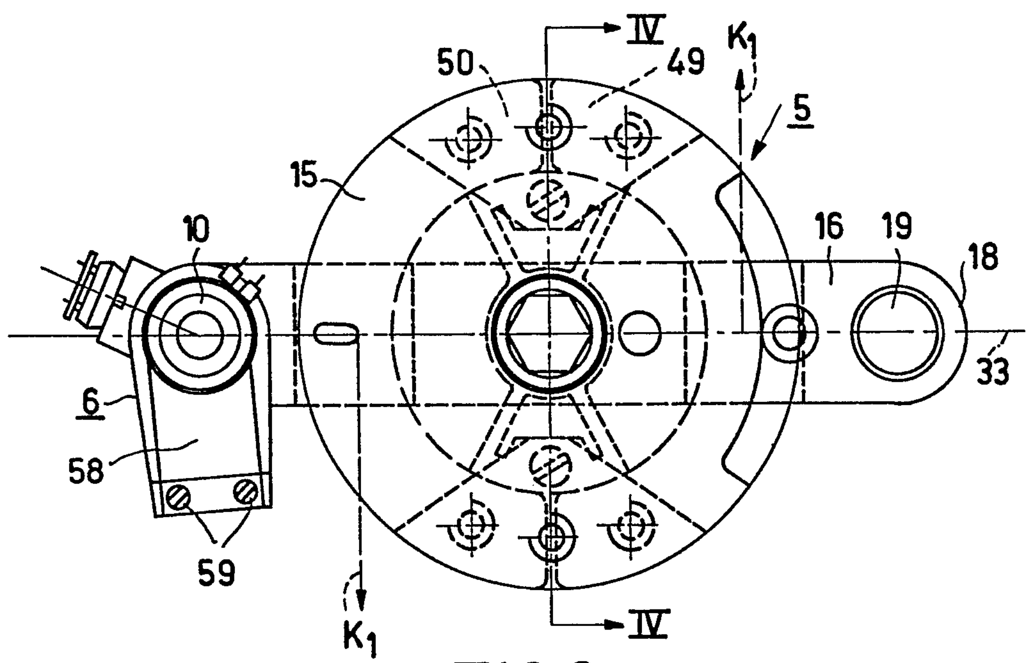
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FIG.3

