The invention relates to an integrated driving system having the features set out in the preamble to Claim 1 and to a method of producing such a driving system having the features set out in the preamble to Claim 18.

In devices of this type, the information carriers themselves and also the recording and pick-up sensors (read-out heads) themselves must be moved most precisely and therefore very accurately. For example, in magnetic pulse-recording devices, the drive shafts for magnetic discs must be adjusted in respect of one another with extreme accuracy, due to the high density of the information recorded in the storage medium. For the parallelism of shafts and the angularity of disc-supporting planes, values in the order of microns are required. Particularly, the main drive shafts of magnetic pulse-recording devices must satisfy the most exacting demands with regard to the concentricity of the shafts in their bearing system, and errors caused by wobbling of the shafts must not exceed for instance 5/10,000 mm.

EP-069 545 discloses a moving head storage device with a device chassis comprising a bearing bore for supporting the motor for driving the recording carrier and another bearing bore for supporting the motor for driving the recording head. The bearing bores and motor fixing parts are produced in one piece with the device chassis.

Certainly, this chassis cannot be produced in one single chucking process with the necessary precision, since a tool-steel introduced on one side of the bearing bores, by reason of the length of the bearing bores, yields upon rotation of the bearing seats which are remote from the introduction side so that the concentricity and parallelism of the bearing seats of the two bearing bores cannot be guaranteed.

The result of this is that the known device chassis, in order to comply at least adequately with the high demands of precision in terms of dimensional stability of the bearing bores and bearing seats, has to be machined from both sides which means a re-chucking of the workpiece.

This does however necessarily entail increased production work and thus a concomitant cost factor, along with a reduction in accuracy, even though this is minor compared with the error which a yielding of the tool would produce.

In contrast, the invention can be used for producing large quantities of fixed disc devices of the type mentioned at the outset at a favourable cost and with minimal tolerances.

In the case of fixed-disc memories of the above-mentioned type, this problem is resolved by the features set out in the characterising part of Claim 1 or in the case of a production method according to Claim 18, by the features set out in the characterising part of Claim 18.

The device chassis and the fixing part for the motor, particularly the motor flange, are in preferred manner cast from metal or are injection moulded, cast or compression moulded, from synthetic plastics material.

Therefore, in the case of the integrated driving system according to the invention, the device chassis and the motor flange consist of one part so that they can be machined jointly. If more than one motor is required for the driving system, then the motor flanges of all the motors are likewise constructed in one piece with the device chassis.

During secondary machining of the bores for all the mounting shafts and spindles which are cast into the device chassis, the chassis need not be re-chucked which makes it possible to position the individual bores precisely in respect of one another and results in a reduction in costs.

By virtue of the integration of the motor flanges into the device chassis, machining tolerances are possible which are smaller than the sum of the tolerances of the individual workpieces or parts. Also by virtue of this smaller "sum tolerance" which can be substantially more easily maintained with the integrated driving system, costs can be cut, i.e. it is possible to achieve a favourable ratio of expense to performance.

Likewise, it is possible with the integrated driving system according to the invention also to set a head-actuating shaft exactly parallel with a disc axis or to define the voice coil guiding edges in a disc memory apparatus precisely and inexpensively generally at right-angles to the disc axis, in that they are set directly into the chassis during the above-mentioned common machining, being preferably machined directly by milling.

A further development of the invention resides in that by virtue of the configuration of and choice of material for the device chassis on the one hand and for the parts mounted thereon on the other hand, it becomes possible to compensate for temperature fluctuations, in other words the heat expansion of the individual component parts. In this way, it is possible to provide an integrated driving system for fixed-disc memories which for practical purposes cannot be affected by fluctuations in the ambient temperature.

Therefore, the device chassis is the carrier for all active and passive driving parts, for additionally required

auxiliary parts and possibly also for control electronics.

The device chassis may consist of metal or synthetic plastics material. The preferred metal is aluminium. It has been found that particularly in the case of a device chassis which consists of aluminium, the influence of temperature can cause a variation in bearing surfaces, which may become manifest in a so-called "tilting" of the axis of rotation of a motor relative to a plane bearing surface for discs, in other words a variation of the perpendicularity between the axis of rotation of a disc stacking hub and the bearing surface of the hard discs on this hub. The effects of temperature can be caused by significant changes in the ambient temperature or may have their cause within the device and particularly in the interior of a bearing if for example the outer bearing race has a heat expansion coefficient which differs substantially from that of the material of the device chassis (e.g. aluminium). In order then to be able to eliminate such negative temperature effects and particularly in order to guarantee that the supporting surface for the stack of discs shows at its edge a difference of not more than 5 microns (related to a hub diameter of 40 mm) with respect to the plane extending through the centre of the bearing surface and being exactly at right-angles to the axis of rotation, even under temperature fluctuations of 60°C, a particularly advantageous embodiment of the invention provides for the motor to be mounted on the fixing part, preferably by means of adhesion, via a sleeve preferably consisting of steel and connected to the bearing surfaces.

