

Device for moving a functional part in an electrical apparatus and electromagnetical device for use with said device.

The invention relates to a device for moving a head-mounting plate in a magnetic-tape apparatus, the head-mounting plate having a rest position, in which it is withdrawn from the magnetic tape by the force of a first spring, a first operating position in a play mode and a second operating position in a fast-winding mode, electromagnetic actuating means being provided, which define the operating positions of the head-mounting plate in conjunction with a spring-loaded latching device, which holds the head-mounting plate in the second operating position.

In magnetic-tape apparatuses intended for playing tape cassettes, in particular so-called Compact Cassettes, it is known to move the magnetic head relative to the magnetic tape in the cassette. For this purpose the magnetic head is arranged on a head-mounting plate which is movable electromechanically. There is a rest position in which the head-mounting plate with the magnetic head is fully withdrawn from the tape by hand; there is a first operating position in which the head-mounting plate with the magnetic head is fully positioned against the tape, referred to as the play position, and finally there is an intermediate position between the first operating position and the rest position, in which the magnetic tape can be moved past the head substantially without mechanical contact. This position is referred to as the Cue or MSS-position.

From DE-AS 29 10 242 it is known to hold the headmounting plate in the rest position by means of a spring. If the head-mounting plate is to be set to the first operating position, an electromagnet is energized to draw the head-mounting plate into the first operating position *via* a lever mechanism. The head-mounting plate can return from this first operating position to the rest position *via* a latching device in the area of the second operating position if the first magnet is de-energized and, in addition, the latching device is released by a second electromagnet. If the second electromagnet does not release the latching device the head-mounting plate remains in the second operating position for the time being.

EP-A-0,290,078 and 0,295,726 each describe a device as defined in the opening part of Claim 1 and comprising electromagnetic control means in the form of

holding magnet devices 20 with armature irons 22, 23, which cooperate with a first armature plate 24 on the head-mounting plate 3 and a second armature plate 25 on the latching device 30, 36 (cf. column 5, lines 26-40 and column 6, lines 33-35 as well as Figs. 1-4 in EP-A-0,290,078 and column 6, lines 33-47 and column 7, lines 35-37 as well as Figs. 2-6 in EP-A-0,295,726). These documents fall under Art. 54 (3) of the EPC and are therefore not relevant with respect to the inventive step.

It is the object of the invention to construct a device of the type defined in the opening paragraph in such a way that the head-mounting plate can be set from a rest position to two operating positions and can be held in these operating positions by means of a minimal number of parts.

According to the invention this object is achieved in that the electromagnetic actuating means are constructed as a holding-magnet device having armatures which cooperate with a first armature plate on the head-mounting plate and a second armature plate on the latching device, the return force of the head-mounting plate is larger than the force exerted by the spring-loaded latching device on the second armature plate to hold it against its associated armature but is such that the second armature plate is still positioned on its associated armature when the first armature plate is already disengaged from the associated armature, and the second armature plate of the latching device holds the head-mounting plate, which is released as a result of a de-energisation of the holding-magnet device, in the second operating position during its release movement in that the holding-magnet device, which is energised immediately after the de-energisation, now holds the second armature plate by means of its armature.

The construction as a holding magnet device enables the control means to be operated with a smaller power. This enables the heat developed in the magnet coils to be minimised. When the head-mounting plate assumes the second operating position the second armature plate, in the same way as previously the first armature plate, can be held by the same holding magnet device. As a result of this, the mechanical construction is simplified considerably.

In a further embodiment of the invention the holding-magnet device comprises only one magnet coil for both armatures. The use of only one electromagnet enables the mechanical dimensions to be reduced.

