

Pivotal-arm device comprising an electro-magnetic drive.

The invention relates to a pivotal-arm device for recording and/or reading record tracks in an optical disc by means of a radiation beam, comprising a stationary frame, and optical scanning unit comprising a lens system which is  
5 movable along an optical axis, a pivotal arm which is supported in the frame to carry the optical scanning unit, an electro-magnetic drive unit for driving the pivotal arm so as to turn it in a plane transverse to said optical axis, which drive unit comprises a stator which is secured to the  
10 frame and an armature which co-operates with the stator via an air gap, which is pivotable about a pivotal axis and which is connected to the pivotal arm.

The invention also relates to an electro-magnetic drive unit suitable for use in a pivotal-arm device as defined above, comprising a stator and an armature which is  
15 pivotable about a pivotal axis and which cooperates with said stator via an air gap. Such a drive unit and a pivotal-arm device of the type defined above are disclosed in European Patent Application EP 0,074,131.

20 In the known pivotal-arm device the optical scanning unit can perform a limited pivotal movement over the information surface of an optical disc. The movement is effected about a pivotal axis which extends parallel to the axis of  
25 rotation of the optical disc. The optical disc may be a video disc, an audio disc or a data-storage disc.

Optical disc players provided with a pivotal-arm device generally comprise at least two automatic control devices, namely a focussing control device and a tracking control device. The focussing control device serves to ensure  
30 that a light beam emitted by a light source is automatically kept focussed as a light spot on the information surface

of the disc. The tracking device serves for automatically correcting deviations in the position of the light spot within the information plane and transverse to the direction of the information track. For this purpose the pivotal arm is included in an automatic control loop and is driven by the electromagnetic drive unit to correct tracking errors by means of pivotal movements of the pivotal arm.

In the known drive unit the stator comprises two permanent magnets having the shape of circular segments, which magnets are secured to an iron yoke and extend transversely of the pivotal axis of the armature. The armature comprises two cylindrical coils which are secured to the pivotal arm and which are movable through an axially oriented magnetic field in an air gap formed between the permanent magnets and a part of said yoke.

In a pivotal-arm device of the type defined in the foregoing it is important that the electromagnetic drive unit has a power and torque such that a detected deviation in the position of the light spot in the plane of the information surface of the optical disc can be corrected rapidly regardless of the instantaneous position of the pivotal arm relative to the disc. In the known drive unit this has resulted in comparatively large dimensions of the drive unit, in particular the diameter of the segment-shaped magnets, so that the drive unit occupies much space. For larger apparatuses this does not present a problem, but currently there is a trend to construct at least specific optical-disc players in such a way that they are compact and light-weight, enabling them to be used as portable or build-in apparatuses. Therefore, the known drive unit seems to be less suitable for use in apparatuses having such small dimensions.

Further, the known drive unit has the disadvantage that the magnets must be made of high-quality and therefore expensive materials, such as samarium-cobalt, in order to enable the required motor specifications to be met. This is mainly a consequence of the arrangement of the coils in the air gap between the magnets.

It is an object of the invention to provide a pivotal-arm device comprising an electro-magnetic drive unit which in addition to excellent motor properties has a small volume.

5 To this end the pivotal-arm device in accordance with the invention is characterized in that the stator comprises at least one pair of polepieces which are interconnected by a magnetisable stator member carrying at least one coil, and the armature comprises a cylindrical or part-  
10 cylindrical armature member which is arranged around the stator and which has a plurality of axially and circumferentially extending radially magnetised poles which are at least equal in number to the number of stator polepieces and which, viewed in the circumferential direction of said armature member, are juxtaposed and alternately have opposite  
15 polarities.

The pivotal-arm device in accordance with the invention thus has a drive unit which combines a high efficiency with a small volume when the stator is dimensioned  
20 correctly. Moreover, this drive unit has the advantage that the construction comprises a limited number of parts, which facilitates automated assembly of these parts.