The film of adhesive consists of a highly viscous anaerobic liquid and is 2 to 30 microns and preferably 2 to 20 microns thick, i.e. the film of adhesive is as thin as possible.

It is of vital importance that the film of adhesive be disposed within a very accurate cylinder bore, in other words the bearing surface of the fixing part which is constructed in one piece with the device chassis, since only then can it be formed to be sufficiently thin. A greater thickness of the adhesive film would cause the position of the disc stack in the device to be other than stable or sufficiently precise.

In order to lengthen the surface area for the adhesive film, the motor may be at least partially accommodated in a trough provided in the device chassis. In this way it is nevertheless possible to guarantee a low overall height.

In order to keep the overall or structural height as low as possible, the output of the motor can be boosted in that a synthetic plastics bonded SmCo magnet is used as the motor magnet, the signal magnet disposed axially underneath possibly being a synthetic plastics bonded ferrite ring. However, it is not possible in the case of synthetic plastics bonded rare earth magnets (such as SmCo) to make axially long rings. It is therefore better to stack short rings as desired. The rings have to be magnetised prior to assembly, regardless of their position, if one is to avoid magnetisation when they are installed. Such pre-magnetisation requires the rings to be precisely positioned in respect of one another and in terms of their circumference so that their polarities do not constitute a reciprocal interference. For this purpose, axial grooves and keys are provided in one position on their circumference. Such an axial groove or key can - if pre-magnetisation is to be avoided - also be provided on the underlying magnet ring, since of course this, too, must be disposed in a correct peripheral position for rotor magnetisation.

The fixing part may have bearing and/or guiding surfaces for various motors. Similarly, motors for three and six discs for instance can be accommodated in sleeves.

The invention will be described in greater detail hereinafter with reference to the accompanying drawings in which:

Figs 1A and 1B a plan (Fig. 1A) and section (Fig. 1B) of an embodiment of a fixed disc memory with a motor and two guide slots for the voice coil motors;

Fig. 2 a further embodiment of the invention with a disc memory motor with a suspended outside rotor bell and a voice coil motor, and

Figs 3 and 4, and 5 and 6 embodiments of the invention with a steel sleeve adhesively bonded to guiding surfaces.

Fig. 1 shows in plan view (Fig. 1A) and section (Fig. 1B) an integrated driving system for fixed-disc memories. A device chassis 401 comprises, projecting at right-angles from it, a mounting guide lug 402 with a mounting bore 403. Dash-dotted lines indicate the outside dimensions of a fixed-disc memory device 410. A so-called hub (core) 411 supports memory discs 412. Scanning heads 413 which are likewise illustrated by dash-dotted lines are propelled by voice motors, not shown, which are guided in a slot 404 or a in a plurality of slots 405, 406 on lateral surfaces 407, 408. The slots 404, 405, 406 are machined together with the mounting bore 403 in one single chucking step and thus they retain a precisely defined position in respect of one another. The slot 404 (shown by broken lines) constitutes an alternative to the two slots 405, 406.

The slots 405, 406 extend at predetermined spacing parallel with each other and in concentric relation with regard to the mounting bore 403 when viewing the plane according to Fig. 1A, while in the alternative example with only one guide slot 404 (broken lines), this latter slot extends substantially in the direction of the mounting bore axis.

The device chassis 1 and 401 is therefore the carrier for all active and passive driving parts and additionally required auxiliary parts and can if necessary also accommodate control electronics (not shown).

Fig. 2 shows a further embodiment of the invention for a hard-disc memory with a voice control motor 768 and a disc motor 766. With these motors, two shafts 776 of for example 5 mm diameter are mounted so that their axes 772 extend precisely parallel with each other. For this, two bearings 770 which consist of identical ball-bearings 778 are mounted on corresponding mounting surfaces on the housing chassis 1. The motor 766 has a stator 780 while the motor 768 has a stator 784. Both stators 780 and 784 are mounted on one circuit board 782 which in addition serves to accommodate Hall elements for example. One stator is fixed on the circuit board 782 while the other, to compensate for tolerances, is movably fixed on it with minimal clearance. A metallic screening ring 786 is provided around each of the stators 780 and 784 between the ring and the housing chassis 1.

