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3,486,274

APPARATUS FOR HONING MAGNETIC DISCS

Filed June 14, 1965

2 Sheets-Sheet 1

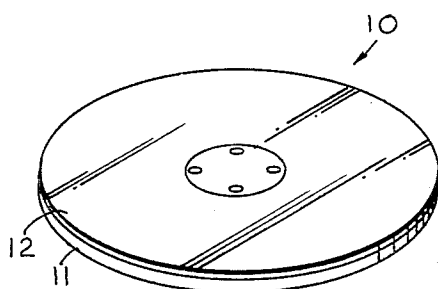


Fig. 1 (a)

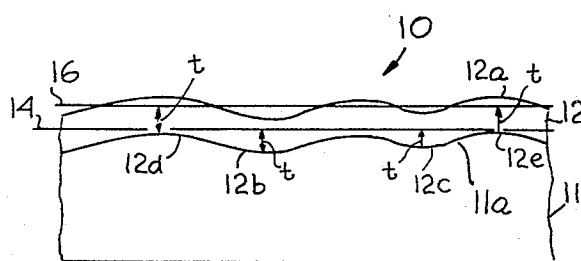


Fig. 1 (b)

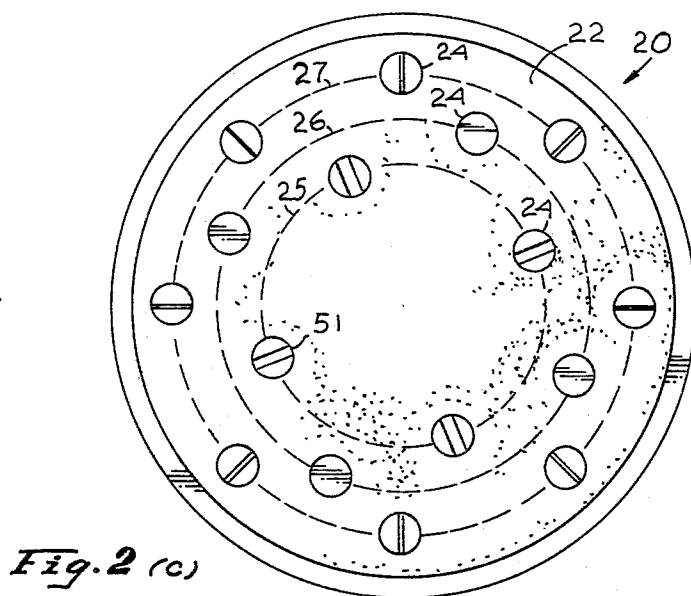


Fig. 2 (c)

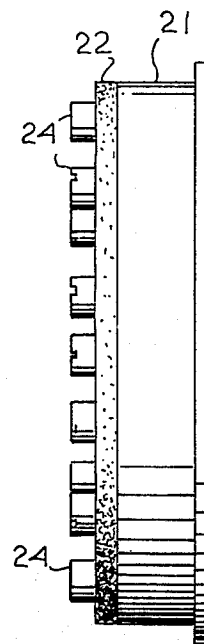


Fig. 2 (b)

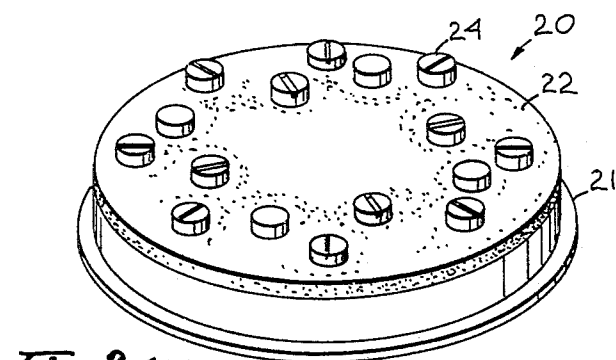


Fig. 2 (a)

