

The present invention concerns a magnetic recording/reading technique, and more particularly a planetary head, that is, a magnetic head in which the magnetic poles are situated in the same plane. Such a magnetic head is of particular interest in techniques of recording/reading on magnetic tapes. The invention also concerns a process for producing such a magnetic head.

It is known that planetary magnetic heads can be made in the form represented in Figure 1. Two such examples are given in EP-A-0.185.406 and JP-A-59.8115.

These heads have a magnetic circuit M comprising a plane face P. The magnetic poles of the recording head and the air gap E separating them are situated in this plane P. The recording medium such as a magnetic tape is placed in the vicinity of the magnetic poles and the air gap E, parallel to the plane P. An induction coil for a magnetic field, supplied with current by connections 70 and 71, surrounds one leg of the magnetic circuit M. As can be seen from Figure 1, such a head comprises a narrowed portion in the area of the air gap E. This narrowed portion is fragile and difficult to produce.

The invention concerns a head of this type which is less fragile and easier to produce.

Furthermore, in known planetary heads, the size of the gap (0.2 micrometres in thickness by one micrometre in height) makes it necessary to produce non-plane accretions of material as described, for example, in French patent application FR-A-2.605.783 filed on 28 October 1986. Thus, as shown in Figure 2, a magnetic pole P1 is produced on a substrate S with a layer of a non-magnetic material E disposed on one side wall of the pole P1. Another layer of magnetic material (P2) is deposited on the whole. Then the upper face of the head is machined to obtain a planetary magnetic head as represented in Figure 3 with the magnetic poles P1 and P2 separated by a gap E.

As can be seen in Figure 2, the layer of magnetic material constituting the magnetic pole P2 must take on the form of the gap E, which interferes with magnetic properties at the edge of the gap E. The definition of the gap and of the discontinuity which it generates in the magnetic field are therefore impaired, this being in an area extending at a distance equal to a few multiples of the height of the gap measured from the gap.

It is however of fundamental importance to produce thin layers of 2 to 3 micrometers thickness for planetary magnetic heads. According to this technique, the magnetic pole P2 is therefore dependent on the height of the gap.

According to one embodiment, the invention provides a solution to this difficulty.

The invention therefore concerns a magnetic head comprising a magnetic circuit of solid form, having a surface parallel to the recording face of the head, characterised in it also comprises:

- a non-magnetic element cutting off the magnetic circuit and flush with said surface;
- two planar layers of a magnetic material forming the magnetic poles of the head, deposited on said surface defined by the non-magnetic element and the magnetic circuit, at least partly covering the magnetic material situated on both sides of the non-magnetic element, thus completing the magnetic circuit of the head and being separated by an air gap situated in the area of the non-magnetic material.

The invention also concerns a magnetic head characterised in that the magnetic circuit comprises two U-shaped parts bonded to each other by the extremities, one of the extremities of at least one of these two parts comprising a part made of non-magnetic material flush with said plane surface, the two layers of magnetic material being produced on said plane face with the air gap situated in the area of the part made of non-magnetic material.

Finally, the invention concerns a process for producing a magnetic head characterised in that it comprises the following stages:

- a first stage of producing a part made of magnetic material comprising at least one plane face and, incorporated in this part, an element made of non-magnetic material flush with the plane face on a predetermined surface;
- a second stage of producing an opening in the part made of magnetic material, extending as far as the element made of non-magnetic material such that this element constitutes a break in the magnetic circuit constituted by said part;
- a third stage of producing magnetic poles situated on the plane face extending relative to the longitudinal axis of the head so as to cover the magnetic material situated on either side of the non-magnetic element and having two edges separated by an air gap situated on said predetermined surface occupied by the element made of non-magnetic material, these magnetic poles being produced using a thin layer of magnetic material;
- a fourth stage of producing at least one magnetic induction coil passing through the opening and surrounding the magnetic circuit of the part made of magnetic material.

The various aims and characteristics of the invention will become more clearly apparent with the aid of the following description, made with reference to the attached figures which represent:

- Figure 1, a planar magnetic head known in the art and described previously;
- Figures 2 and 3, an embodiment of magnetic poles separated by a gap for a planar magnetic head, as known in the art and described previously;
- Figure 4, a perspective view of an embodiment of a magnetic head according to the invention;
- Figure 5, a front view of the magnetic head of Figure 1;
- Figure 6, a perspective view of a variant embodiment of a magnetic head according to the invention;
- Figure 7, a front view of the magnetic head of Figure 6;

- Figures 8 to 11, an example of the process for producing a magnetic head according to the invention.

