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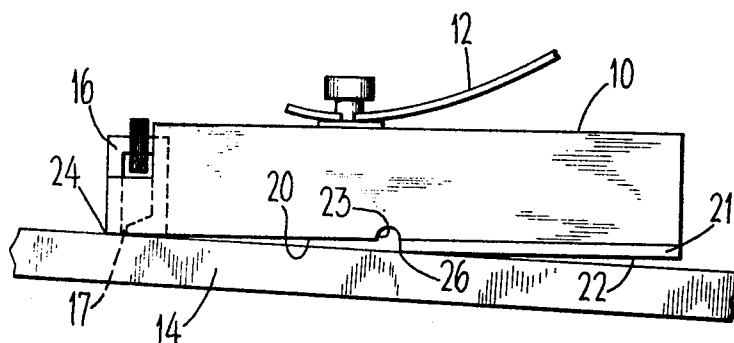
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UNITED STATES PATENTS
 3,187,315 6/1965 Cheney 179/100.2
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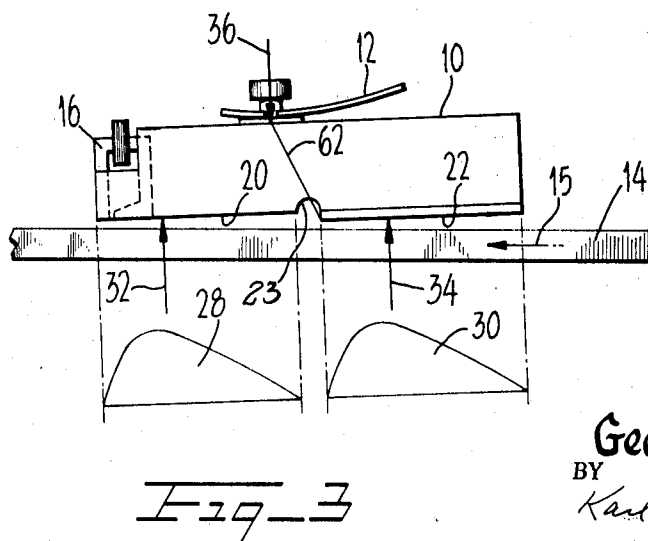
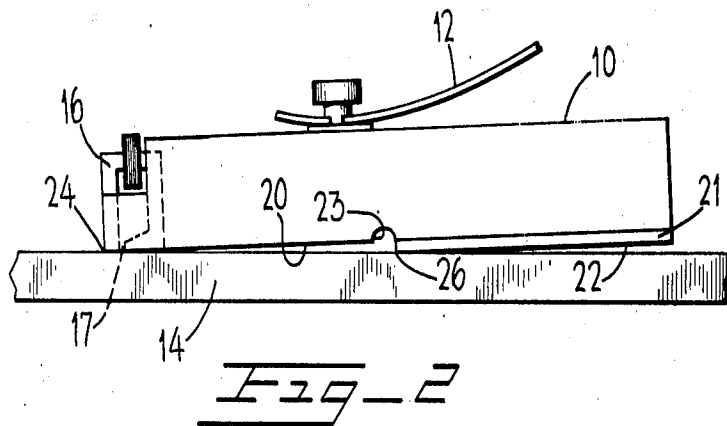
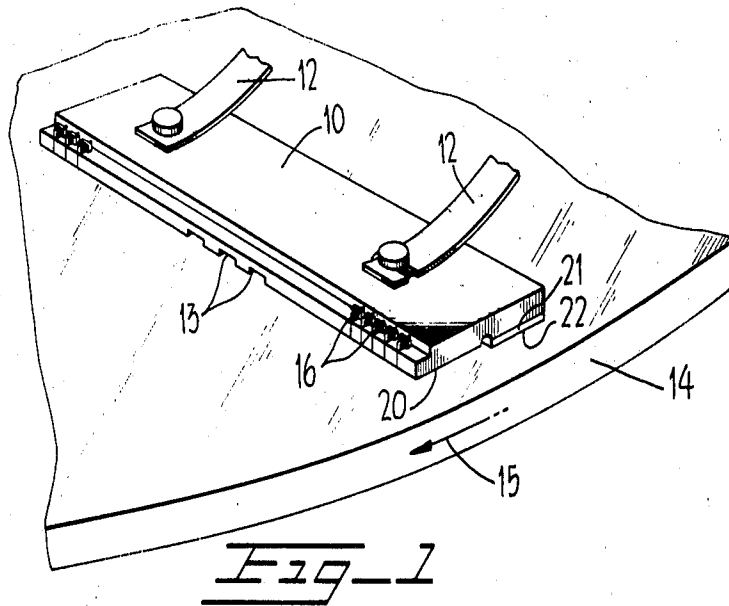
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[54] **STEPPED MAGNETIC HEAD WITH OFFSET
 BIASING**
 7 Claims, 5 Drawing Figs.

