

[54] **METHOD FOR FABRICATING A DISCFILE**

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[52] U.S. Cl. **51/323, 51/281 SF, 51/327**

[51] Int. Cl. **B24b 1/00**

[58] Field of Search 51/281 SF, 283, 323, 327,
51/131, 132, 318

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Primary Examiner—Donald G. Kelly

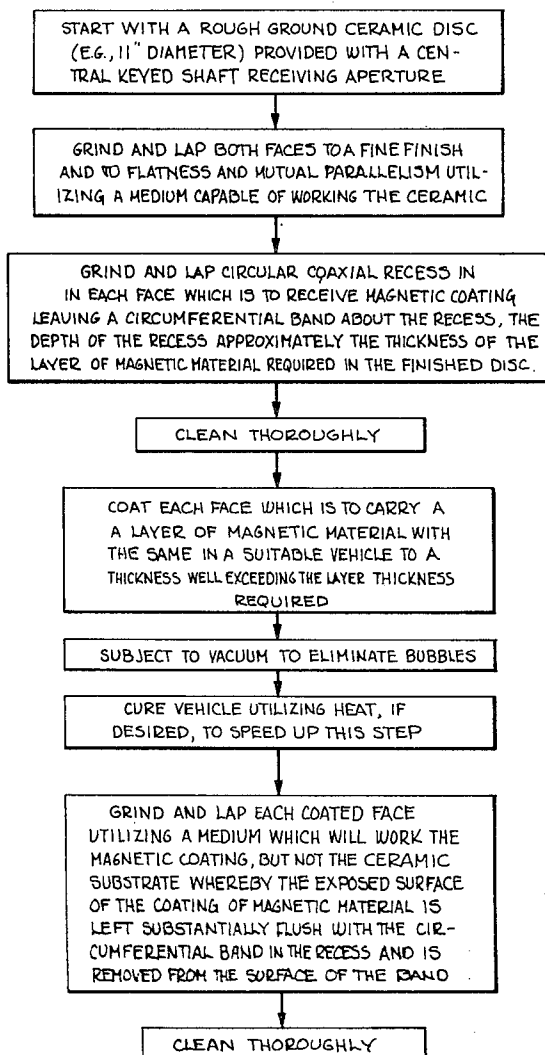
Attorney, Agent, or Firm—Cahill, Sutton & Thomas

[57]

ABSTRACT

A method for fabricating magnetically responsive circular discs to store magnetically encoded information is disclosed. The faces of rough finished circular discs of ceramic material are ground to a predetermined degree of flatness and mutual parallelism. A centrally located recess is ground in at least one of the faces whereby the perimeter of the recess defines a circular band extending radially outwardly to the edge of the disc. The recess of the disc is coated with a magnetically responsive material to a thickness at least equal to the depth of the recess. Alternately, a coating of magnetically responsive material may be formed across the whole surface of each recessed face. Each recessed face is ground with a grinding medium acting only upon the magnetically responsive material until the coating is essentially flush with the surface of the circular band.