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Fig. 3

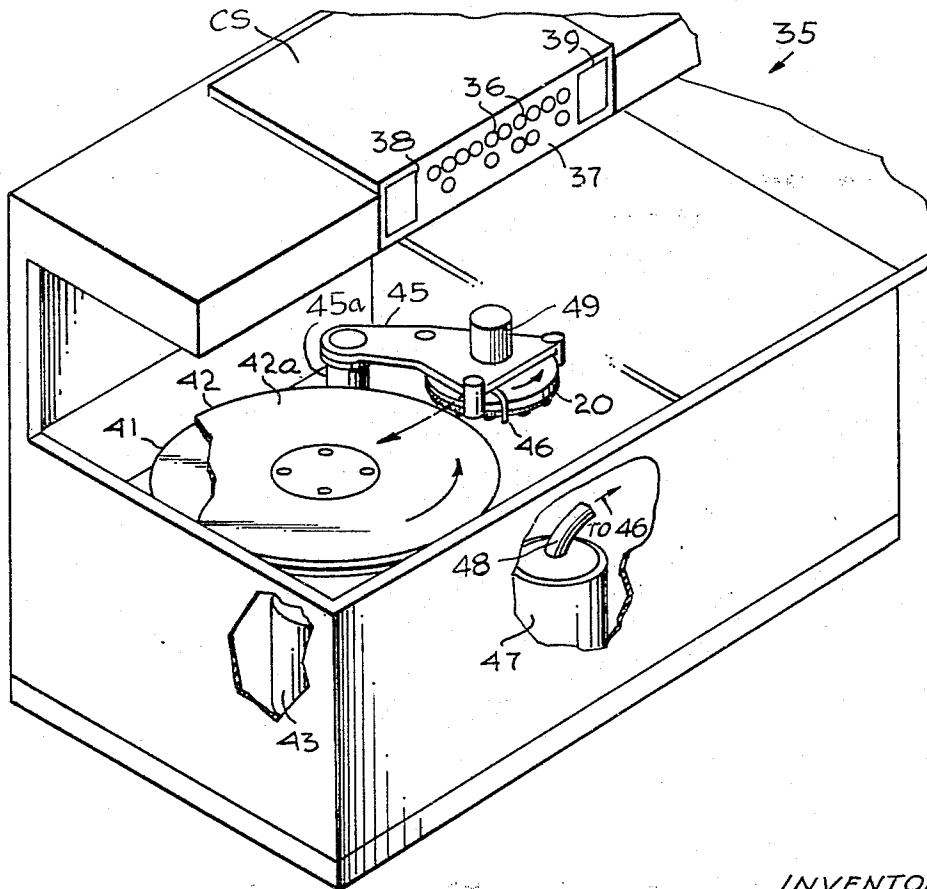
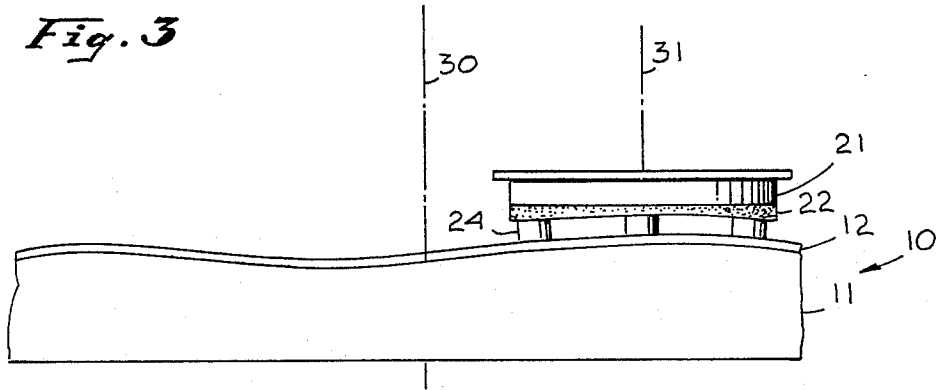


Fig. 4

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5 Claims

ABSTRACT OF THE DISCLOSURE

An apparatus for grinding a layer of magnetic material deposited on a nonuniform surface of a metallic disc to a uniform thickness. The apparatus consists of a rotatable table on which the disc is supported, a grinding head which includes a rigid member to which a flexible pads-supporting member is fastened. The head which is rotatable about its center is in turn supported by an assembly which is movable to bring the pads of the head in contact with the layer of magnetic material. The pads, due to the flexible member on which they are supported, conform to the nonuniform surface of the layer. Grinding starts when the pads are in contact with the layer, with both the disc and the grinding head being rotated about fixed axes at predetermined rates. Grinding is terminated while the two rotate and the head is disengaged from the disc.