Referring to Figures 4 and 5, a description will first be given of an example embodiment of the magnetic head according to the invention:

This head comprises a magnetic circuit produced in solid form. This magnetic circuit comprises a plane face 10. Substantially in the middle of this plane face, the magnetic circuit is broken by a width 11 and comprises in the break an element made of non-magnetic material 6. On the face 10 comprising non-magnetic material 6, with magnetic material 1 on either side, two magnetic poles 3 and 3' are made, separated by an air gap 5 situated substantially in the middle of the element 6. These magnetic poles are produced using a magnetic material in a thin layer. Each pole covers the magnetic material situated on one side of the element 6 and narrows, over the part 6 made of non-magnetic material, as far as the air gap 5. Thus the magnetic circuit 1 is closed off by the magnetic poles 3 and 3' and by the air gap 5. The width 11 of the element made of non-magnetic material 6 is distinctly greater than the width of the air gap 5 such that the magnetic field is closed off by the air gap 5.

The magnetic circuit has an opening 12 which, as shown in Figure 5, allows the coiling of a winding 7 for inducing a magnetic field which can be supplied with current by connections 70 and 71. This winding then allows the induction of a magnetic field in the magnetic circuit. Figure 5 shows only a single winding 7 but it is obvious that several may be provided.

The magnetic poles 3, 3' can be produced in such a way that the air gap 5 is perpendicular to the axis XX' of displacement of the recording carrier, but they can also be such that the air gap 5 makes an angle other than 90 degrees.

According to the invention, a recording/reading head has thus been produced in planar form making it possible to record on a magnetic tape or read the latter.

Figure 6 represents a variant embodiment of a planar magnetic head according to the invention.

This magnetic head comprises two magnetic circuits 1 and 1' which have been separated in Figure 6 to provide a clearer representation.

Each magnetic circuit comprises a part made of non-magnetic material 6, 6'. Each part 6, 6' comprises a face 14, 14' which is in the same plane as a face 13, 13' of the magnetic circuit 1, 1'. The two magnetic circuits 1, 1' are attached to each other, as shown by the arrow F, by the faces 13, 13' and 14, 14'.

The upper portions of the magnetic circuits 1, 1' and the parts made of non-magnetic material 6, 6' comprise plane faces 10, 10'. On these plane faces 10, 10' there are magnetic poles 3, 3' constituted of a thin layer of magnetic material.

Each magnetic pole 3, 3' is flush with the face 14, 14' of the part made of non-magnetic material 6, 6'. Each pole thus ends at a face 30, 30' contained within the same plane as the faces 14, 14' of the parts 6, 6'.

Furthermore, each magnetic pole 3, 3' has, in the area around its face 30, 30', a narrowed shape 31, 31', the shape of which allows a concentration of the magnetic flux.

When the two magnetic circuits are attached as shown by the arrow F, the faces 13 and 13' face each other and the faces 30 and 30' of the poles also face each other. As shown in Figure 7, the two magnetic circuits are firmly attached to one another by a layer of an adhesive material placed between the faces 13, 13' and 14, 14'. The faces 13, 13' are bonded by a layer 8. The faces 14,

14' and 30, 30' are bonded by a layer 5. The adhesive material may be a glass-based material.

The layer 5 takes the place of an air gap between the faces 30 and 30' [of] the magnetic poles. The adhesive material may be a glass-based material. A coil 7, supplied in a circuit by the connections 70, 71 and surrounding one leg of a magnetic circuit, completes the recording/reading head.

It may be noted that the faces 30, 13, 14 and 30', 13', 14' may be perpendicular to the axis XX' of displacement of the recording carrier (not shown). They may also, while being parallel to each other, form an angle other than 90 degrees with this axis XX'.

Referring to Figures 8 to 11, a description will now be given of a process for producing the planar magnetic head of Figures 6 and 7, in accordance with the invention.

In a first stage (Figure 8) of this process, two parts 1 are produced, made of magnetic material, comprising in an angle of the part an element 6 of non-magnetic material. This element 6 is flush with a face 10 and a face 15 of the part 1. The thickness e of the part 6 along the face 10 will for example be about a hundred micrometres.

During a second stage (Figure 9), a magnetic pole 3 is made on the face 10 of each part 1 in a thin layer. On the face 10 the pole covers the magnetic material of the part 1 so as to receive the whole magnetic field flowing through the magnetic circuit of the magnetic head. In the area of non-magnetic material of the face 10, the pole 3 is produced with a narrowing 31. The thickness h of the thin layer of magnetic material will be 1 to 3 micrometres for example.

The magnetic pole will be produced by any deposition process such as a process of epitaxy followed by an engraving operation to produce the narrowing 30.