4 Claims, 14 Drawing Figures



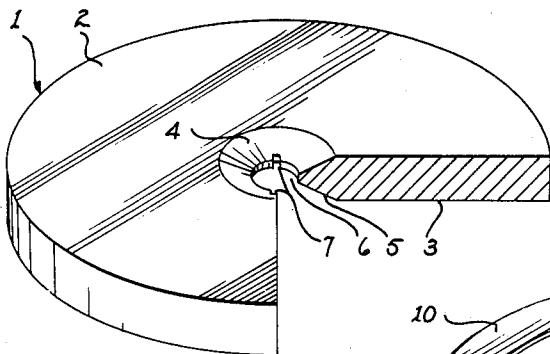


fig. 1

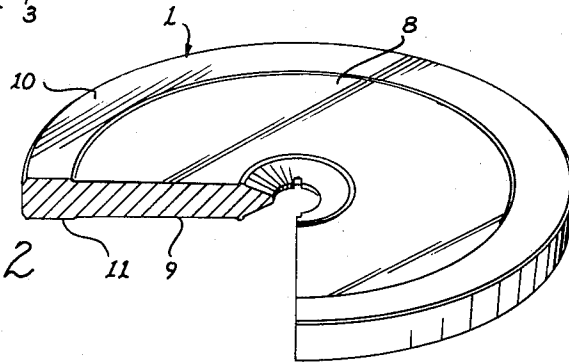


fig. 2

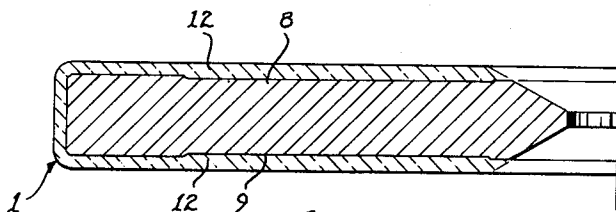


fig. 3

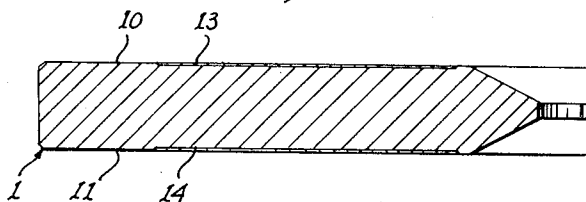


fig. 4

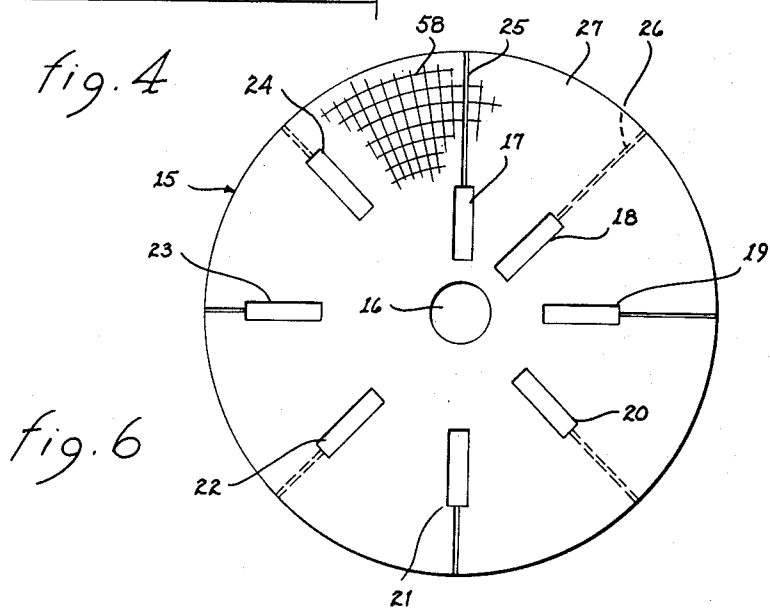
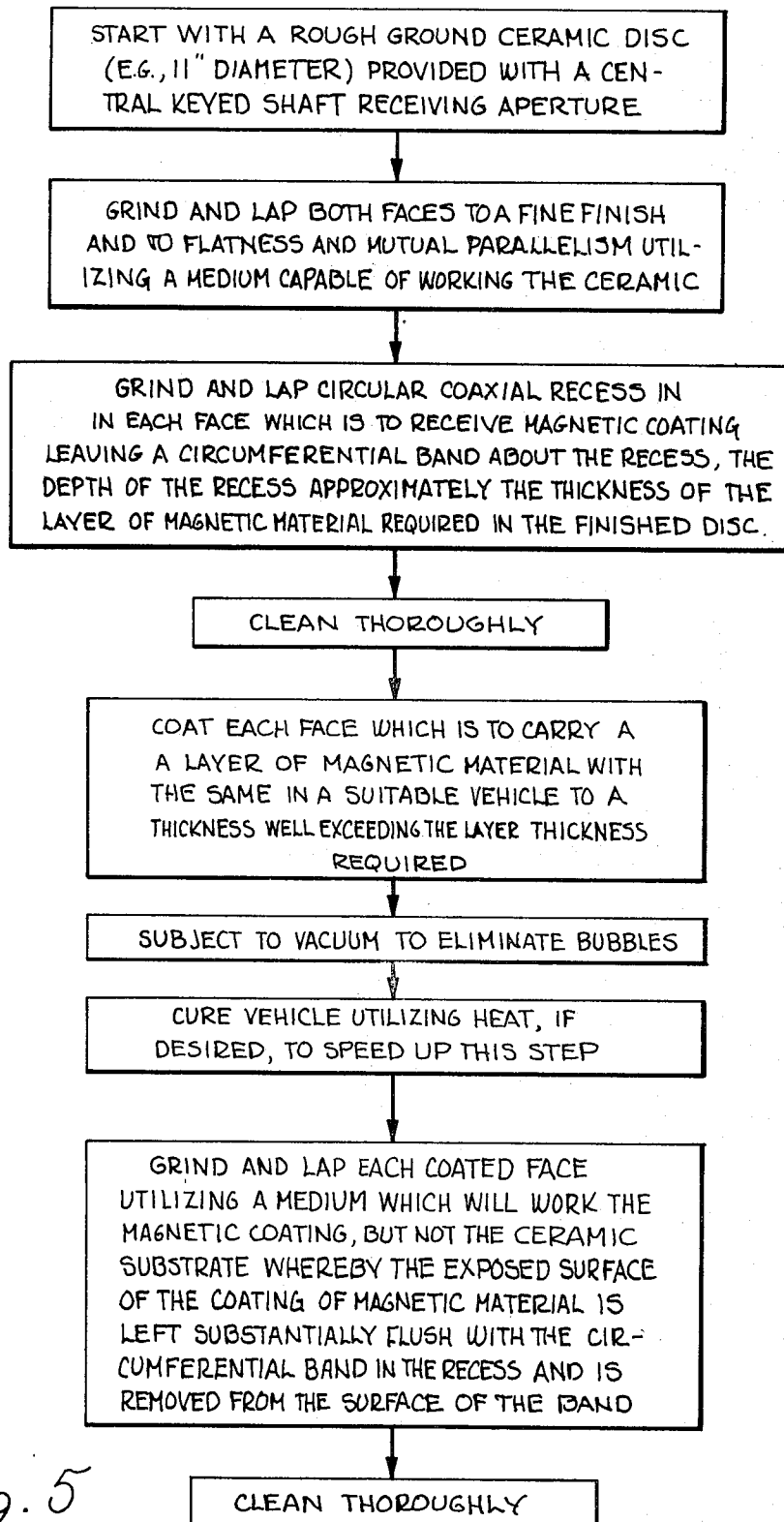