The present invention relates to grinding equipment and, more particularly, to an improved grinding or honing apparatus.

In manufacturing a magnetic disc which generally comprises a thin metallic disc, coated with a layer of magnetic material, it is difficult to control the uniformness of the thickness of the finished layer of the magnetic material. For best performance, it is necessary to lap or grind the magnetic material to a very precise finish. However, it is not possible to employ conventional techniques of lapping or grinding precisely flat surfaces. This is due to the inability to machine a metallic surface of appreciable area to be perfectly flat, especially when the metal is quite thin. Most thin metallic discs have rolling surfaces with gradual rounded undulations, which are also present on the top of any layer of magnetic material which is deposited thereon. Consequently, the top of the magnetic material is not absolutely flat and therefore, conventional grinding or lapping techniques cannot be employed. A system is therefore needed for grinding or honing the top of a flatless surface of deposited material, while precisely controlling the uniformness of the thickness thereof.

Accordingly, it is an object of the present invention to provide a novel apparatus for grinding surfaces to a precise finish.

Another object of the present invention is the provision of a novel grinding apparatus for machining to a precise finish a rolling surface.

A further object of the present invention is the provision of a new apparatus for grinding the top surface of a layer of material deposited on a rolling metallic surface, so that the thickness of the layer is uniform and the top thereof is ground to a precise lapped finish.

Still a further object of the invention is the provision of a new apparatus which is easily operable to control the uniformness of the thickness of magnetic material deposited on a rolling metallic surface, while controlling the finish characteristics of the top surface of the magnetic material.

These and other objects of the invention are achieved by providing an apparatus which includes a rotatable platform for supporting a metallic disc, which is coated with a layer of material such as magnetic material. The

apparatus has a novel grinding assembly comprising of a rotatable grinding plate or head, to which a plurality of grinding members are flexibly coupled.

The size of each grinding member is a function of the rolling characteristics of the layer of magnetic material on the metallic disc. The size is controlled so that the grinding members, which themselves rotate about an axis of the grinding assembly, are in contact with the magnetic material of the rotating disc. Each member is small enough so that it can conform to the gradual rounded undulations of the surface of the magnetic material. The number of the grinding members and their distribution, with respect to the rotatable plate to which they are flexibly coupled, are controlled to insure that each incremental area of the surface of the magnetic material is equally ground so that the finished surface has the desired finish properties and the thickness of the layer of magnetic material is uniform within predetermined design limitations.

The novel features that are considered characteristic of this invention are set forth with particularity in the appended claims. The invention itself both as to its organization and method of operation, as well as additional objects and advantages thereof, will best be understood from the following description when read in connection with the accompanying drawings, in which:

FIGURES 1(a) and 1(b) are an isometric and side view of a coated magnetic disc with a flatless surface;

FIGURES 2(a), 2(b) and 2(c) are an isometric, side and top view of a novel grinding head incorporated in the present invention;

FIGURE 3 is a side view of a magnetic disc and the novel grinding head; and

FIGURE 4 is an isometric view of the grinding apparatus of the present invention.

Referring to FIGURES 1(a) and 1(b), there are shown isometric and side views respectively of a magnetic disc 10 comprising a metallic disc 11 coated with a layer of magnetic material 12. As is known by those familiar with the art, it is extremely difficult to machine a thin metallic disc to have a perfectly flat surface especially when the disc is of substantial area. Generally the surface, such as 11a, on which the magnetic material 12 is deposited has rolling characteristics with gradual rounded undulations. Therefore, when the magnetic material 12 is deposited thereon, its top surface 12a has similar gradual rounded undulations. For explanatory purposes, in FIGURE 1, the undulations have been greatly enlarged with respect to the thickness of the disc.