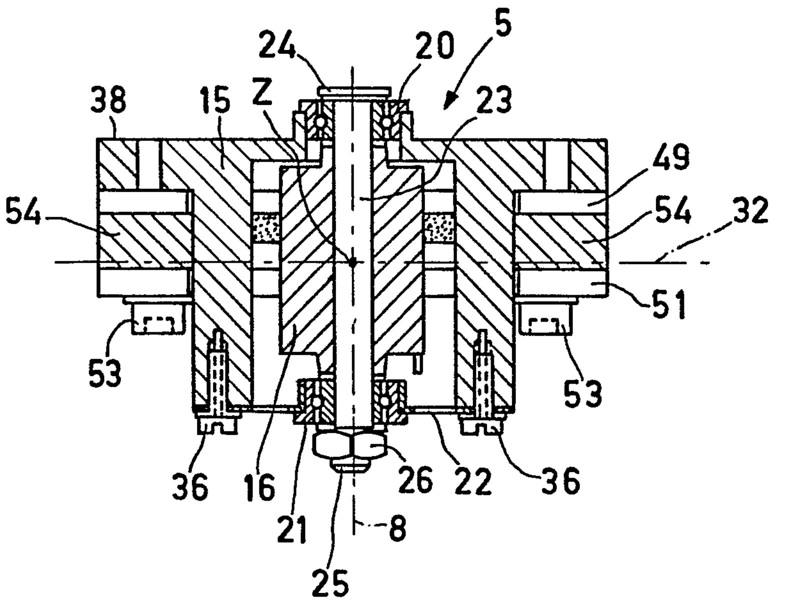

FIG.4

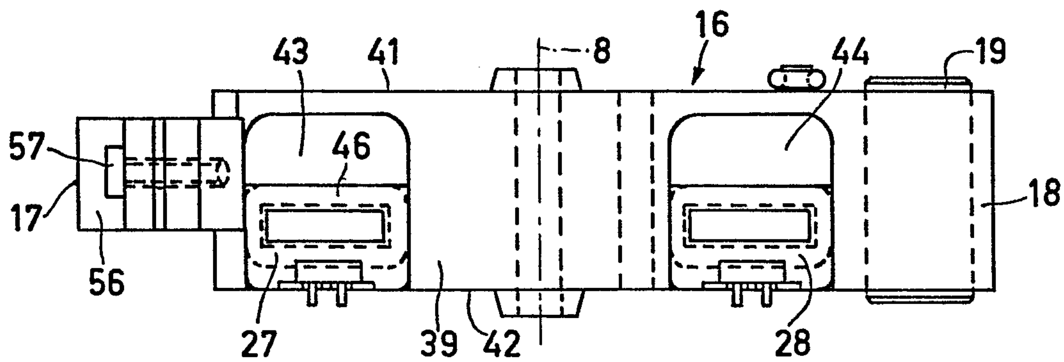

FIG.5

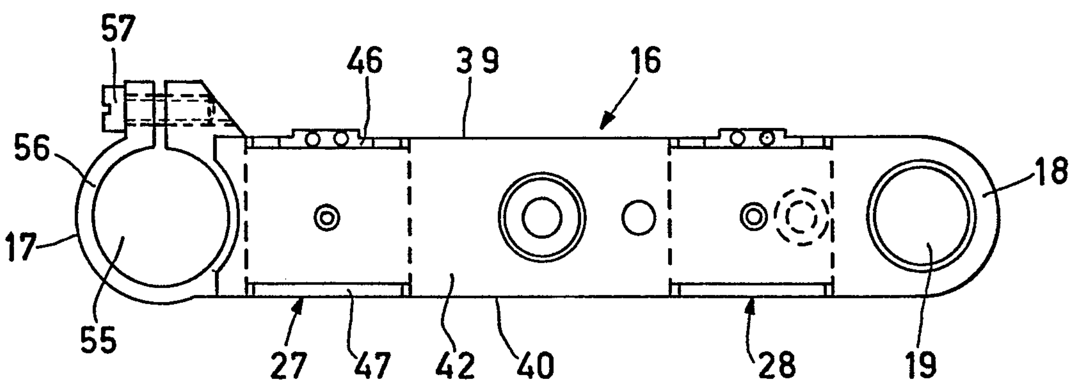

FIG.6

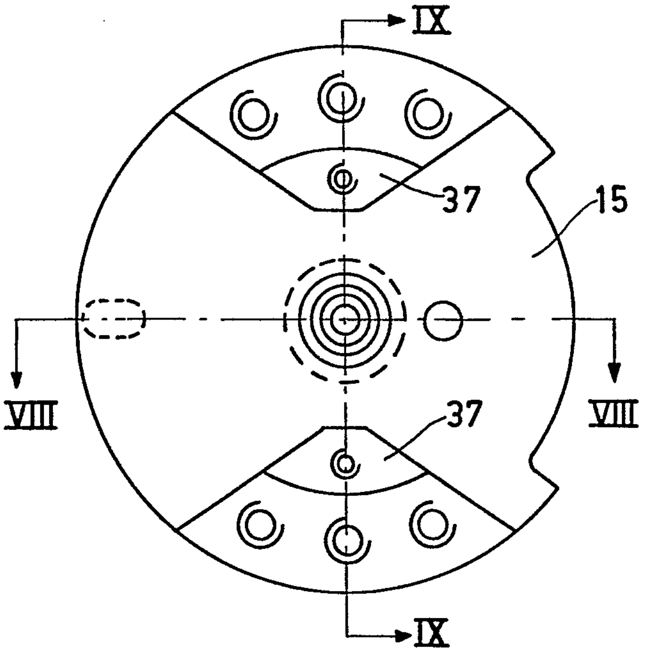

FIG.7

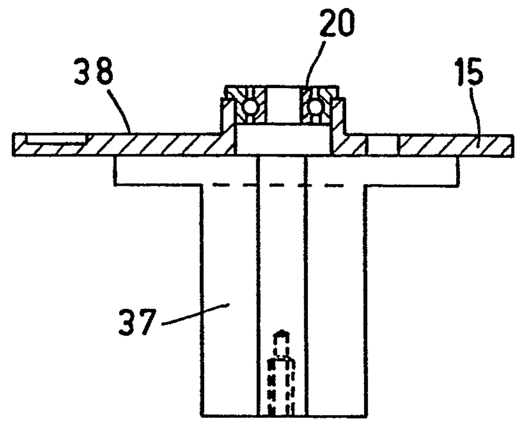

FIG.8

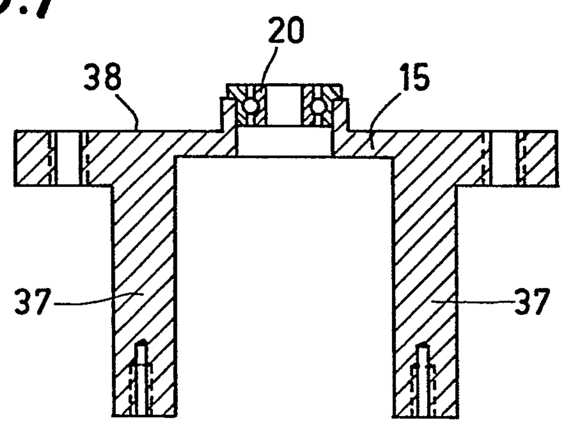

FIG.9

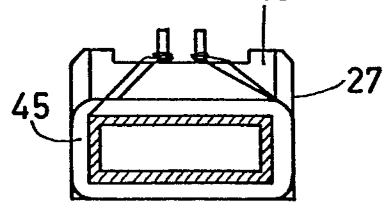

FIG.10

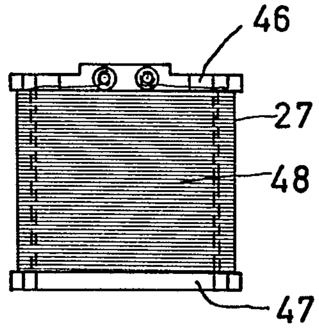

FIG.11

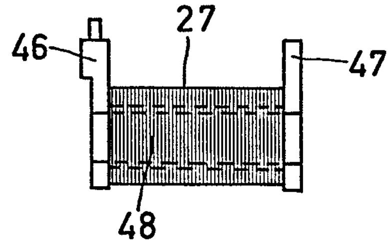

FIG.12

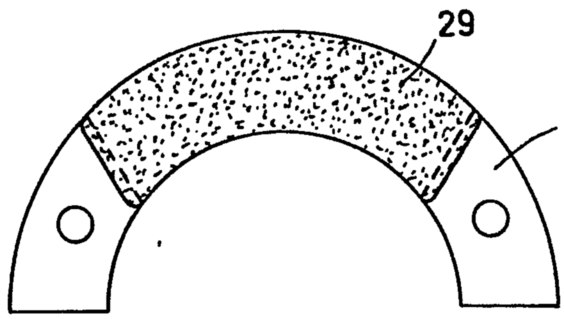

FIG.13

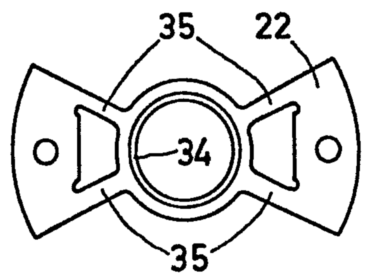

FIG.15

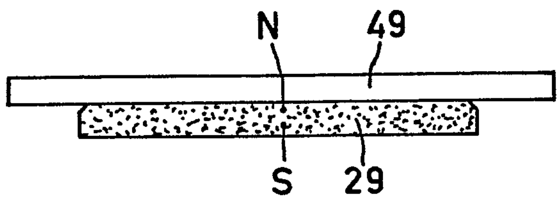

FIG.14

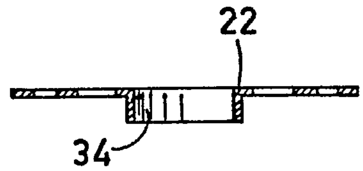

FIG.16

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DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
A	US-A-4 239 942 (PHILIPS) *Column 8, line 36 - column 9, line 21; figures 4,5*	1,3,6	G 11 B 7/08
A	US-A-4 150 407 (DIJKSTRA) *Column 1, lines 5-23; column 4, lines 62-66; column 5, line 64 - column 6, line 14,64-65*	1,3,4	
A	US-A-3 849 800 (CUZNER et al.) *Column 4, lines 40-45; figure 1*	1	
A	GB-A-1 036 561 (DAIEI PRESSCORDER) *Page 2, lines 78-123; page 3, lines 50-83; figures 1,2,3,10*	1	TECHNICAL FIELDS SEARCHED (Int. Cl. 3)