[52] U.S. Cl. **340/174.1,**
 179/100.2
 [51] Int. Cl. **G11b 5/60**
 [50] Field of Search 340/174
 (1F), (E); 179/100.2 (P), (C)

ABSTRACT: The slider of a flying head is stepped to provide a plurality of support areas, equal or not, preferably two, one upstream from the other, which fly with their trailing edges at equal distances from the record disc and with a stable up-attitude. The step may be formed by the vacuum deposition of, for example, 50 microinches of metal on the upstream support area.





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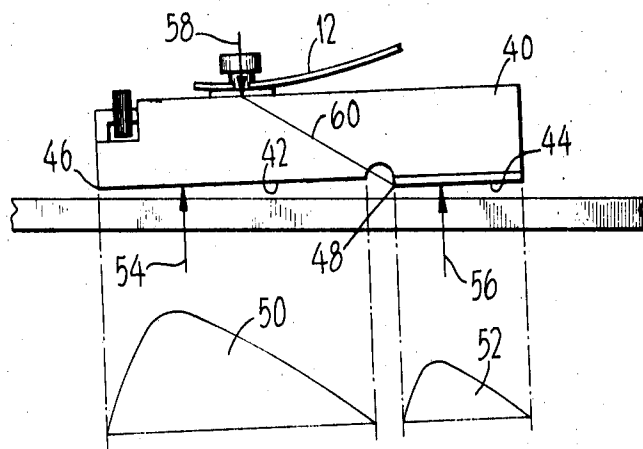


Fig. 4

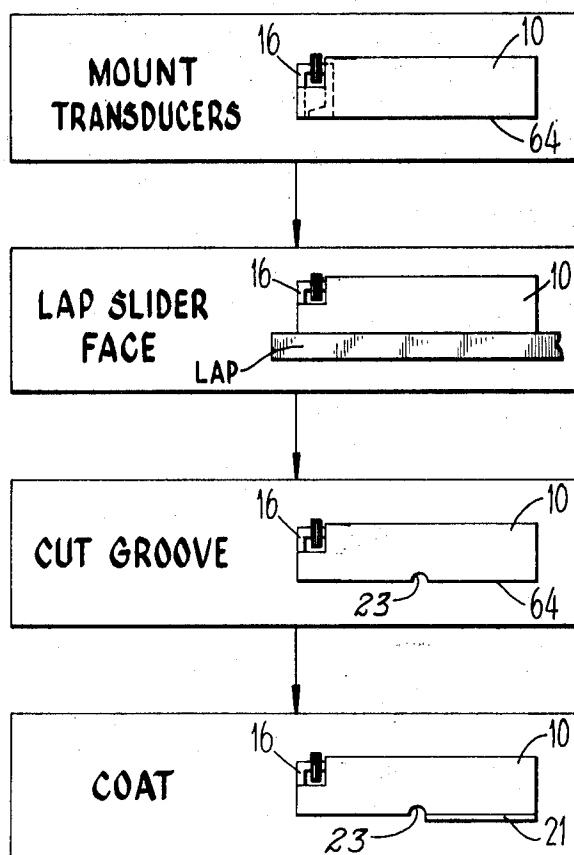


Fig. 5

STEPPED MAGNETIC HEAD WITH OFFSET BIASING

BACKGROUND OF THE INVENTION

1. Field of Invention

The present invention relates to transducer-carrying heads for magnetic-disc, data storage for computers, and particularly to such heads that ride, or "fly", on self-acting gas bearings.