In order to obtain optimum performance from the magnetic disc, it is necessary to grind or lap the surface 12a of the deposited layer 12 to a perfect finish, while maintaining the thickness thereof to be as uniform as possible. In FIGURE 1(b), the desired thickness is represented by arrows *t*. From FIGURE 1(b), it is appreciated that if conventional techniques of grinding flat surfaces were used to grind or lap surface 12a, it would be impossible to control the thickness uniformity of the layer 12. By grinding the layer 12 along a line 14 so that the layer has the desired thickness *t* at the bottom of undulations 12b and 12c, the magnetic material on some portion of the surface of the metallic disc would be completely ground off. Similarly, if the layer 12 is ground along a line 16 so that, at the top of undulations 12d and 12e, the layer has the desired thickness, only portions of the surface 12a of layer 12 will be ground. Thus, its finished surface will not have the desired uniform characteristics.

It should therefore be appreciated that the layer 12 with rolling surface 12a must be ground or lapped by a new technique whereby despite the rolling surface 12a, the

desired thickness t can be achieved. This can be accomplished by a novel grinding or honing head 20, an isometric view of which is shown in FIGURE 2(a). FIGURES 2(b) and 2(c) are a side view and top view respectively of the novel head. As seen, the head comprises a disc-like metallic member 21 with a rubber or felt-like material 22 glued thereon. A plurality of metallic grinding pads 24 are fastened to the other side of the material 22, each pad having a disc-like shape. The pads are positioned on top of the material 22 along a plurality of circular paths designated by numerals 25, 26 and 27 in FIGURE 2(c).

Reference is now made to FIGURE 3 which is another side view of the disc 10 with the honing head 20 placed thereon. As seen, the head 20 is lowered onto the surface 12a of magnetic layer 12 so that the disc-like pads 24 are in contact therewith. Since the pads are mounted on the rubber or felt-like material 22, they are capable of conforming to the surface 12a despite its rounded undulations.

In practice, prior to lowering the head 20 unto the disc 10, an abrasive compound is deposited on the surface. Thereafter, the head is lowered and disc and head are rotated at predetermined speeds for fixed durations about axes of rotations designated by lines 30 and 31 respectively. The pads 24 are accurately distributed over the material 22 so that at the end of the grinding operation, the desired amount of material is ground off the magnetic material 12. Since the pads 24 continuously conform to the surface 12a, the amount of material which is ground off is uniform over the selected area of surface 12a despite the rolling characteristics thereof.

The entire grinding operation may be automatically accomplished in a grinding apparatus 35 shown in isometric view in FIGURE 4. The apparatus 35 houses a control stage CS which is actuated by means of control switches 36 mounted on a control panel 37. A pair of timers 38 and 39 are also mounted on the panel 37 to enable an operator to preset the sequence of operations and the time of each step. The apparatus 35 includes a hone table 41 on which a magnetic disc 42 to be ground is placed. A motor 43 is connected to the table 41 in order to rotate the disc about its center at a selected speed. The apparatus 35 also includes a head assembly 45 in which the head 20 is mounted. The assembly 45 is supported on a shaft 45a. The assembly includes a nozzle 46 which is connected to an abrasive compound container 47 by means of a conduit 48, which may reach in the particular described embodiment nozzle 46 through shaft 45a and assembly 45. However to simplify the drawing, the actual connection between conduit 48 and nozzle 46 is deleted. The compound may be a mixture of water and alumina AlO_2 which is continuously mixed. The compound is supplied to the nozzle 46 under pressure so that when the assembly 45 is turned by being partially rotated about shaft 45a from a quiescent position (as shown) to a second position in which the head 20 is above the disc 42, the compound is deposited onto the surface 42a of the disc 42. The assembly 45 also supports a motor 49 which when energized causes the head 20 to rotate about its center at a controlled speed or rate.