In a further embodiment of the invention the latching device comprises a spacing member carrying the second armature plate, the second armature plate and the

first armature plate are arranged parallel to one another in the same direction, and the spacing member comprises a latching pin which is spring-loaded in the holding direction, the latching pin being arranged in the path of a latching nose of the head-mounting plate between the first (play) operating position and the rest position in the area of the second (MSS) operating position. In order to hold the head-mounting plate in the first operating position the first armature plate is held by the holding magnet. In order to hold said head-mounting plate in the second operating position the second armature plate is held by the holding magnet. As the plate is thus held in the second operating position the second armature plate ensures that the latching device remains latched. When the second armature plate is not held magnetically the mechanical latching function is not adequate to hold the spacing member in the second operating position. When the magnet coil remains de-energized for a prolonged time the head-mounting plate is therefore returned to the rest position. However, if the magnet coil is de-energized in order to release the functional element from the first operating position and is re-energized briefly after this, the functional element can move out of the first operating position but is subsequently held in the second operating position, because the second armature plate again holds the latching device electrically; the head-mounting plate cannot move out of this second operating position towards the rest position until the electromagnet is de-energized again.

In a further embodiment of the invention the spacing member is pivotable parallel to the plane of the head-mounting plate about a pivot adjacent the holding-magnet device and comprises two latching arms, of which a longer arm carries the second armature plate and a shorter arm carries the latching pin, and there is provided a spring member which urges the spacing member towards the holding-magnet device. Since the longer latching arm carries the armature plate an extremely small holding force of the electromagnet is adequate to hold the latching pin behind the latching nose in the second operating position.

In a further embodiment of the invention the spring member is a resilient plastics arm which bears on the chassis of the apparatus. The resilient plastics arm can be injection-moulded together with the spacing member, which does not entail any additional production or assembly costs.

In a further embodiment of the invention the length ratio between the shorter and the longer latching arm is approximately 1:2.5. Such a length ratio is

adequate to hold the latching device in the latching position with a small holding force.

In further embodiment of the invention the armatures of the holding magnet are U-shaped and are arranged one above the other, the armature poles all being situated on one of the end faces and like armature poles being arranged in spaced-apart pairs above one another. Such an arrangement leads to a slight increase in manufacturing cost of the magnet; however, it is substantially cheaper than two separate electromagnets.

In a further embodiment of the invention the armature poles adapted to cooperate with the second armature plate of the spacing member have a larger cross-sectional pole area than the armature poles adapted to cooperate with the first armature plate of the head-mounting plate. In this way the force with which the armature plates are held on the armature poles can be influenced. The holding force of the armature plate of the functional element on the holding magnet device may be, for example, 8 N and the holding force of the armature plate for the spacing member may be 14 N if the pole width is the same and the armature poles are 2 mm high for the first armature plate and 3 mm high for the second armature plate.

The holding magnet device has a specific time constant within which it can be de-energized and subsequently re-energized. This time constant can be reduced, in accordance with a further embodiment of the invention, in that the time constant of the holding-magnet device is reduced by applying a higher voltage for re-energisation of the second armature plate. This enables the time between de-energisation by switching off the current and re-energisation by switching on the current to be reduced to, for example, approximately 3 ms.

In a further embodiment of the invention the armature plates and the latching device are arranged on a limb of the U-shaped apparatus head-mounting plate, the base of said U-shaped head-mounting plate carrying at least one magnetic head and pressure rollers, the other limb being adapted to be acted upon by an actuating mechanism, and the U-shaped head-mounting plate being pivotable about a pivot against the action of a return spring in order to move the magnetic head and the pressure rollers towards a magnetic tape, the magnetic tape being situated against the magnetic head in the first operating position (play position) and being slightly lifted off the magnetic head in the second operating position (MSS position).

The invention will now be described in more detail with reference to the

accompanying drawings. In the drawings:

Fig. 1 shows a part of a magnetic tape apparatus comprising a deck plate which supports a head-mounting plate so as to be pivotable about an eccentric pivot, the head-mounting plate being pivoted into its rest position under the influence of spring force, two operating positions being defined by an electromagnet device,

Fig. 2 shows an electromagnet of the electromagnet device,

Fig. 3 is a divided diagrammatic view showing the electromagnet device which enables the head-mounting plate to be held, in particular, in two predetermined operating positions,

Fig. 4 shows the head-mounting plate in a position in which the electromagnet device holds the head-mounting plate in a pivoted position in which it has been pivoted so far that the magnetic head has reached the play position,

Fig. 5 shows the head-mounting plate in a position in which the magnetic head is lifted slightly off the magnetic tape, but in which a first armature plate is positioned against the electromagnet device,

Fig. 6 shows functional diagrams illustrating the time relationship between the functions performed to achieve holding in the second operating position.