The circuit board 782 is preferably attached in separable manner to the housing chassis 1. The position of the stator 784 of the voice coil motor 768 can for example be adjusted in the bearing by means of a pin (not shown), while the rotor of the disc motor 766 can be screwed into its position with a conductive adhesive.

In the example of embodiment shown in Fig. 2, there is once again illustrated a chassis board which extends substantially in one plane in which two cylindrical bosses are integrally cast. Also in the case of this hard disc memory, what is important is to cause the discs disposed about the so-called hub motor 766 to rotate in a highly accurate position which is constant over the effective life, while the left-hand voice coil motor 768 has to control or perform a precise movement radially in relation to the axis of the motor 766 since a high track density on the memory discs rotating about the axis of the motor 766 requires a very precise radial positioning of the scanning heads (as indicated, controlled and moved by the motor 768). Hollow cylindrical parts 791 and 792 which are like bearing pipes are machined integrally with the chassis plate 1 and (both bearings) in one stage. Thus, the shafts 776 or spindles 772 are positioned as accurately as possible in respect of one another. This is the main condition. This purpose is naturally served by the rotors being perfectly mounted and weighted, without generating any vibration, as they rotate about these axes. The stators are so to speak associated with these respective axes in that they are mounted with sufficient accuracy that the prescribed air gaps between stators and rotors are maintained. The stator of the motor 766 is fitted relatively precisely on the mounting pipe projection 792 (in that for example an outer seating face 793 is also provided during the same working stage). The accuracy of the stator of the hub motor must therefore be relatively great.

The inner stator of the outer rotor hub motor 766 can however be mounted on the bearing pipe seat 793 relatively accurately and conveniently.

Axially compactly under the chassis plate 1 is the hub motor which has a diameter/length ratio of 5-10:1, i.e. the air gap diameter is five to ten times the axial length of the air gap or ring magnet. Substantially at the same axial height the voice coil motor is disposed in the very shallow chassis 1 with the edge 712 which engages over the axial length of the driving motors with a safety margin 715. Above the plate, is the so-called hub or disc hub 713 of the motor 766 . It will be understood that the outer rotor motor for this hub 713 may also be an inner rotor or so-called in-hub motor in which a rotating or even a so-called stationary shaft carries a motor disposed in the interior of the hub. The problems which arise in connection with the bearing seat accuracy are the same in that case. The keen tolerance requirements also prevail with a so-called in-hub motor and the in-hub motor can for practical purposes only be constructed as an outer rotor, but it can be provided with a rotating or a fixed shaft. In the case of a fixed shaft, this is itself fixed with the necessary precision in a bore in the chassis plate 1. This solution is preferred on account of the extreme radial limitation (for the outer hub diameter, a standardised diameter of for instance 40 or even 25.4 mm is prescribed. This solution with the fixed shaft constitutes a more advantageous construction with regard to motor output, in combination with space utilisation.

In any case, then, this fixed and non-rotating (or even rotating) shaft must be positioned with corresponding precision in the plate or in relation to the plate support. The hub motor has a steel yoke 714 which as a ferro-magnetic component is disposed on the outer rotor prior to balancing and induces into an oppositely disposed magnetic field sensitive sensor one pulse for every rotation. A permanent magnet ring 716 is adhesively secured in an outer rotor bell 717, and may even take the

form of half or quarter shells and it may be screwed or adhesively secured to the shaft 776 via an intermediate flange part 718. By using conductive adhesive or current-conducting ferro-fluids at the location 719 (magnetic seal 720 between the shaft 776 and the chassis 1), the mounting system is on the one hand sealed in respect of the space containing the hub 713 which is subject to an extremely precise cleansing requirement and on the other it is at the same time earthed, i.e. it is necessary to establish a certain conductive connection between the rotor or the hub and the chassis plate. If necessary, this can also be resolved in the mounting area by a metal spring spirally surrounding the shaft 716 and sliding on it.

The magnetic seal 720 is so axially inter- engagingly provided in the interior of the hub 713 that it lies in a small axial raised portion of the plate 1 so that no additional structural height is required.