During a third stage, a recess 12 is made from the face 15 of the part 1. This recess extends as far as the element 6, and indeed even, as represented in Figures 9 and 10, removes a portion of the element 6. The height H of this recess will be for example 200 to 300 micrometres and its depth also 200 to 300 micrometres.

During a fourth stage represented in Figure 11, two layers are bonded to each other as represented in Figure 10. The faces 13 and 13' of two parts are bonded to each other by a layer of adhesive 8. The faces 30 and 30', and 14 and 14' are bonded to each other by a layer of adhesive 5. The layer of adhesive 5 constitutes the recording gap of the magnetic head. The thickness of the layer 5 is then around 0.2 micrometres.

Bonding takes place by welding using a non-magnetic material based on glass, for example. The technique used may be glass sputtering.

During a fifth stage not shown in the figures, one or more magnetic circuit induction coils are produced surrounding at least one part 1 of the magnetic circuit.

According to a first variant of the process described thus, the stage of producing a recess 12 in each part 1 is carried out before the second stage of producing the magnetic pole 3.

According to a second variant of the process in the invention, the fifth stage of producing a coil is provided after the stage of making a recess 12 and before the stage of bonding two parts 1, 1' to each other.

According to a third variant embodiment of the process in the invention, the stage of producing magnetic poles 3, 3' is performed after bonding two parts 1, 1' to each other. The magnetic poles 3, 3' separated by a gap 5 are then produced on the faces 10, 10' by a known technique such as that described in French patent application no. 86 14974.

The process in the invention and all the variants thus described provide, before the bonding of two parts 1, 1', for the polishing of the faces 30, 13, 14, and 30' 13', 14'.

Furthermore, according to the invention these faces can be perpendicular to an axis XX' along which a magnetic carrier is displaced in front of the head, but according to another variant embodiment of the process in the invention, a phase of machining is provided followed by a phase of polishing the faces 13, 14 and 30 at a predetermined angle relative to the axis XX', for a part 1. During these phases, the part 1' to be bonded to the part 1 undergoes the machining and polishing of the faces 13', 14', 30' at an adjacent angle (at 180 degrees) to the preceding angle relative to the axis XX'.

According to another variant embodiment, after the production of magnetic poles and bonding of the two parts 1, 1', the magnetic head is coated at these poles 3, 3' and on its face 10, 10' with a layer of a non-magnetic material such as a silica-based material. Then this layer is machined and polished until the magnetic poles 3, 3' are reached. This machining and this polishing may be carried out so as to give a convex curve to the magnetic head. It should besides be noted that the faces 10, 10' can themselves be machined so that the magnetic head has a curve.

Through the production process described previously and its variants, a magnetic head can be obtained in accordance with Figures 6 and 7. To obtain a magnetic head in accordance with Figures 4 and 5, the invention provides for a process according to which an opening 12 is made in a part 1 comprising a face 10 and an element made of non-magnetic material 6 integrated into the part 1 and flush with the face 10. This opening 12 is such that the element made of non-magnetic material 6 determines a break in the magnetic circuit 1.

Then, the magnetic poles 3 and 3' are produced on the face 10 according to a technique such as that described in French patent

application FR-A-2.605.783 with the air gap perpendicular or slanting relative to the axis XX'.

Finally the coil or coils are produced around a magnetic circuit.

Quite clearly, the preceding description has been given only by way of non-limitative example. Other variants can be envisaged without leaving the scope of the invention. Numerical examples have been provided merely to illustrate the description.



CLAIMS

1. A magnetic head comprising a magnetic circuit (1) of solid form, having a surface (10) parallel to the recording face of the head, characterised in that the magnetic head also comprises:
 - a non-magnetic element (6) cutting off the magnetic circuit and flush with said surface (10);
 - two planar layers of a magnetic material (3, 3') forming the magnetic poles of the head, deposited on said surface defined by the non-magnetic element (6) and the magnetic circuit, at least partly covering the magnetic material situated on both sides of the non-magnetic element (6), thus completing the magnetic circuit of the head and being separated by an air gap (5) situated in the area of the non-magnetic material (6).
2. A magnetic head according to Claim 1, characterised in that the magnetic circuit comprises two U-shaped parts (1, 1') having these extremities (13, 13' and 14, 14') bonded to each other by a layer of adhesive, one of the extremities (14, 14') of at least one of these two parts (1, 1') comprising a part made of non-magnetic material (6) flush with said plane surface (10).
3. A magnetic head according to Claim 2, characterised in that the edges (30, 30') of the magnetic poles (3, 3') are bonded to each other by said layer of adhesive which then forms the gap which must exist between said poles.
4. A magnetic head according to Claim 2, characterised in that the two U-shaped parts are similar in shape and symmetrical relative to a plane containing the gap and perpendicular to the plane surface (10).
5. A magnetic head according to Claim 1, characterised in that the magnetic poles (3, 3') have a narrowed shape in the area around the air gap (5).