In operation, the disc 42 is first placed onto table 41. Thereafter, an automatic switch 36 is pressed which actuates the control stage CS. Motor 43 is actuated to rotate the disc about its center at a selected rate. Also, the head assembly is caused to partially rotate about shaft 45a that it moves from its quiescent position to position the head 20 over the disc. As the head assembly moves, abrasive compound flows through nozzle 46 into surface 42a. When the head reaches a desired position above the disc, the motor 43 is deenergized; the flow of the abrasive compound is stopped. After a time delay sufficient for the disc to stop coasting, the head 20 is lowered onto the disc so that pads 24 are in contact with the surface 42a, with a layer of compound therebetween. The lower-

ing of the head is accomplished by merely lowering the shaft 45a which supports the head assembly.

Thereafter, both the head and disc are caused to rotate simultaneously about their axes of rotation at selected rates for a fixed time period. This is achieved by the proper energization of motors 43 and 49. At the end of the period, while the disc and head rotate, the head is raised by raising shaft 45a and stopped by deenergizing motor 49. After the two are separated, the motor 43 is again deenergized to stop the disc from rotating. Thus, by separating the disc and head from one another while both rotate, the surface 42a is protected from any undesired scratching. After both disc and head are stopped, the head assembly returns to its quiescent position. The entire operation can be automated by presently known control techniques.

From the foregoing, it should be appreciated that the novel honing head 20 with the plurality of pads on a flexible material 22 enables the grinding or lapping of a rolling surface such as surface 12a [FIGURES 1(b) and 3]. The amount of material which is lapped depends on the rates of rotation of the disc and the head and the fixed period during which the grinding is performed. The uniformity with which the material is lapped is accurately controlled by the relative positions of the pads 24 on the felt-like material 22 and their relative cross-sectional areas. The pads are distributed in such a manner so that each unit of area of the disc's surface is lapped equally during the operation so that the finished layer of magnetic material is of uniform thickness.

As seen from FIGURE 2(c), the pads 24 are arranged in three circular paths 25, 26, and 27, with four pads equally spaced in each of paths 25 and 26, and eight pads equally spaced in path 27 in relation to the pads in the other two paths. The pads 24 are of equal circumferences. However, in order to insure that the surface of the magnetic material is lapped to a uniform thickness, it may be necessary to remove portions of the grinding surfaces of some of the pads. Thus, for example, each of the pads in path 25 has a slot 51 of a first width, whereas each pad in path 27 has a slot 52 of a different width.

In one actual reduction to practice, a magnetic disc coated with a magnetic material 0.0004 inch thick was lapped with a honing head similar to the head diagrammed in FIGURES 2(a), 2(b) and 2(c), which removed only 0.0001 inch of material leaving a layer of uniform magnetic material of 0.0003 inch, plus or minus 0.000010.

In one actual reduction to practice, a honing head similar to that diagrammed in FIGURES 2(a), 2(b) and 2(c) was constructed of a disc-like steel 2.00 thick. A felt-like material 0.5 inch thick was adhesively attached to the steel member with sixteen pads of mehanite, each one inch in diameter and one-half inch thick distributed on the felt-like material as shown in FIGURE 2(c). The four pads in path 25 had slots 0.160 inch wide, while each of the eight pads in the path 27 had a slot of 0.080 inch. Paths 25, 26, 27 were of diameters 6.40 inches, 8.40 inches and 10.40 inches respectively about a center 60. The head was used to precisely grind the surface of a magnetic layer of a magnetic disc. By controlling the rates of rotation of the disc and the head, as well as the fixed duration of grinding, it was possible to remove one ten-thousandths of an inch from a layer with rolling undulations 0.0004 inch. Thus, the magnetic layer could be machined to have a very precise finish with a highly uniform thickness even though the finished surface is not perfectly flat.