The drawings show a deck plate 1 which serves as a chassis for a magnetic-tape cassette apparatus comprising an apparatus part 3 which is pivotable about an eccentric pivot 5. The apparatus part 3 is U-shaped and comprises limbs 9 and 11 which project in the same direction from the ends of its base 7 which constitutes a head-mounting plate. The limbs 9 and 11 are connected to the corner portions 12 and 13. The limb 9 cooperates with an actuating member 14 and the limb 11 constitutes a functional element adapted to cooperate with a holding electromagnet device 15.

The head-mounting plate 7 of the apparatus part 3 carries a magnetic head 16 and pressure rollers 17a, 17b, which are pivotable relative to the head-mounting plate 7, in a manner not described. The pressure rollers 17a and 17b can be applied to capstans 18a and 18b in order to move a magnetic tape, not shown, past the magnetic head 16 in one of the two directions.

The apparatus part 3 is pivoted *via* an actuating member 14 constituted by an eccentric wheel. This actuating member 14, which obviously may also be constructed as a rod, influences a spring 19 attached to the limb 9. The apparatus part 3 is pivotable about the eccentric pivot 5 *via* the actuating member 14 each time that the actuating

member 14, which can revolve for example in the clockwise direction, is actuated. A return spring 37 urges the apparatus part 3 carrying the magnetic head 16 and the pressure rollers 17a, 17b back towards the rest position.

The holding magnet device 15 comprises an electromagnet 120 having a magnet coil 121. The magnet coil 121 is wound on a hollow coil former 122 having coil flanges 132. The coil former 122 is traversed by two U-shaped armatures 124 and 125, of which only two limbs 124a and 125a extend through the coil former 122 and the other limbs 124b and 125b are situated outside the magnet coil 121. The armatures 124 and 125 comprise armature poles 124c, 124d and 125c, 125d, all situated at an axial end 126 of the magnet coil 121. All the armature poles are disposed in one plane. The poles are arranged in pairs in such a way that the armature poles 124c and 125c are situated before the coil end 126 at a distance above one another and the poles 124d and 125d are also situated pairwise above one another. All the armature poles have a unitary width b; their height is different. The height of the armature poles 124c and 124d is smaller than that of the armature poles 125c and 125d. In a practical embodiment the armature poles 124c and 124d have a height d1 of approximately 7 mm and the armature poles 125c and 125d have a height d2 of approximately 10.5 mm.

Fig. 3 shows the holding magnet device 5 diagrammatically in two parts to clarify its construction and operation. The front portion 127 of the functional element 11 comprises a moulded-on plastics base 128. At its underside this moulded-on plastics base carries a soft-iron armature plate 131 by means of a pivot 130. This armature plate 131, hereinafter referred to as the first armature plate, can be positioned against the armature poles 124c and 124d with its end face 132. The armature plate 131 is pivotable in a plane parallel to the plane of the functional element 11. The plastics base 128 comprises a moulded-on nose 133 behind which, viewed towards the functional element 11, a recess 134 is formed. A latching pin 135 is engageable in the recess 134. This latching pin 135 is moulded on a spacing member 136, which is the central part of a latching device 137. The spacing member 136 is pivotable about a pivot 136a. The spacing member 136 carries a second armature plate 138, which is pivotable about a pivot 139 in a plane parallel to the functional element. The length L1 of the spacing member between the pivot 136a and its free end (latching arm 136b) corresponds to 2.5 times the length L2 of the spacing member between the pivot 136a and the latching pin 135 (latching arm 136c). The end face 140 of the second armature plate 138 can be

positioned against the armature poles 125c and 125d of the armature 125. As can be seen in Fig. 2, the armatures 125 and 124 extend parallel to and above one another. The spacing member 136 comprises a resilient plastics arm 141, which bears against a stationary chassis portion 142. The resilient plastics arm 141 constantly urges the
5 second armature plate 138 slightly against the armature poles 125c and 125d *via* the spacing member 136.