fig. 6

SHEET 2 OF 5

*Fig. 5*

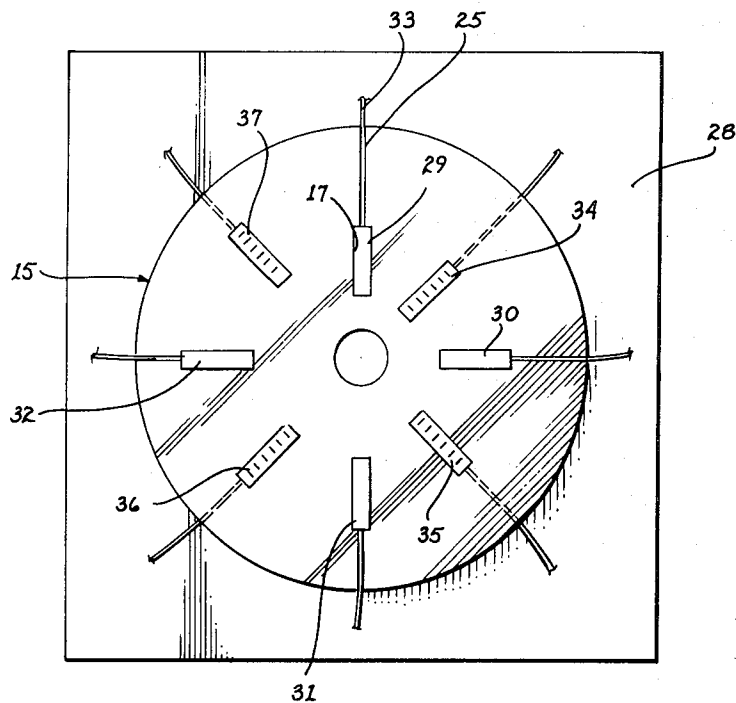


fig. 7

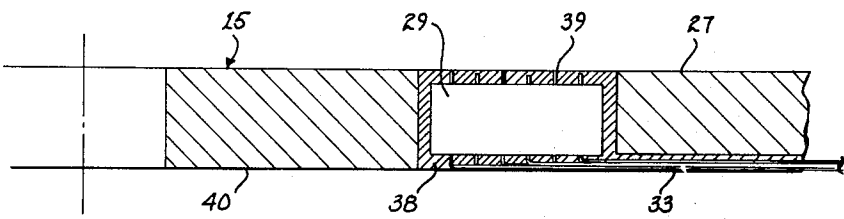


fig. 8

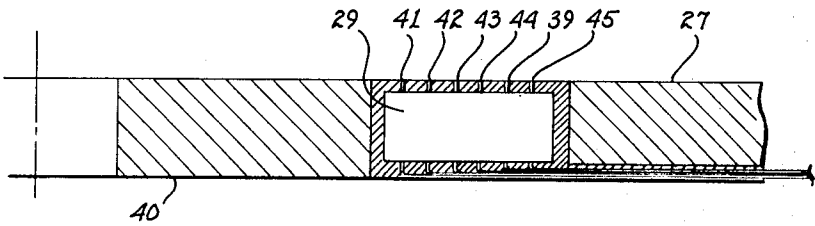