2. Description of the Prior Art

It has been proposed that flying heads ride on flat sliders, as in U.S. Pat. No. 3,177,495, and on slightly angled sliders as in U.S. Pat. No. 3,229,268, but such sliders tend to pitch.

It is desirable that a slider accommodate itself in the pitch direction to undulations of the record disc, but such prior constructions tend to be unstable and to pitch excessively.

IBM Manual Y26-5897-3, "2311 Disc Storage Drive", 1965, at Page 2.18 shows a slider with bleed holes for separating the bearing areas. U.S. Pat. No. 3,129,297 shows separate air bearings at opposite ends of a long beam.

SUMMARY OF THE INVENTION

The slider of a flying head has a forward support area stepped toward the record disc relative to an area trailing it, a distance about equal to the desired flying height, so that in operation the separate support areas fly at substantially equal distances from the recording surface with a stable up-attitude. The step may be made by vacuum deposition of metal on one area of a plane slider surface.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects and advantages of the present invention will be apparent from the following description of a specific embodiment thereof, wherein:

FIG. 1 is a fragmentary perspective view showing the flying head of the present construction in operating position with respect to a magnetic recording disc;

FIG. 2 is an elevational view showing the head resting on a stopped disc;

FIG. 3 is a partially diagrammatic view, similar to FIG. 2, but showing the head in a typical flying position, and including a diagrammatic representation of forces;

FIG. 4 is a view similar to FIG. 3, showing a modified construction; and

FIG. 5 is a flow diagram of a process of making the flying head of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The flying head of my invention may carry one or more transducers, and may be made of any stable, nonmagnetic material such as ceramic, glass or metal. In the specific example shown in FIG. 1, the flying head includes a slider 10 formed of a ceramic block approximately 3 inches long, 1 inch wide, and three-sixteenths of an inch thick. Leaf springs 12 hold it in position and urge it toward a record disc 14 which rotates under the slider 10, from right to left in the view, as indicated by the arrow 15. The slider 10 carries an array of electromagnetic transducers 16 which write data magnetically onto the surface of the rotating disc 14 and also read data therefrom. A film of air, dragged by the motion of the disc 14, develops a pressure under the slider 10 for supporting it just off the disc.

As seen in FIGS. 2 and 3, the lower, or bearing, surface of the slider 10 has two parallel faces, or support areas, 20 and 22, separated by a step at a groove 23. The lower face 22 is formed by a thin coating 21 and is upstream from the other face 20. The thickness of coating 21 is greatly exaggerated in the drawing. Since the disc 14 moves to the left, as seen in FIGS. 1 and 3, the flow of air is from right to left, and the right side of slider 10 is the leading, or upstream, side. When the disc 14 is stopped, as shown in FIG. 2, the slider rests on the two trailing edges 24 and 26 of these separate supporting faces or support areas, 20 and 22. The transducers 16 are mounted

in slots at the trailing side of the slider 10 to place the gaps 17 thereof close to the recording disc 14. Spoiler slots 13, FIG. 1, may be provided in a known manner near the center of the slider 10 to bleed off the air pressure there, for confining the lift to the areas directly under the springs 12 and thereby reducing the bending of the block 10.