At its rear the holding magnet device has, for example, a groove 143 to secure the holding magnet device 15 to a chassis portion. A support 144, in which the groove 143 is formed, also carries the pivot 136a for the spacing member 136. The
10 operating position shown in Fig. 3 is the so-called play position, in which the functional element 11 is in its most advanced position and the first armature plate 131 and the second armature plate 138 are positioned against the respective armature poles 124c, 124d and 125c, 125d.

Reference is now made again to Fig. 1, in which the head-mounting plate is shown in its rest position. It can be seen that the functional element 11 is disengaged from the holding magnet device 15 and the first armature plate 131 is consequently
15 remote from the armature 124. The latching nose 133 and the recess 134 are free. The plastics arm 141 urges the second armature plate 138 against the armature poles 125c and 125d. The plastics arm 141 exerts a force *F* on the stationary chassis portion 142 of the deck plate 1. In this rest or stand-by position the electromagnet 120 is de-energized.
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The spring 37, which is attached to the deck plate 1 by means of a clip 37a, ensures that the head-mounting plate 7 is pivoted anti-clockwise, said plate abutting against a stop 38. Both the magnetic head 16 and the pressure rollers 17a and 17b are entirely clear of a magnetic tape, not shown, which moves between the pressure
25 rollers/capstan pairs 17a, 18a/17b, 18b past the magnetic head 16.

When the apparatus is put into operation and the head-mounting plate 7 must be pivoted into its play position, *i.e.* the first operating position, a drive motor 1a is activated to rotate the actuating member 14 *via* a mechanism 1b, in a manner not shown. This actuating member may alternatively be a slide. When the actuating member
30 14 is rotated in the direction indicated by the arrow the head-mounting plate 7 is pivoted clockwise. If the electromagnet 120 is now energised, all the armature poles 124 and 125 are magnetized. If the functional element 11 moves the armature plate 131 towards the associated magnet poles 124c and 124d, this plate will stick to these armature poles,

thus holding the head-mounting plate 7 in the play position. The actuating member 14 is rotated further, allowing the spring 19 to relax. The head-mounting plate 7 is now only held in the first operating position, the play position, by means of the electromagnet 120, which is constructed as a holding magnet.

5 Figs. 3 and 4 show this play position. In the play position the second armature plate 138 is also drawn against the armature poles, in the same way as the first armature plate 131.

 If the head-mounting plate 7 is to return directly from the play position shown in Figs. 3 and 4 to the rest position the electromagnet 120 is merely de-
10 energized. The armature poles 124 and 125 release the armature plates and the functional element 11 moves towards the rest position, the latching nose 133 abutting against the latching pin 135, which has engaged the recess 134. This delays the spring-return of the functional element. As it abuts against the latching pin the latching nose 133 pivots the spacing member 136 clockwise against the opposing force exerted by the
15 plastics arm 141 to move past the latching pin 135, which pivots away, and the functional element 11 returns to its rest position shown in Fig. 1.

 However, to proceed from the first operating position to an intermediate position, for example the Cue or MSS (Music Sensing System) position, for fast forward and reverse operation, the electromagnet 120 is also de-energised. The latching
20 nose 133 abuts against the latching pin 135, which has engaged the recess 134. The anti-clockwise movement of the functional element 11 towards the rest position is discontinued at the location where the latching nose 133 abuts against the latching pin 135. At this instant the first armature plate 131 has already become disengaged from the armature poles 124. As a result of the return force exerted by the plastics arm 141 the
25 second armature plate 138 is not yet disengaged from the armature poles 125c and 125d; it still occupies the position shown in Fig. 3, in which it is positioned against the armature poles 125c and 125d. The return spring force of the functional element 11 is larger than the holding force exerted by the plastics arm 141. The latching device 133 to 135 cannot hold the functional element 11 in the second operating position. The
30 element is held in the second operating position by the electromagnet 120, which is re-energised briefly after its de-energisation. As a result of the re-energisation the holding force of the spacing member 136 and consequently of the latching pin 135 is increased to such an extent that the latching nose 133 cannot move past the latching pin 135.