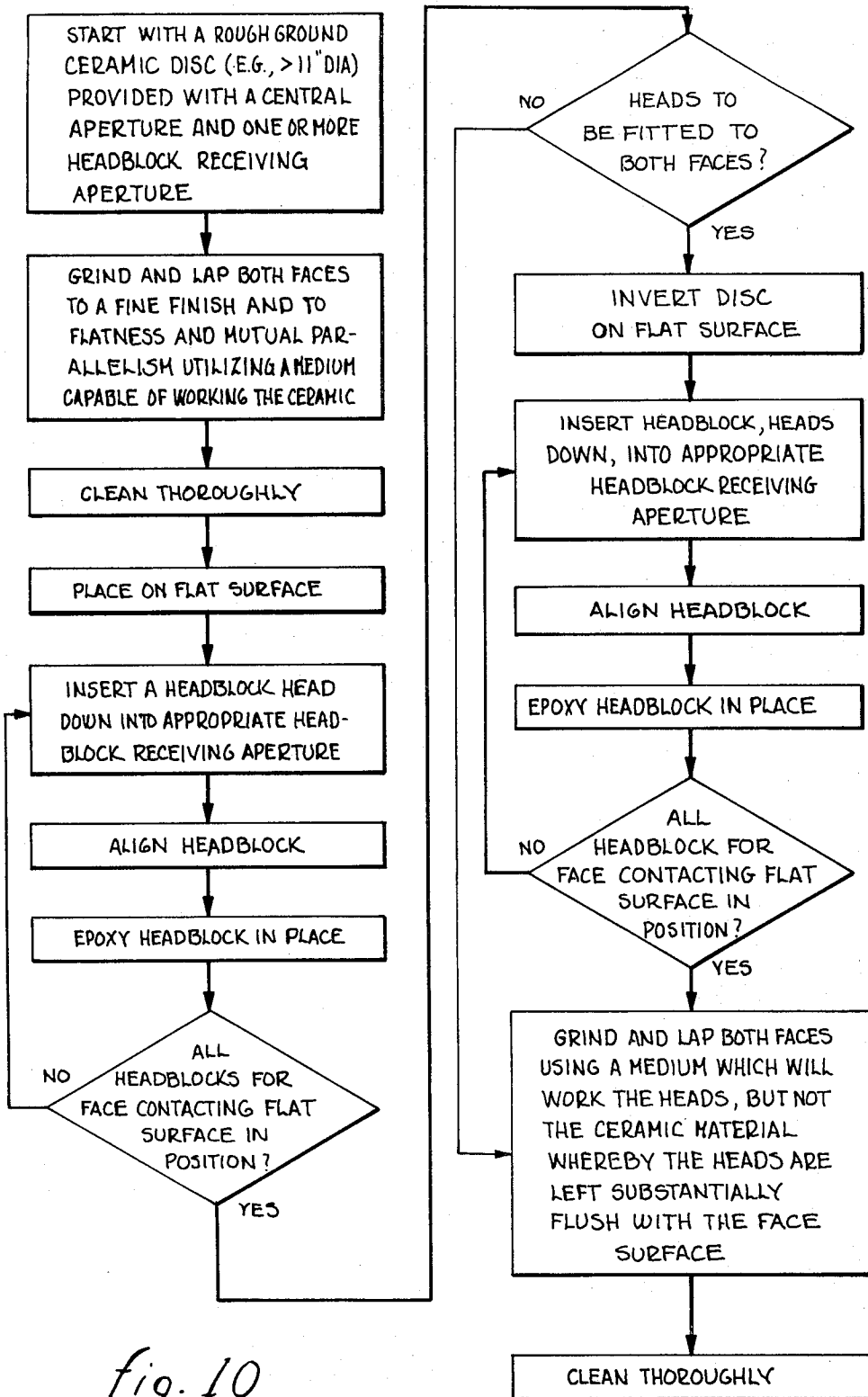
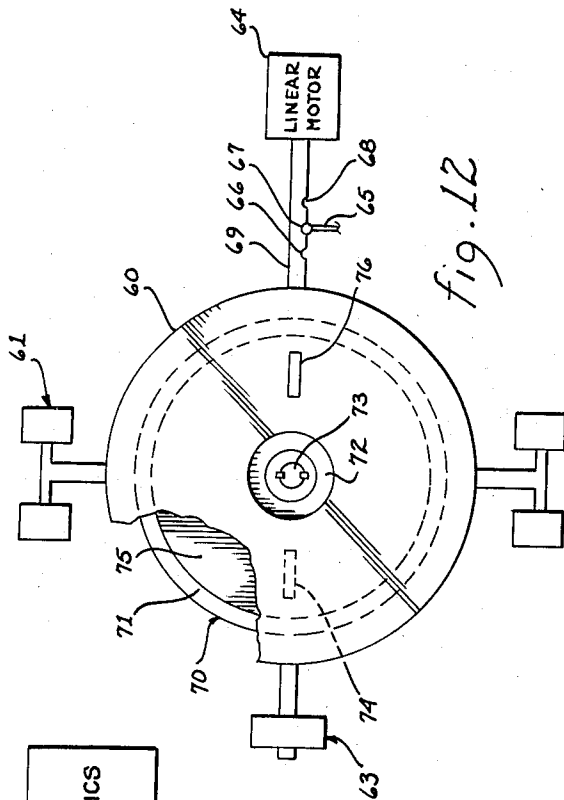
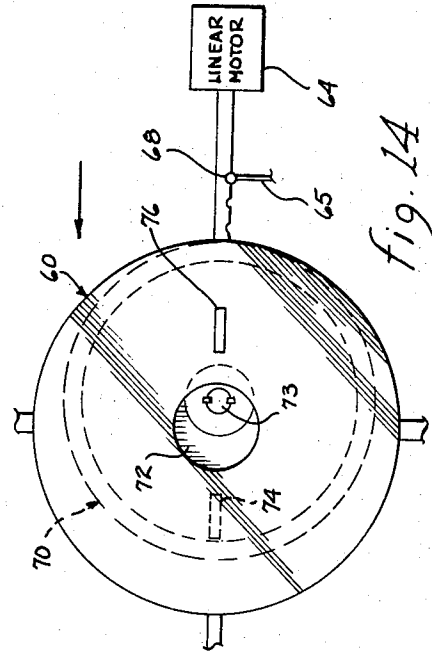
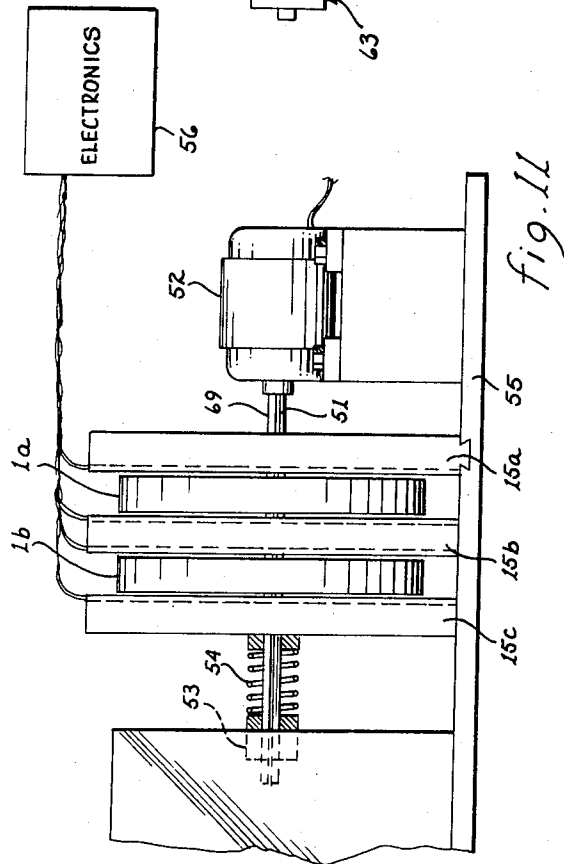
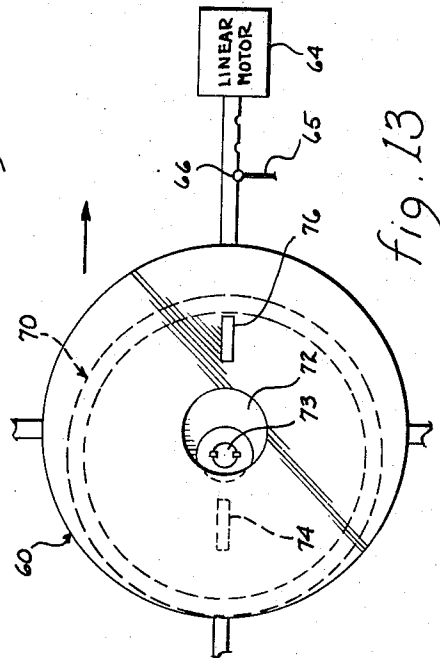