FIG. 3 shows a flying position of the slider 10 and also includes diagrams relating to the forces acting on the slider. The forces act perpendicular to the support areas 20 and 22, and are so shown. It is characteristic of self-acting gas bearings, such as are involved here, that the pressure of the gas in the bearing space increases as the spacing is decreased. Accordingly, the slider 10 may be held toward the rotating disc 14 with a spring, and the slider will seek a spacing at which the bearing forces balance the spring force. It is desired that the two supporting areas 20 and 22 fly at the same distance from the moving disc 14. With the two areas operating independently and having the same area, this desideratum requires that the spring force be applied equally to the two support areas 20 and 22. It is known that, under an inclined bearing such as the area 20 or 22, the gas pressure increases from the upstream edge to a region near the downstream edge and then decreases. For equal flying heights and equal total forces, the distribution of gas pressure under the faces 20 and 22 may be represented approximately by the two, similar, generally triangular areas 28 and 30. The total of the force against the support area 20, as represented by the pressure diagram 28 is equivalent to one force concentrated at a position about two-thirds of the way downstream from the leading edge of the face 20, approximately as indicated by the arrow 32. Similarly, the pattern of forces represented by the diagram 30 is equivalent to a single force indicated approximately by arrow 34 acting against area 22. Accordingly, the force of springs 12 is applied at a position midway between these two arrows 32 and 34, as indicated by the arrow 36. Preferably, the step between the two faces 22 and 20 is about equal to the height at which it is intended that the two trailing edges 24 and 26 fly above the record disc 14, for example, about 50 microinches, or in the range of 50 to 100 microinches. The groove 23 separates the two support areas 20 and 22 so that they act independently.

Typically, the springs 12 are adjusted to make the slider 10 fly about 50 microinches off the disc 14 at the end nearest the center of the disc, and somewhat higher at the outer end. The higher speed at the outer edge of the disc causes the air to exert a greater lift there against the slider 10. Although the greater height at the outer edge tends to reduce the read-out voltage, the greater speed tends to increase it. The greater length of the outer tracks results in a lower packing density for the bits of the magnetic record. For example, the distance between the planes of the faces 20 and 22 may be 50 microinches, the innermost track of disc 14 may have half the radius of the outermost track so that the speed ratio will be 2, and the springs 12 may be adjusted to provide a flying height of 50 microinches at the inner edge and 80 microinches at the outer edge, for a ratio of 1.6. The greater flying height at the outer edge will somewhat reduce the resolution of reading, but this will be acceptable because of the lower packing density. Under these conditions, the read-out signal voltage at the outer track may be 1½ times that of the inner track.

FIG. 4 shows a slider 40, similar to the slider 10 except that its downstream support area 42 occupies approximately the rear two-thirds of the slider area, and its upstream support area 44 occupies about one-third. With this construction it is again desirable that the trailing edges 46 and 48 of the two support areas 42 and 44 fly at equal distances from the record disc 14. Under such a condition the air pressure acting on the support areas will be approximately as indicated by the pressure diagrams 50 and 52, with approximately four-fifths of the total force being exerted against the support surface 42. The total force acting against the support surface 42 is equivalent to a single force acting approximately at the location indicated by the arrow 54, and the total force acting against the support

surface 44 is equivalent to a single force acting approximately at the position indicated by the arrow 56. Since the force acting on the rear face is about four times the other, the position of application of the spring force to balance these is close to the position of arrow 54, as indicated approximately by the arrow 58.

One advantage of this construction of FIG. 4 is that this spring force 58 must be applied farther back on the slider than in the structure of FIGS. 1, 2 and 3 and, in addition, the trailing edge 48 of the front support surface is farther forward. Since such flying heads typically fly less than 100 microinches off the record disc, it is possible for a small particle of dirt on the disc 14 to strike the slider. In the worst situation, the dust particle would strike the support surface 44 near the trailing edge 48. Since the slider is restrained against moving with the disc by the springs 12, the slope of the line 60 from the attachment of spring 12 to the edge 48 is a measure of the tendency of the slider 40 to pitch forward under this condition. The slope of this line 60 in FIG. 4 is much less than the slope of the corresponding line 62 in FIG. 3. Accordingly, the slider 40 of FIG. 4 is less likely to pitch and gouge the record disc in the event of this type of accident.