Fig. 5 shows the second operating position, in which the first armature plate 131 is slightly withdrawn but the second armature plate 138 is still positioned against the armature poles 125c and 125d. The magnetic force exerted on the armature plate 138 by the associated armature poles ensures that the latching pin 135 retains the latching nose 133.

To proceed again from the second operating position to the first operating position the actuating member 14 must pivot the head-mounting plate clockwise so that the armature plate 131 can again be held magnetically by the armature poles 125c and 125d. A return of the head-mounting plate 7 from the second operating position shown in Fig. 5 to the rest position shown in Fig. 1 is possible by de-energising the magnet coil 120.

The functions performed during a change-over from the first operating position to the second operating position take place very shortly after one another within a time interval of approximately 4 ms. These functions will be described in detail with reference to the functional diagram in Fig. 6. In Fig. 6 a number of inter-related functions are plotted against a horizontal time scale in milliseconds. The upper diagram A represents the energising current. The next diagram B represents the movement of the functional element 11. The diagram C represents the movement of the latching nose 133. Finally, the diagram D represents the magnetizing current of the electromagnet or the magnetizing condition of the yoke.

It is assumed that at the instant t_0 the functional element 11 and the armature plate 131 are positioned against the armature poles 124c and 124d and that the coil 121 is energized. The functional element 11 is then in its first operation position or play position (1°). By pressing a push-button at the instant t_1 the command is given that the functional element 11 is to be set to the second operating position or MSS position (2°). As a result of this command the energizing current I is switched off. The diagram A shows that the energising current is switched off at the instant t_1 . The magnetization of the armature ceases when this current is switched off. At the instant t_2 , as is shown in the diagram D, only a residual magnetisation exists. Since the magnetisation of the armature poles has ceased, the functional element 11 is released with a specific time delay. Immediately after this release has begun at the instant t_3 the energising current of the coil 121 is switched on again, namely at the instant t_4 . Diagram D shows that the magnetisation of the armature poles increases again. At the instant t_5 the magnetisation

of the armature poles is restored to substantially its normal value, and at the instant t_7 the latching nose 133 is situated before the latching pin 135. In Fig. 2 this situation is indicated by the dashed latching projection 133'. The armature plate 138, which is still held against the armature poles 125c and 125d by means of the plastics arm 141, is now held by the armature poles 125c and 125d. Thus, the functional element 11 is held in the MSS or Cue position.

It may be advantageous if at the instant t_4 the energising voltage applied to the magnet coil 121 is higher than normal. The magnetisation of the armature poles at the instant t_5 then has already reached such a value that the holding force provided by the armature poles 125c and 125d backs up the force provided by the plastics spring 141 to such an extent that the sum of the resulting magnetic holding force and the mechanical holding force is larger than the return spring force of the functional element 11. The time interval in which the magnet coil 121 is not energised (t_1 to t_4) is approximately 2.3 ms. When the over-voltage pulse I_p is applied, which leads to the magnetisation at the instant t_5 , the time interval t_1 to t_4 can be prolonged to approximately 3 ms. This constitutes an additional security. The device then requires approximately 4 ms to switch the functional element 11 from the first operating position (1°) to the second operating position (2°).

The combination of mechanical and electrical functions in order to reach the MSS position leads to a very simple construction. Altogether the construction with the double-armature magnet substantially simplifies the construction of a tape deck.