fig. 9





METHOD FOR FABRICATING A DISCFILE

This is a divisional application of an application entitled DISCFILE FOR STORING MAGNETICALLY ENCODED INFORMATION AND METHOD FOR FABRICATING ESSENTIAL COMPONENTS THEREOF filed Dec. 18, 1972, assigned Ser. No. 317,731 and describing subject matter invented by the present inventor.

This invention relates to the information storage and retrieval arts, and, more particularly, to a method for fabricating magnetically responsive discs.

Discfile information storage and retrieval apparatus has been a constituent of information storage systems for some years. However, certain problems remain in state-of-the-art discfiles which are deemed to be very serious to those skilled in the art. Two broad categories of discfiles in common use may be categorized as flying head and fixed head.

In flying head systems, ceramic or stainless steel heads float on air bearings 50–100 micro inches from a rotating disc coated with a recording medium. The heads must conform to a very closely defined curvature in order to "fly" correctly, and it is a difficult and expensive process to achieve the proper contour. A particular problem that plagues flying head discfiles is that the heads must either be picked up in flight or allowed to land on the disc when the disc is inactivated. The former approach manifestly requires a complicated and expensive mechanical arrangement capable of both loading and unloading the head on the fly. Nonetheless, slight head touches are experienced, and damage is caused each time a head touch occurs. The alternative of allowing the head to drop onto the disc requires expensive rhodium plating, produces oxide dust that necessitates mandatory periodic cleaning, deteriorates the flying quality of the heads, and can cause head crashes. All flying head systems are prone to damage from contamination with particulate matter even as fine as cigarette smoke and must therefore be operated in a controlled environment.

Fixed head systems suffer from related drawbacks. While the components are easier to make (at the state-of-the-art) than flying heads, very skilled personnel are required to assemble and align the systems utilizing very expensive apparatus to true the rotating discs to their shaft. Extremely tight tolerances are required in this operation because cumulative error must be minimized in stacked discs and no wobble can be tolerated. The assembly must be done in a clean atmosphere to avoid contamination. Nonetheless, despite every precaution, fixed head systems are subject to jitter, and the head leading edge can and does dig into the rotating disc causing catastrophic damage. Further, since more heads are required for a given storage capacity, correspondingly more electronics are required.

The present invention completely overcomes all the enumerated drawbacks of both the flying head prior art systems by virtue of its simplicity, extreme ruggedness, and ease of fabrication.

It is therefore a broad object of the present invention to provide an improved disc information storage system.

A more specific object of the present invention is to provide a method for fabricating an essential component of the system.

Another object of the present invention is to provide a method for coating a disc with magnetically responsive material.

Yet another object of the present invention is to provide a method for forming a ceramic disc to receive magnetically responsive material.

A further object of the present invention is to provide a method for regulating the removal of a part of the coating formed on a disc.

A yet further object of the present invention is to provide a method for gauging the grinding of a coating on a disc.