One advantage of the slider of the present invention is that it tends to fly with its two support areas 20 and 22, or 42 and 44, at equal distances from disc 14, so that the slider always assumes an up-attitude. Furthermore, the force of the springs 12 falls between the trailing edges of the support areas such as the edges 24 and 26 so that, when the disc 14 is stopped, the slider rests on it, as in FIG. 2, with the same up-attitude. Accordingly, when the disc is slowing down, and when it is starting up, there is no tendency for the leading edge of the face 22 to gouge the disc. The head of the present invention is stable in pitch, that is, it does not tend to rock in the direction of motion of the disc 14. If, for instance, the forward end moves down, the air film under the forward support area will be reduced in thickness and will cause a sharp increase in pressure which will immediately rock the slider back toward its balanced flying position.

FIG. 5 is a flow diagram showing a process of making the flying head of the present invention. Preferably, the ceramic block, which is to become the slider 10, is slotted to receive the transducers 16, and the transducers are fixed in place. The pole pieces of the transducers are set substantially flush with the surface 64 of the ceramic block that is to become the support surface, the bottom in FIG. 5. Next, the surface 64 is lapped to make it flat and smooth, and to make the pole pieces of all the transducers 16 flush with the lapped ceramic surface. Next, the groove 23 is cut to separate the two support areas. Finally, a coating 21 is placed on the upstream support area 22. Preferably, this is accomplished by vacuum deposition. The coating under these conditions may consist of chromium, 50 microinches thick.

It will be apparent that the invention is capable of modifications and variations within the scope of the claims.

I claim:

1. In an air-lubricated, flying-head construction for supporting a magnetic transducer adjacent a movable magnetic record surface, the combination comprising:

- a. a slider having stepped separate support areas spaced apart in the direction of motion of said record surface relative to said slider, the upstream one of said support areas having a leading edge and a lagging edge with

respect to the direction of motion of said record surface, the support forces due to the pressure of the air lubrication being concentrated in said separate areas;

- b. means supporting the slider for rotation in the pitch direction; and

- c. yieldable biasing means for applying a force to said slider toward said record surface at a location situated downstream of said lagging edge, for causing said lagging edge to contact said record surface when the support forces due to the pressure of the air lubrication between said support areas and said record surface is less than the force of said biasing means, the contact between said lagging edge and said record surface acting as a pitch axis about which said biasing force imposes a torque on said slider so as to bias said leading edge away from said record surface.

2. The combination of claim 1 wherein the force and rate of said biasing means is proportioned and adjusted with respect to the size of said slider and the speed of said motion to cause said slider to fly with the trailing edges of the leading and trailing support areas at substantially equal distances from said record surface.

3. The combination of claim 2 wherein said separate support areas are substantially flat and parallel.

4. The combination of claim 1 wherein the force and rate of said biasing means is proportioned and adjusted with respect to the size of said slider and the speed of said motion to cause said slider to fly with the trailing edges of the leading and trailing support areas at a distance from said record surface substantially equal to the step between adjacent support areas.

5. In an air-lubricated, flying-head construction for supporting a magnetic transducer adjacent a movable magnetic record surface, the combination comprising:

- a. a slider having separate support areas spaced apart in the direction of motion of said record surface relative to said slider, the upstream one of said support areas having a leading edge and a lagging edge with respect to the direction of motion of said record surface, the support forces due to the pressure of the air lubrication being concentrated in said separate areas;

- b. means supporting the slider for rotation in the pitch direction; and

- c. yieldable biasing means for applying a force to said slider toward said record surface, the foremost support area being stepped toward said record surface relative to the support area immediately downstream from it; said force of said biasing means being applied to said slider at a location situated downstream of said lagging edge, for causing said lagging edge to contact said record surface when the support forces due to the pressure of the air lubrication between said support areas and said record surface is less than the force of said biasing means, the contact between said lagging edge and said record surface acting as a pitch axis about which said biasing force imposes a torque on said slider so as to bias said leading edge away from said record surface.

6. The combination of claim 5 wherein the upstream one of said separate support areas extends less than half the distance from its leading edge to the trailing edge of the downstream support area.

7. The combination of claim 5 wherein said separate support areas are substantially flat and parallel.