Figs. 3 and 4, or 5 and 6 show two further embodiments of the invention for a hub motor as shown in Fig. 2 but in which a steel sleeve 802 is connected to a mounting surface 801 of the aluminium housing chassis 1 via a 2 to 20 microns thick film of adhesive consisting of a highly viscous anaerobically hardening adhesive fluid. In the steel sleeve 802 are ball-bearings 803 which are clamped by means of a spring 804.

The difference between the embodiments shown in Figs. 3, 4 and 5, 6 is that three or alternatively six discs can be accommodated, whereby the same motor is used and also the electronics including a signal magnet 805 can be retained at the bottom edge of the outer rotor bell 806.

In order to enlarge the adhesive seat area, both embodiments have the motor disposed in a trough 807 in the

device chassis 1. Similarly, in the case of both embodiments, circuit boards 808 fixed by snap-action fixing means 809 are identical in plan view and in section but are shown in the drawings as rotated through 90°, with connecting conductors 810 and magnets 811. Where the embodiment according to Fig. 5, 6 is concerned, there is in addition a non-magnetic spacer ring 813 between the magnets 805 and 812, and on the right in Fig. 5 the (left-hand) magnet ring 811 is replaced by two axially halved motor magnet rings 811, 812.

By reason of the joint machining of the mounting bores, the reference surfaces and possibly the slots, extreme accuracy is very easily achieved while at the same time the construction of the driving system is simplified since the device chassis and for instance the motor flanges are constructed in one piece.

The trough 807, i.e. the depression, additionally enhances the rigidity of the chassis plate 1. Furthermore, the length of the adhesive seat is axially extended (surface 801). At the upper edge of the steel sleeve 802 is a so-called magnetic seal which, in known manner, works with a magneto-liquid fluid. The shaft 816 fits with constantly high accuracy in the hub 817. The cylindrical outer surface 818 of the hub 817 must be exactly coaxial with the axis 819. Formed into the shaft 816 are ball races 820 for the balls 821 of the bearings. The shaft 816 acts like an inner race for the bearings. This solution is known per se. At its bottom end, the shaft 819 comprises a rounded portion 823 which in the centre (as far as possible also in the axis 819) runs against a synthetic plastics block 824 in the manner of a one-point bearing. The electrostatic charge of the rotor is dispersed via this one-point bearing surface, passing to a resilient cap 815 which is supported in the steel sleeve 802. By reason of

the depression (trough 807), the adhesive seat surface 801 is extended at least to half the axial length of the steel sleeve without the hub 806 projecting any higher above the chassis plate 1. In the case of Fig. 10, the additional adhesive seat length is obtained by virtue of the taller hub (for several discs), in that the bearing pipe-like integrally moulded sleeve 825 is integrated into the construction in the interior of the hub in such a way as to extend upwardly.

Patent claims

1. An integrated driving system for fixed-disc memories with
   - at least one recording carrier (412) and at least one write/read head (413) adapted for movement in respect of the recording carrier (412), with
   - a device chassis (401),
   - a motor (766) imparting rotation to the recording carrier (412) and housed in the device chassis (1, 401) via bearings (403, 792),
   - a voice-coil motor (768) imparting movement to the write/read head (413) and supported by the device chassis (1, 401) via bearings and/or mounting surfaces (404 ... 408, 791), whereby
   - the device chassis (401) is constructed in one piece with the bearings (403 ... 408) for the motors (766, 768) as one component, characterised in that
   - the bearing (403) of the motor (766) imparting rotation to the recording carrier (412) and the bearings and/or mounting surfaces (404... 408, 791) of the voice-coil motor (768) imparting movement to the write/read head (413) in the device chassis (1, 401) are produced in one working stage and maintain a precisely determined geometric relationship to one another with a high degree of precision,
   - whereby the voice-coil motor (768) imparting movement to the write/read head (413) is supported in at least one bearing bore (791) of constant diameter or on mounting surfaces (407, 408) of the surface on the device chassis (1, 401), and
   - the motor (766) with a fixed shaft, imparting rotation to the recording carrier (412) is

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mounted in a bearing bore (792) of constant diameter or on a mounting surface in the device chassis (1, 401), or

- the motor (766) with a rotating shaft, imparting rotation to the recording carrier (412) is mounted in the device chassis (1, 401) in a bearing bore (792) of constant diameter.

2. An integrated driving system for fixed disc memories, according to claim 1, characterised in that the shaft of the motor (766) imparting rotation to the recording carrier (412) and the bearing bore of the voice-coil motor (768) imparting movement to the write/read head (413) extend parallel with each other.