A still further object of this invention is to provide such a discfile which is inexpensive to fabricate and maintain.

These and other objects of the present invention will become apparent to those skilled in the art as the description of the invention proceeds.

The present invention may be understood with greater specificity and clarity with reference to the following figures, in which:

FIG. 1 is a partially cutaway illustration of a rough disc after a first truing operation has been carried out, which disc is to be finished into a magnetic medium-carrying, rotating disc;

FIG. 2 is a partially cutaway illustration of the disc shown in FIG. 1 after coaxial circular recesses have been ground into both faces thereof;

FIG. 3 is a half-section of the disc after a coating operation has been carried out;

FIG. 4 is a half-section of the disc after a final grinding operation has been carried out exposing flying band portions thereof;

FIG. 5 is a flow diagram summarizing the process by which the magnetic medium carrying disc is fabricated;

FIG. 6 is a plan view of a headframe disc after a preliminary truing operation has been carried out;

FIG. 7 is a plan view of the headframe illustrating the manner in which record/playback heads are mounted therein;

FIG. 8 is a partial section through the headframe illustrating the orientation of a head within the frame after it has been mounted;

FIG. 9 is a corresponding view illustrating the manner in which the heads are trued to the headframe faces;

FIG. 10 is a flow diagram summarizing the process by which the headframe is fabricated;

FIG. 11 illustrates a representative assembly of headframes and rotating discs in accordance with the present invention;

FIG. 12 illustrates a variant, shifting headframe embodiment of the invention in a first position;

FIG. 13 illustrates the variant embodiment in a second position; and

FIG. 14 illustrates the shifting head embodiment in a third position.

Reference is now taken to FIGS. 1–5 in conjunction with the following description of the process for fabricating a magnetic medium-bearing rotating disc according to the present invention.

With known techniques, a ceramic block is hydrostatically cast in the green, sliced into discs, fired and rough ground to relatively broad tolerances of thickness, parallelism, and flatness. A ceramic material found especially suitable is Coor's AD series of which

the 999 grade approaches sapphire in hardness. A fine grain is preferred to achieve the smooth substrate necessary for uniform magnetic properties.

The rough discs may then be usefully sorted into closer thickness tolerances to accommodate surface working by a grinding and lapping machine tool such as that illustrated and claimed in patent application Ser. No. 311,233, filed Dec. 1, 1972, entitled "Radial Surface Finishing Apparatus", invented by Harold R. Klievoneit. The disc is then lapped and ground to very close tolerances of flatness, finish and parallelism of the two faces, preferably on the aforereferenced machine utilizing spindle oil and diamond paste, spindle oil and a boron nitride slurry or an equivalent cutting medium. The resulting disc 1 has upper 2 and lower 3 faces which are true across their surfaces and parallel with respect to one another. Central, inwardly tapered portions 4, 5 of the upper and lower surfaces terminate in a central shaft receiving aperture 6 including diametrically opposed keyways 7. The tapered portions 4 and 5, the aperture 6 and the keyways 7 may be prepared in the disc while it is still in the green.

With reference to FIG. 2, each face of the disc 1 has had a circular recess 8, 9 ground therein leaving respective circumferential bands 10, 11 extending about the outer edges of the faces. The depth of the recesses 8 and 9 should be sufficient to accommodate the thickness of the magnetic medium coating in the finished disc. This dimension may be on the order, by way of example, of 100 micro inches for a conventional ferrous oxide coating. Inner bands 10a and 11a may optionally be left to provide an increase in accuracy in carrying out a subsequent step.

After a very thorough cleaning (utilizing for example, vapor degreasing and aqua regia soak) followed by appropriate rinsing and drying steps, the disc is coated, as shown in FIG. 3, with a layer of magnetic material in a suitable vehicle. The coating 12 may be applied by spraying, dipping, or in such other fashion as may be convenient and need not be done to any particular standards other than to a thickness exceeding the depth of the recesses 8 and 9 across the entire surface thereof. Depending upon the porosity of the substrate ceramic material chosen, it may be desirable to lay down a sealer coat prior to applying the magnetic medium coating. The magnetic medium may usefully have an epoxy base in accordance with materials already in use in the preparation of state-of-the-art discfiles. To achieve a uniformly high quality coating, the disc may be subjected to a vacuum to eliminate all bubbles and then baked to heat cure the vehicle.

The disc faces are then ground with a medium which will cut the coating, but not the ceramic substrate material. An example of a suitable cutting medium for carrying out this step is aluminum oxide in epoxy blocks utilizing oil or kerosene to prevent loading. As a result of this step, the disc is brought to its final form illustrated in FIG. 4 in which it will be observed that the flying bands 10 and 11 have been exposed and the recesses 8 and 9 now carry individual coatings 13 and 14 of the magnetic medium, the upper surfaces being nominally flush with flying bands 10 and 11 (and inner bands 10a and 11a if provided). It has been found that, in actual practice, the upper surfaces of the coatings 13 and 14 are very slightly below the upper surface of the flying bands 10 and 11 because of the slight resiliency of the working medium and the softness of the coatings

compared to the ceramic material. Those skilled in the art will appreciate, of course, that the depth of the recesses 8 and 9 and the thickness of the coating 12 (and the surface finished derivative coatings 13 and 14) are greatly exaggerated for clarity in explaining the process. As previously noted, the depth of the recesses 8 and 9 may be on the order of 100 micro inches for a ferrous oxide magnetic medium while good flying characteristics are achieved with flying bands having a width on the order of 10 percent or less of the disc diameter. Thus, an 11 inch disc could have a nominal 1 inch flying band although satisfactory flying characteristics may be achieved, according to specific system parameters, with flying bands of one-eighth inch or even narrower.