The combination of the present steps with respect to the stator and the distinct pole separations in the armature enable the driving torque of the drive unit to remain  
25 substantially constant as a function of the pivoting angle over a comparatively large pivoting angle. Moreover, if care is taken that the magnetic resistance of the polepieces is equal to the magnetic resistance of the stator member interconnecting the polepieces, the amount of magnetic energy in  
30 the stator will, in principle, not change when the armature is pivoted, so that the armature can assume an arbitrary position when the drive unit is not energised. This means that the armature has no preferred positions, which has substantial advantages, in particular with respect to the  
35 control of the drive unit in the pivotal-arm device in accordance with the invention.

Since the coil or coils in the drive unit is or are arranged around the magnetisable stator member, a high efficiency can be achieved without the need to use high-quality magnetic material.

5           An electro-magnetic drive unit which is suitable for use in the pivotal-arm device in accordance with the invention and which comprises a stator and an armature which  
10       corporate with the stator via an air gap and which is pivotable about a pivotal axis is characterized in that the stator comprises at least one pair of polepieces which are inter-  
15       connected by a magnetisable stator member carrying at least one coil, and in that the armature comprises a cylindrical or part-cylindrical armature member which is arranged around the stator and which has a plurality of axially and  
20       circumferentially extending radially magnetised poles which are at least equal in number to the stator polepieces and which viewed in the circumferential direction of said armature member, are juxtaposed and alternately have opposite polarities, the armature member comprising a magnetisable  
25       ring and a permanent-magnetic annular magnet body which is arranged inside the ring and which is provided with said poles.

This drive unit has the advantage that it can be manufactured very simply.

25           The ring, which need not be closed entirely and which serves to return the magnetic flux, may be manufactured from soft-iron. It is important that the permanent-magnet body has a high degree of homogeneity and a radially oriented preferred magnetic direction. Therefore, the magnet material  
30       is preferably an anisotropic material such as a plasto-ferrite.

A suitable embodiment of the drive unit is characterized in that the pair of polepieces of the stator are diametrically opposed and together with said stator member constitute a double T-shaped stator element, the polepieces each  
35       having a cylindrically curved surface on the side facing the armature member.

Because of its special properties, the electromagnetic drive unit in accordance with the invention described above is also particularly suitable for use in constructions in which accurately defined rapidly reciprocating movements have to be performed, such as, for example, in a carburettor of an internal-combustion engine.

Embodiments of the invention will now be described in more detail, by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is a longitudinal sectional view of a first embodiment of the electromagnetic drive unit of the pivotal-arm device according to the invention,

Fig. 2 is a sectional view of this drive unit taken on the lines II-II in Fig. 1,

Fig. 3 is a plan view of a pivotal-arm device in accordance with the invention employing the drive unit shown in Fig. 1, and

Fig. 4 is a sectional plan view of a second embodiment of a drive unit suitable for the pivotal-arm device according to the invention.

The drive unit shown in Figs. 1 and 2 comprises a stator 2 and an armature 4 mounted coaxially around the stator 2. The stator 2 comprises a double T-shaped stator element 6 and two coils 8 electrically arranged in series. The stator element 6, which is of laminated construction, has two diametrically opposed polepieces 6A, and a stator member 6B interconnecting the polepieces 6A. In the stator member 6B a central opening 10 is formed for the passage of the spindle 4A of the armature 4. The coils 8 are wound around portions of the stator member 6B which are situated between the central opening 10 and the polepieces 6A. The stator 2 is secured to a frame plate 12A by means of an adhesive.

As already stated the armature 4 has a spindle 4A by means of which the armature 4 can pivot relative to the stator about a pivotal axis 5. For this purpose the armature spindle 4A has recesses 14 in its two ends, in each of which recesses a ball 16 engages with a moderately tight

fit. In the frame plate 12A opposite one of the ends of the armature spindle 4A a bearing race 18 with balls 20 is mounted and rotatably supports one of the balls 16. At the other end of the armature spindle 4A a similar bearing race 18 with  
 5 balls 20 is arranged. This bearing race 18 extends through a resilient member 22 which by means of screws 24 is secured with a specific pretension to a constructional member connected to the frame plate 12A (see also Fig. 3), so that the armature 4 is supported without play. When the armature 4  
 10 is mounted care must be taken that the pivotal axis 5 of the armature 4 coincides exactly with the central axis of the stator 2.