3. An integrated driving system for fixed disc memories according to claim 1, characterised in that the shaft of the motor (766) imparting rotation to the recording carrier (412) and the mounting surface of the voice-coil motor (768) imparting movement to the write/read head (413) extend at right-angles to each other.

4. An integrated driving system for fixed disc memories according to one or more of claims 1 to 3, characterised in that the connection between the shaft of the motor (766) imparting rotation to the recording carrier (412) and the bearing bore (792) thereof and/or the connection between the mounting surface of the voice-coil motor (768) imparting movement to the write/read head and the voice-coil motor (768) are formed by adhesion.

5. An integrated driving system for fixed disc memories according to claim 4, characterised in that the connection is by a film of adhesive 2 μm to 30 μm and

preferably 2 µm to 20 µm thick.

6. An integrated driving system for fixed disc memories according to claim 4, characterised in that the film of adhesive is formed by a highly viscous anaerobic liquid adhesive.

7. An integrated driving system for fixed disc memories according to one or more of claims 1 to 6, characterised in that the motor imparting rotation to the recording carrier is mounted on the chassis by a sleeve connected to the bearing bore.

8. An integrated driving system for fixed disc memories according to claims 4 and 7, characterised in that the sleeve is glued to the bearing bore.

9. An integrated driving system for fixed disc memories according to one or more of claims 1 to 8, characterised in that the motor (766) imparting rotation to the recording carrier (412) is at least partially disposed in a preferably outwardly protruding trough-like depression provided in the device chassis.

10. An integrated driving system for fixed disc memories according to one or more of claims 1 to 9, characterised in that the external rotor of the motor (806) imparting rotation to the recording carrier (412) is enclosed by the hub of the recording carrier.

11. An integrated driving system for fixed disc memories according to one or more of claims 1 to 10, characterised in that a shaft (816) of the motor imparting rotation to the recording carrier (412) comprises grooves (820) for bearing balls (821).

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12. An integrated driving system for fixed disc memories according to claim 11, characterised in that external races for two bearings (803) are accommodated in one sleeve, the sleeves being inserted into the bearing bore (791, 792).

13. An integrated driving system for fixed disc memories according to one or more of claims 1 to 12, characterised in that the device chassis (401) has projecting at right-angles therefrom bearing guide journals (402) with a bearing bore (403).

14. An integrated driving system for fixed disc memories according to one or more of claims 1 to 12, characterised in that bearing tube-like hollow cylindrical parts (791, 792) are provided in one piece in the chassis plate (1).

15. An integrated driving system for fixed disc memories according to one or more of claims 1 to 13, characterised in that a bearing tube-like stalk (825) projects into the interior of the hub.

16. An integrated driving system for fixed disc memories according to one or more of the preceding claims, characterised in that the interior stator of the external rotor motor (766) is mounted on a bearing tube seat (793).

17. An integrated driving system for fixed disc memories according to one or more of the preceding claims, characterised in that the chassis (1) has an edge (712) which engages with a safety margin over the axial position of the driving motors.

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18. A method of producing an integrated driving system for fixed disc memories with

- at least one recording carrier (412) and at least one write/read head (413) adapted for movement in respect of the recording carrier (412) with
- a device chassis (401)

- a motor (766) imparting rotation to the recording carrier (412) and housed in the device chassis (1, 401) via a bearing (403, 792),
- a voice-coil motor (768) imparting movement to the write/read head (413) and which is supported by the device chassis (1, 401) via bearing surfaces and/or mounting surfaces (404 ... 408, 791), whereby
- the device chassis (401) is constructed in one piece with the bearing surfaces and/or the mounting surfaces (404 ... 408) for the motors (766, 768) as one component, characterised in that
- the bearing bore (403) of the motor (766) imparting rotation to the recording carrier (412) and the bearing surfaces and/or the mounting surfaces (404 ... 408, 791) of the voice-coil motor (768) imparting movement to the write/read head and mounted in the device chassis (1, 401) are produced in one working stage and maintain an exactly predetermined geometrical relationship to one another with a high degree of precision, whereby the voice-coil motor (768) imparting movement to the write/read head (413) is supported at least in a bearing bore (791) of constant diameter or on mounting surfaces (407, 408) of the surface of the device chassis (1, 401) and the motor (766) with a fixed shaft, imparting rotation to the recording carrier

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(412), is mounted in the device chassis (1, 401) in a bearing bore (792) of constant diameter or on a mounting surface, or the motor (766) with a rotating shaft, imparting rotation to the recording carrier (412), is mounted in the device chassis (1, 401) in a bearing bore (792) of constant diameter.

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