Attention is now directed to FIGS. 6-10 in conjunction with the following description of the process by which a ceramic headframe may be fabricated for use with rotating discs prepared in accordance with the above discussed process. The rough disc 15, illustrated in FIG. 6 is provided with a central aperture 16 which is larger than the aperture 6 of the magnetic medium carrying disc. Additionally, elongated rectangular headblock receiving apertures 17, 18, 19, 20, 21, 22, 23, and 24 are disposed in a generally spiral configuration about the disc. Alternate ones of the elongated apertures have lead receiving channels, such as the channels 25 and 26, radially outwardly directed on the upper face 27 and the lower face of the disc. Alternatively, radially drilled passages may be provided between the elongated apertures and the edge of the disc 15 for housing the leads from the headblocks which are subsequently incorporated into the headframe.

After the faces of the headframe 15 have been trued to flatness and finish as previously described in conjunction with fabricating the rotating discs, the headframe 15 is placed on a true surface, such as the granite surface plate 28, FIG. 7. Downwardly directed headblocks 29, 30, 31, and 32 are pushed into their respective elongated apertures, such as the aperture 17 for the headblock 29, and glued in with a relatively fast setting epoxy compound. Radial and circumferential alignment of the individual headblocks may be effected by utilizing a suitable jig (not shown). The leads 33 are laid into the channel 25 and also epoxied into position. As shown in FIG. 7, upwardly directed headblocks 34, 35, 36 and 37 have already been fixed into the headframe 15 during a previous corresponding operation in which the headframe was positioned with its other face down.

After the headblocks have been fixed in the headframe 15, the farthest extending individual heads will be flush with the surface of the face to which they are directed. Referring, by way of example, to FIG. 8, the headblock 29 is fixed within the elongated aperture 17 by means of cured epoxy compound 38, and the leads 33 are similarly fixed within the channel 25. The farthest extending head 39 of the headblock 29 is flush with the surface 27 of the headframe 15, and it will be understood that the farthest extending downwardly directed heads of each of the headblocks 34, 35, 36 and 37 will be flush with the surface 40 of the headframe 15.

In order to obtain a correct gap for all the heads, as best shown in FIG. 9, the surfaces 27 and 40 are again ground parallel to one another until each of the heads, such as the heads 39 and 41-45 of the headblock 29,

are flush with a face of the headframe 15. As previously noted with reference to the final surface finishing step of the disc 1, the upper extremities of the heads are found to be very slightly below the surfaces 27 and 40 of the headframe 15 because of their relative softness compared to the ceramic. The distribution of headblocks depicted in FIGS. 6 and 7 is, of course, merely a representation of one distribution approach. Others will occur to those skilled in the art and are equally susceptible to practice in accordance with the teachings of the present invention. Further, it is not necessary that headblocks be directed toward both faces of the headframe unless an assembly is contemplated using two or more rotating discs.

It has been found in practice that the ceramic material from which the headframe 15 is cast may usefully be somewhat coarser than that used to cast the disc 1 in order to eliminate chipping.

Fabrication of the headframe 15 is completed by a thorough cleaning step, preferably by using ultrasonic apparatus of the well known type.

A horizontally configured system utilizing components fabricated in accordance with the present invention is depicted in FIG. 11. A shaft 50 having a key 51 extends between a motor 52 and an aligned bearing 53. Nonrotating headframes 15a, 15b and 15c are separated by rotatable discs 1a and 1b. The key 51 engages the keyways 7 (see FIG. 1) of each of the rotatable discs 1a and 1b while the shaft 50 extends through the apertures 16 (see FIG. 6) of the headframes 15a, 15b and 15c with clearance. Inasmuch as the components are self-aligning, the stack may be assembled with a minimum skill requirement.

A compression spring 54 bearing on the outer surface of the headframe 15c represents a force biasing the headframes and rotatable discs together. Hence, when the motor 52 is not energized, adjacent surfaces of the headframes and the flying heads of the discs will be in contact. Once the motor 52 is energized, rotation of the discs 1a and 1b creates an air bearing between the flying bands 10, 11 (see FIG. 4) and the adjacent surface area of the headframes 15a, 15b, and 15c. During start up, rubbing will occur between the flying bands and the opposing surfaces, but the contact is highly polished ceramic-to-ceramic and thus is very long wearing. When sufficient angular velocity of the discs 1a and 1b are achieved to institute an air bearing, the headframes 15c and 15b move laterally against the compression spring 54 while the headframe 15a, which is fixed to base member 55, remains stationary. As a result, gaps (shown greatly magnified in FIG. 11) appear between the discs 1a and 1b and the adjacent headframes. The discs 1a and 1b are, in effect, flying on the flying bands with an air gap existing between the heads supported within the headframes 15a, 15b and 15c and the recording surfaces on the faces of the rotating discs. The flying bands may lift from the headframes a distance on the order of 10-100 micro inches. Maximum stability is achieved by the very large flying area positioned radially outboard to give a lever advantage. The shape and thickness of the keyways 7 (FIG. 1) permit a slight accommodation to non-parallelism which will take place automatically when the air bearing is achieved. Storage and retrieval is effected under control of the electronics block 56 communicating through the conductors 57 in the usual fashion.