Claims:

1. A device for moving a head-mounting plate (3) in a magnetic-tape apparatus, the head-mounting plate (3) having a rest position, in which it is withdrawn from the magnetic tape by the force of a first spring (37), a first operating position in a play mode and a second operating position in a fast-winding mode, electromagnetic
5 actuating means (120) being provided, which define the operating positions of the head-mounting plate (3) in conjunction with a spring-loaded latching device (137), which holds the head-mounting plate (3) in the second operating position, characterised in that the electromagnetic actuating means are constructed as a holding-magnet device (120) having armatures (124, 125) which cooperate with a first armature plate (131) on the
10 head-mounting plate (3) and a second armature plate (138) on the latching device (137), the return force of the head-mounting plate (3) is larger than the force exerted by the spring-loaded latching device (137) on the second armature plate (138) to hold it against its associated armature (125) but is such that the second armature plate (138) is still positioned on its associated armature (125) when the first armature plate (131) is
15 already disengaged from the associated armature (124), and the second armature plate (138) of the latching device (137) holds the head-mounting plate (3), which is released as a result of a de-energisation of the holding-magnet device (15), in the second operating position during its release movement in that the holding-magnet device (15), which is energised immediately after the de-energisation, now holds the second
20 armature plate (138) by means of its armature (125).
2. A device as claimed in Claim 1, characterised in that the holding-magnet device (120) comprises only one magnet coil (121) for both armatures (124, 125).
3. A device as claimed in Claim 1, characterised in that the latching device (137) comprises a spacing member (136) carrying the second armature plate (138), the
25 second armature plate (138) and the first armature plate (131) are arranged parallel to one another in the same direction, and the spacing member (136) comprises a latching pin (135) which is spring-loaded in the holding direction, the latching pin (135) being arranged in the path of a latching nose (133) of the head-mounting plate (3) between the



first (play) operating position and the rest position in the area of the second (MSS) operating position.

4. A device as claimed in Claim 3, characterised in that the spacing member (136) is pivotable parallel to the plane of the head-mounting plate (3) about a pivot adjacent the holding-magnet device and comprises two latching arms (136b, 136c), of which a longer arm (136b) carries the second armature plate (138) and a shorter arm (136c) carries the latching pin (135), and there is provided a spring member (141) which urges the spacing member (136) towards the holding-magnet device (15).

5. A device as claimed in Claim 4, characterised in that the spring member (141) is a resilient plastics arm which bears on the chassis (1) of the apparatus.

6. A device as claimed in Claim 4, characterised in that the length ratio ($L1/L2$) between the shorter and the longer latching arm (136b, 136c) is approximately 1:2.5.

7. A device as claimed in Claim 2, characterised in that the armatures (124, 125) of the holding magnet (120) are U-shaped and are arranged one above the other, the armature poles (124c, d; 125c, d) all being situated on one of the end faces (126) and like armature poles (124c, 125c; 124d, 125d) being arranged in spaced-apart pairs above one another.

8. A device as claimed in Claim 7, characterised in that the armature poles (125c, 125d) adapted to cooperate with the second armature plate (138) of the spacing member (136) have a larger cross-sectional pole area than the armature poles (124c, 124d) adapted to cooperate with the first armature plate (131) of the head-mounting plate (3).

9. A device as claimed in Claim 1, characterised in that the time constant of the holding-magnet device (120) is reduced by applying a higher voltage for re-energisation of the second armature plate (138).

10. A device as claimed in Claim 1 or 3, characterised in that the armature plates (131 and 138) and the latching device (137) are arranged on a limb (11) of the U-shaped apparatus head-mounting plate (3), the base of said U-shaped head-mounting plate (3) carrying at least one magnetic head (16) and pressure rollers (17a, 17b), the other limb (9) being adapted to be acted upon by an actuating mechanism (14), and the U-shaped head-mounting plate (3) being pivotable about a pivot (5) against the action of a return spring (37) in order to move the magnetic head (16) and the pressure rollers



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(17a, 17b) towards a magnetic tape, the magnetic tape being situated against the magnetic head (16) in the first operating position (play position) and being slightly lifted off the magnetic head in the second operating position (MSS position).