A	US-A-2 788 215 (TOHT) *Column 1, lines 15-27; column 2, lines 2-5,69 - column 3, line 24; column 4, lines 8-32; figures 1,2,3,4,5*	1	G 11 B
A	GB-A-2 049 259 (MICHELL ENGINEERING) *Page 1, lines 28-46; figure*	1	

-/-

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Place of search	Date of completion of the search	Examiner
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DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
A	PATENTS ABSTRACTS OF JAPAN, vol. 3, no. 156, 21st December 1979, page 148 E 161; & JP - A - 54 138 415 (NIPPON DENKI) (26-10-1979) *The whole document* ---	1,3	
A	IBM TECHNICAL DISCLOSURE BULLETIN, vol. 12, no. 12, May 1970, pages 2160-2161, New York (USA); R.C.TRESEDER: "Access mechanism with reset devices". *The whole document* ---	1,3	
A	PATENTS ABSTRACTS OF JAPAN, vol. 5, no. 26, 17th February 1981, page 8 P49; & JP - A - 55 150 163 (NIPPON DENKI)(21-11-1980) *The whole document* ---	1,3	TECHNICAL FIELDS SEARCHED (Int. Cl. 3)
A	US-A-3 983 317 (GLORIOSO) ---	1	
A	FR-A-2 238 210 (ROBERT BOSCH) & US - A - 4 004 081 -----	1	

The present search report has been drawn up for all claims

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