A horizontal orientation to a stack is preferred to provide an equal bias against each of the air bearings. A vertical orientation with more than two stacked elements is observed to cause a narrower gap at the lower part of the stack because of the relatively high weight of the discs and headframes.

In order to promote a sufficient volume of air flow and to flush out contaminants, it is useful to slightly waffle the entire surface of both faces of the headframes as indicated at the exemplary area 58 of FIG. 6. This waffling may be readily carried out while the headframe disc is in the green. Any contaminant particle drawn into the system will be caught between a flying band and opposing headframe surface where it will be ground up and spewed out.

It will be observed that the flying bands of the rotatable discs 1 may fly against any portion of the surface area on the faces of headframes 15 because these faces are planar within close limits. For this reason, the headframe may be shifted in its own plane to pick up different tracks on a rotating disc which does not shift laterally. Such an arrangement is illustrated in FIGS. 12, 13 and 14. A headframe 60 is supported for lateral movement by sliding bearing means 61, 62 and 63 and by linear motor 64. A detent 65, working into notches 66, 67 and 68 on shaft 69 coupling the linear motor to the headframe, defines three exemplary lateral positions for the headframe.

FIG. 12 illustrates the headframe 60 in an intermediate position generally coaxial with disc 70 which has a flying band 71. The headframe 60 is provided with a relatively large central aperture 72 giving ample clearance to shaft 73 to which the disc 70 is keyed in the manner previously described. Downwardly directed headblock 74 operates generally in the middle portion of the recording area 75 of the disc 70 while upwardly directed headblock 76 would function in a corresponding area of a disc (not shown) overlaying the headframe 60, which disc would also be keyed to the shaft 73.

In FIG. 13, the headframe 60 has been pulled to a second position by the linear motor 64, in which second position the downwardly directed headblock 74 registers with a generally inboard portion of the recording area of the disc 70 while the upwardly directed headblock 76 registers with a generally outboard portion of a disc (not shown) which would overlay the headframe 60. The relationship of the shaft 73 to the aperture 72 in the headframe 60 may be noted.

Similarly, FIG. 14 depicts the headframe 70 in a third position with respect to the disc 70, in which third position the detent 65 engages the notch 68. In this position, the downwardly directed headblock 74 registers with a generally outboard portion of the recording area of the disc 70 while the upwardly directed headblock 76 would register with a generally inboard portion of the recording area of a disc (not shown) overlaying the headframe 70. The relative positions of the shaft 73 and the aperture 72 may again be noted.

Those skilled in the art will appreciate that the assemblies illustrated in FIGS. 11-14 are substantially simplified in order to more clearly present the inventive subject matter. In particular, a system utilizing a laterally shiftable headframe, shown in FIGS. 12-14, may in fact have a number of closely spaced positions to permit interlacing adjacent, relatively narrow tracks. Position control may be effected electronically rather than

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with a mechanical detent. Both headblocks may be directed toward the same disc positioned at slightly different distances from the headframe centerline to interlace every other track on the disc. In relatively simple systems, a single headblock may be utilized. The headblocks must, of course, translate in a path which intersects a diameter of the shaft 73 to prevent cross-talk between adjacent channels.

While the principles of the invention have now been made clear in an illustrative embodiment, there will be immediately obvious to those skilled in the art many modifications of structure, arrangement, proportions, the elements, materials, and components, used in the practice of the invention which are particularly adapted for specific environments and operating requirements without departing from those principles.

I claim:

1. A method for fabricating, from a rough ceramic casting, a circular disc carrying a magnetic medium coating on one or both faces thereof for storing information, the method comprising the steps of:

A. finishing the faces to a predetermined tolerance of flatness and mutual parallelism;

B. grinding a recess in at least one face, which recess is concentric with the axis of the disc and terminates

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short of the disc periphery to form a raised circumferential band about the outer portion of the face;

C. coating the recessed area and raised circumferential band with a coating of magnetic material; and,

D. surface grinding the face utilizing a grinding medium which will work the coating of magnetic material, but not the ceramic material; whereby the coating of magnetic material is ground substantially flush with the circumferential band in the recess and is removed from the surface of the circumferential band.

2. The method as set forth in claim 1 wherein steps B, C and D are performed on both faces of the disc.

3. The method as set forth in claim 1 including the step of cleaning the ceramic disc after completion of step B and a further step of cleaning the composite disc on completion of step D.

4. The method as set forth in claim 1 including a step of regulating said grinding step to grind a recess of a depth equivalent to a predetermined thickness of the coating.

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