There has accordingly been shown and described herein a novel grinding apparatus in which a novel honing head is used to precisely lap a layer of material which does not necessarily have a flat surface. The invention enables the lapping of the surface of the layer to a precise finish while controlling the uniformity of the thickness of the

finished layer. Although the invention has been described in conjunction with magnetic discs, it should be appreciated that the invention is not limited thereto or to the specific arrangements shown to explain the teachings thereof. Those familiar with the art may make modifications without departing from the spirit of the invention. Therefore, all such modifications are deemed to fall within the scope of the invention as claimed in the appended claims.

What is claimed is:

1. An apparatus for grinding the surface of a magnetic disc comprising a layer of magnetic material deposited on a metallic disc surface which has gradual rounded undulations, to control the thickness of the layer of magnetic material and the finish thereof, comprising:

a disc assembly including a table for positioning said disc thereon, and a motor for rotating said table and said disc positioned thereon at a first predetermined rate;

a head assembly including a grinding head, means for positioning said grinding head with respect to said disc, and rotating means for rotating said head about a center thereof;

position means for controlling said head assembly to position said head on the surface of the layer of magnetic material on said disc;

control means for energizing said motor to rotate said disc about the center thereof at a first rate, and for energizing said rotating means to rotate said grinding head about its center at a second rate; and

timing means for controlling the period said head is on said surface while said disc and said head are rotating at their respective rates, and for energizing said positioning means to raise said head from said disc at the end of said period while said head and disc are rotating, said head including a flexible member and a plurality of grinding pads attached thereto, said grinding pads being in contact with and conforming to the surface of the layer of magnetic material so as to grind said layer to a uniform thickness irrespective of the gradual rounded undulations of said surface.

2. An apparatus as recited in claim 1 wherein said grinding head comprises a disc-shaped rigid member, a rubber-like flexible member attached thereto and a plurality of metallic disc-shaped grinding pads attached to said flexible member and distributed thereon to grind the surface of the layer of magnetic material to a uniform thickness and a predetermined finish by conforming to the surface irrespective of gradual rounded undulations thereof.

3. An apparatus as recited in claim 2 wherein said head assembly includes means for depositing an abrasive compound on the surface of the layer of magnetic material before said head is positioned by said positioning means on said surface for grinding said magnetic material to a uniform thickness and to a predetermined finish.

4. An apparatus for finishing the surface of a layer of magnetic material deposited on a surface with gradual rounded undulations of a rigid disc-shaped member, to control the uniformity of the thickness of the layer of magnetic material on said surface with the gradual rounded undulation, and to grind the surface of said layer to a desired precise finish comprising:

a disc assembly for positioning said disc-shaped mem-

ber thereon and for rotating it about a center axis thereof;

a head assembly including a grinding head and a nozzle; a container of a grinding compound connected to said nozzle;

control means for energizing said disc assembly to rotate said disc and for energizing said head assembly to position said grinding head above said rotating disc-shaped member and to deposit through said nozzle said grinding compound on the surface of the layer of the magnetic material on said disc-shaped member;

switching means for stopping said disc-shaped member and for lowering said grinding head onto the surface of said layer of magnetic material, said head including flexible means so that said head conforms to the gradual rounded undulations of the surface of the layer of the magnetic material, said control means including means for energizing said disc and head assemblies to rotate said disc-shaped member and the layer of magnetic material deposited thereon at a first rate and to rotate said grinding head at a second rate;

timing means for controlling the period said disc and head are rotating to control the grinding of said layer of magnetic material; and

means for energizing said switching means at the end of said period to raise said head from the surface of said layer of magnetic material while said disc-shaped member is rotating to prevent scratching of the ground surface of said layer and to control the uniformity of the thickness thereof.

5. An apparatus as recited in claim 4 wherein said grinding head comprises a rigid member, a flexible rubber-like material attached thereto and a plurality of metallic disc-shaped grinding pads which are in contact with the surface of the layer of magnetic material when said head is positioned thereon whereby said flexible rubber-like material enables said plurality of pads to conform to and be in contact with the surface irrespective of the gradual rolling undulations thereof, said pads being distributed on said flexible rubber-like material to control the grinding of said magnetic material so that each unit area of the surfaces is uniformly ground.

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