The armature 4 further comprises a cylindrical armature member 4B comprising a soft-iron ring 26 and an annular  
 15 permanent magnet 28 of an anisotropic material, for example a plastroferrite, which is glued inside said ring. The magnet 28, which is radially magnetised, has two poles 28A and 28B of opposite polarity. In Fig. 2 the direction of magnetisation of the poles 28A and 28B, which each cover  $180^\circ$  in  
 20 a circumferential direction, is indicated by arrows. The stator 2 and the armature 4 are positioned in such a way relative to each other that in the central position of the armature 4 the bounding surfaces 30 between the poles 28A and 28B are situated in a plane which coincides with the  
 25 plane of symmetry of the stator 2 which extends through the polepieces 6A perpendicularly to the cross-sectional view of Fig. 2.

Between the polepieces 6A of the stator 2, which have cylindrically curved surfaces at their sides facing  
 30 the magnet 28, and the poles 28A and 28B of the armature 4 an air gap 32 is formed in which a radially directed magnetic field exists.

By suitably dimensioning the electromagnetic drive unit 1, in particular the stator member 6, preferred positions of the armature 4 can be avoided, so that in principle  
 35 the armature can assume any arbitrary position when the coils 8 are not energised. When the coils are energised the

armature 4 will perform a pivotal movement about the pivotal axis 5, in a direction which obviously depends on the direction of the current in the coils. In the present embodiment the armature 4 can pivot clockwise and anticlockwise through an angle of  $37^{\circ}$  out of its central position without the driving torque changing significantly during this movement.

The drive unit described here is suitable for use in equipment of various types in which limited rotational or reciprocating movements have to be performed. An example of such an apparatus in which the drive unit described here can be used with advantage is an optical-disc player, namely an optical-disc player equipped with a pivotal-arm device for optically reading and recording record tracks in an optical disc.

Such a pivotal-arm device in accordance with the invention is shown in plan view in Fig. 3. This pivotal-arm device is intended in particular for use in an optical audio-disc player by means of which an optical audio disc (compact disc) having a diameter of approximately 120 mm can be read. The pivotal-arm device comprises a frame 12 in which a spindle 40 with a supporting surface 42 for the optical disc is journaled. The spindle 40 is driven about an axis of rotation 41 by means of an electric motor which, like the optical disc, is not shown. The optical disc is read in reflection by means of an optical scanning unit 44 comprising a lens system 48 which is movable along an optical axis 46. The optical scanning unit 44 is mounted in a pivotal arm 50 of the pivotal-arm device. The scanning unit 44 may comprise a semiconductor laser as a light source and optical and optoelectronic means necessary for reading and processing the optical information read from the disc. Since the nature and construction of the optical scanning unit 44 are irrelevant for a correct understanding of the invention, they will not be described in more detail.

The pivotal arm 50 has a first end 50A with securing means for the optical scanning unit and a second end

50B carrying a counter-weight 52. For radially moving the scanning unit 44 relative to the optical disc the pivotal arm 50 is secured to the electromagnetic drive unit described in the foregoing and is thus pivotable about the pivotal axis 5 of the armature 4. The drive unit itself is secured to the frame 12 by its frame plate 12A. This may be effected by means of an adhesive or by screwthreaded means. However, it is alternatively possible to manufacture the frame plate 12A and the frame 12 integrally, for example by injection-moulding, so that a further reduction of the number of parts and a reduction of the assembly time can be obtained. For the sake of completeness it is to be noted that the axis of rotation 41 of the spindle 40, the pivotal axis 5 of the pivotal arm 50 and the optical axis 46 of the lens system 48 extend parallel to one another.