6. A magnetic head according to Claim 1, characterised in that the edges (30 and 30') of the magnetic poles (3, 3') facing each other and defining the air gap (5) form an angle of 90 degrees relative to the longitudinal axis (XX') of the head.
7. A magnetic head according to Claim 1, characterised in that the edges of the magnetic poles (30, 30') facing each other and defining the air gap (5) form an angle other than 90 degrees relative to the longitudinal axis (XX') of the head.
8. A magnetic head according to Claim 2, characterised in that at least one of the bonded extremities (13, 13', 14, 14') of each U-shaped part (1, 1') forms an angle relative to the longitudinal axis (XX') of the head.
9. A process for producing a magnetic head according to Claim 1, characterised in that it comprises the following stages:
 - a first stage of producing a part made of magnetic material (1) comprising at least one plane face (10) and, incorporated in this part (1), an element (6) made of non-magnetic material flush with the plane face (10) on a predetermined surface;
 - a second stage of producing an opening (12) in the part made of magnetic material (1), extending as far as the element made of non-magnetic material (6) such that this element (6) constitutes a break in the magnetic circuit constituted by said part (1);
 - a third stage of producing magnetic poles (3, 3') situated on the plane face (10) extending relative to the longitudinal axis of the head so as to cover the magnetic material situated on either side of the non-magnetic element (6) and having two edges (30, 30') separated by a gap (5) situated on said predetermined surface occupied by the element made of non-magnetic material (6), these magnetic poles being produced using a thin layer of magnetic material;
 - a fourth stage of producing at least one magnetic induction coil (7) passing through the opening (12) and surrounding



the magnetic circuit of the part made of magnetic material (1).

10. A process for producing a magnetic head according to Claim 2, characterised in that it comprises the following stages:
- a first stage of producing at least two parts made of magnetic material (1, 1') each comprising a first plane face (10, 10'), a second plane face (15, 15') and, incorporated in each of these parts, an element (6, 6') made of non-magnetic material flush with the first plane face (10, 10') and the second plane face (15, 15').
 - a second stage of producing a recess (12, 12') in each part (1, 1'), in the second plane face (15, 15'), such that, on one side of the recess, there is a face (14, 14') of the element made of non-magnetic material (6, 6') and, on the other side of the recess, a face (13, 13') of the magnetic material of said part (1, 1');
 - a third stage of bonding two parts made of magnetic material (1, 1') by bonding to each other faces (14, 14') of non-magnetic material and faces (13, 13') of magnetic material;
 - a fourth stage of producing on the first faces (10, 10') of the two parts (1, 1') a thin layer of a magnetic material extending relative to the longitudinal axis of the head so as to cover the magnetic material (1, 1') situated on either side of the non-magnetic element (6, 6') and producing two magnetic poles (3, 3') in this layer, separated by a gap (5) situated above the elements made of non-magnetic material (6, 6');
 - a fifth stage of producing at least one magnetic induction coil (7) passing through the recesses (12, 12') surrounding a portion of the magnetic circuit of a part (1, 1') made of magnetic material.
11. A process according to Claim 10, characterised in that the fourth stage of producing magnetic poles (3, 3') on the first



faces (10, 10') is performed before the third stage of bonding.

12. A process according to Claim 10, characterised in that the third stage of bonding is preceded by a phase of polishing the faces (13, 13', 14, 14') to be bonded.
13. A process according to Claim 10, characterised in that the third stage of bonding takes place by welding with a glass-based material.
14. A process according to Claim 10, characterised in that the fifth stage of producing at least one coil is provided after the second stage of making recesses and before the third stage of bonding by producing at least one coil around a part made of magnetic material (1, 1') and passing through the recess (12, 12') in this part.
15. A process according to Claim 10, characterised in that the fourth stage of producing magnetic poles (3, 3') involves making a narrowing (31, 31') of the poles near the gap.
16. A process according to Claim 10, characterised in that the first stage of producing parts made of magnetic material (1, 1') comprises machining the second faces (15, 15') to an angle other than 90 degrees relative to the longitudinal axis (XX') of the magnetic head to be obtained.
17. A process according to Claim 10, characterised in that the third stage of producing magnetic poles is followed by a stage of depositing a layer of a non-magnetic material on the first faces (10, 10') and on the magnetic poles (3, 3'), then a stage of machining and polishing this layer until the magnetic poles are reached (3, 3').
18. A process according to Claim 17, characterised in that the layer of non-magnetic material is a silica-based material.



19. A process according to Claim 10, characterised in that it comprises a stage of drum-machining the magnetic head.