Fig. 4 is a sectional view of another drive unit. As, in principle, the construction of this drive unit is identical to the drive unit described in the foregoing, it is represented only schematically. The drive unit comprises a stator 102 comprising two stator-element portions 103A and 103B which extend transversely of each other and which are interconnected. Each of portions 103A and 103B carries a pole-piece 106A and 106B respectively and a coil 108A and 108B respectively. The stator 102 further has an opening 110 for the passage of an armature spindle 104A. The armature spindle 104A forms part of an armature 104 of the drive unit. The armature 104 is of part-cylindrical form and is mounted coaxially around the stator 102. When the coils 108A and 108B are energised the armature 104 can perform pivotal movements about a pivotal axis 105. For this purpose the armature 104 comprises a part-cylindrical magnet 128 which is spaced at a small distance from the polepieces 106A and 106B and which is magnetised radially in such a way that at the side of the magnet 128 which faces the polepieces three poles 128A, 128B and 128C are formed. In the drawing the directions of magnetisation of the poles 128A, 128B and 128C are indicated by arrows. In order to close the magnetic circuit when the

coils 108A and 108B are energized the armature 104 further comprises a soft-iron member 126 of part-cylindrical form, against whose inner side the magnet 128 is arranged. As a result of the asymmetrical shape of the stator 102, as is shown in Fig. 4, a part-cylindrical section can be removed from the magnet 128 and the soft-iron member 126 without the operation of the actuating unit being affected significantly. The armature 104 can be secured to a pivotal arm 150 of a pivotal-arm device, not shown. The dimensions of the polepieces 106A and 106B and of the magnet 128 as shown in Fig. 4 in principle enable a pivotal movement of the armature 105 through an angle of approximately  $90^\circ$  to be obtained. As a result of its asymmetrical construction the present embodiment is particularly suitable for use in cases where only a limited space for the drive unit is available.

It is obvious that apart from the embodiments of the drive unit of the pivotal-arm device in accordance with the invention described herein, many other constructions are possible within the scope of the appended claims. For example, it is possible to provide the electromagnetic drive unit in accordance with the invention with two pairs of polepieces in combination with four poles. Such a construction is particularly suitable where a drive unit is required which has a large driving torque but in which the armature need only be pivotable through a comparatively small pivoting angle.

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## Claims

## Claim(s)

1. A pivotal-arm device for recording and/or reading record tracks in an optical disc by means of a radiation beam, comprising a stationary frame, an optical scanning unit  
5 comprising a lens system which is movable along an optical axis, a pivotal arm which is supported in the frame to carry the optical scanning unit, and an electro-magnetic drive unit for driving the pivotal arm so as to turn it in a plane transverse to said optical axis, which drive unit comprises a stator which is  
10 secured to the frame and an armature which co-operates with the stator via an air gap and which is pivotable about a pivotal axis and is connected to the pivotal arm, characterized in that the stator comprises at least one pair of polepieces which are interconnected by a magnetisable stator member carrying at least  
15 one coil, and the armature comprises a cylindrical or part-cylindrical armature member which is arranged around the stator and which has a plurality of axially and circumferentially extending radially magnetised poles which are at least equal in number to the stator polepieces and which, viewed in the  
20 circumferential direction of said armature member, are juxtaposed and alternately have opposite polarities.

2. An electro-magnetic drive unit which is suitable for use in a pivotal-arm device as claimed in Claim 1 and which comprises a stator and an armature which co-operates with the  
25 stator via an air gap, characterized in that the stator comprises at least one pair of polepieces which are interconnected by a magnetisable stator member carrying at least one coil, and in that the armature comprises a cylindrical or part-cylindrical armature member which is arranged around the stator and which has  
30 a plurality of axially and circumferentially extending radially magnetised poles which are at least equal in number to the stator polepieces and which, viewed in the circumferential direction of said armature member, are juxtaposed and alternately have opposite polarities, the armature member comprising a  
35 magnetisable ring and a permanent-magnetic annular magnet body.

which is arranged inside the ring and which is provided with said poles.

5        3.    A drive unit as claimed in Claim 2, characterized in that the pair of polepieces of the stator are diametrically opposed and together with said stator member constitute a double T-shaped stator element, the polepieces each having a cylindrically curved surface on the side facing the armature member.

10       4.    A pivotal-arm device substantially as herein described with reference to Figure 3 and Figures 1 and 2 or Figure 4 of the accompanying drawings.

      5.    An electro-magnetic drive unit substantially as herein described with reference to Figures 1 and 2 or Figure 4 of the accompanying drawings.

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