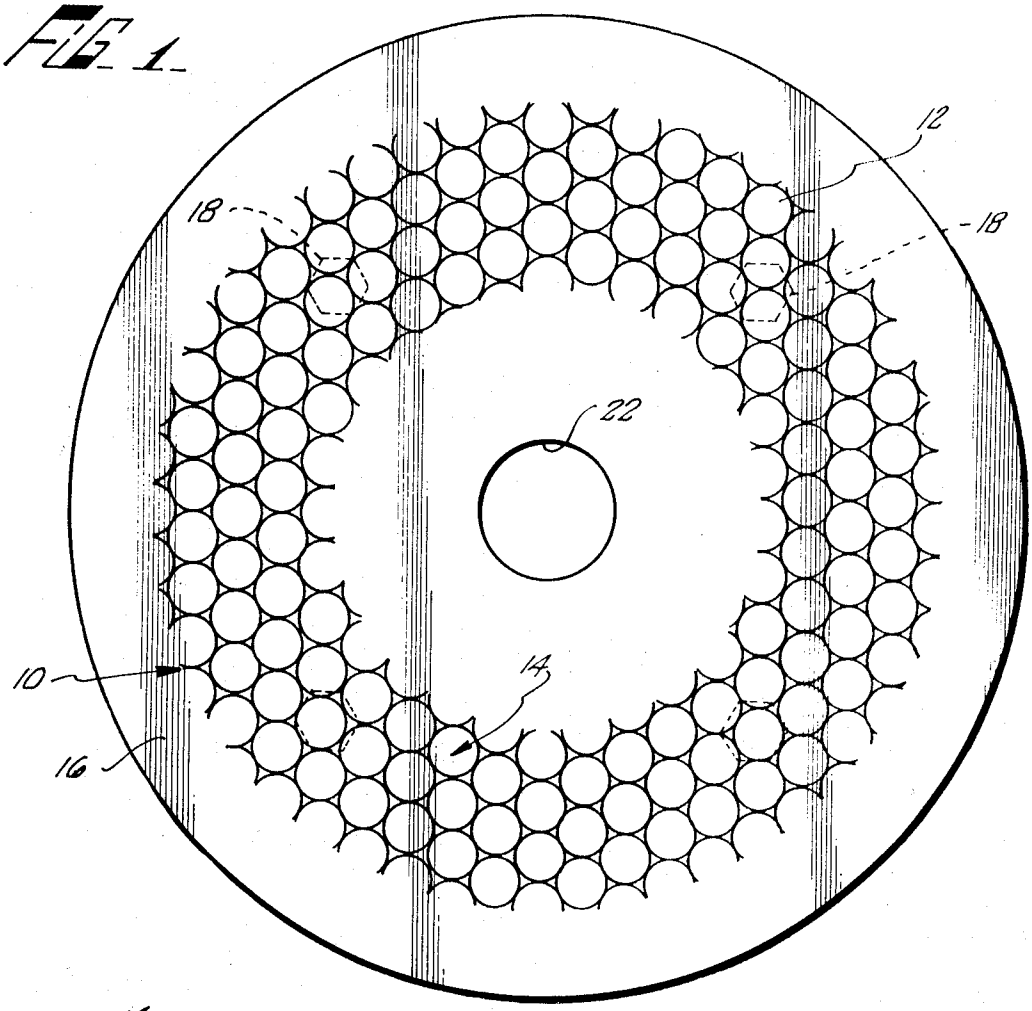
Nov. 30, 1971 W. C. TWIGG 3,623,276

MULTICELLULAR LAPPING HEAD

Filed March 5, 1970

2 Sheets-Sheet 1

FIG. 1



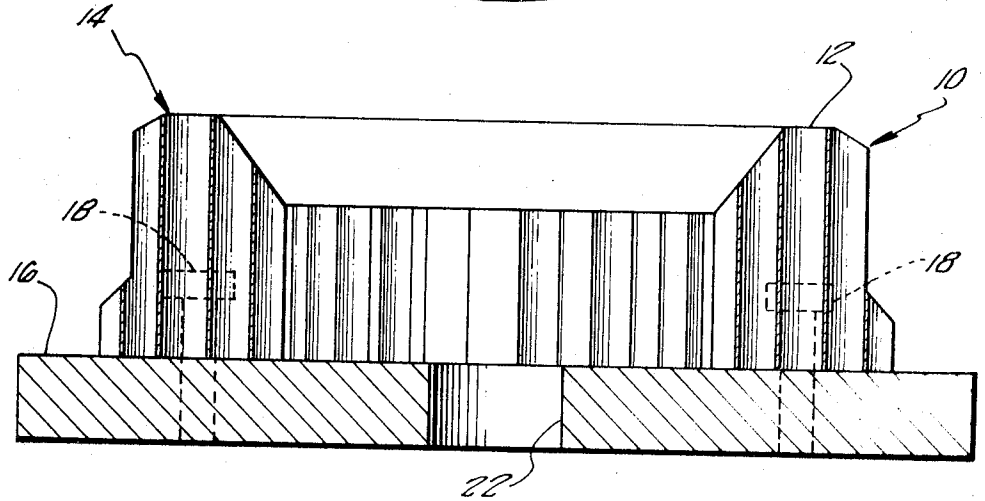


FIG. 2

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2 Sheets-Sheet 2

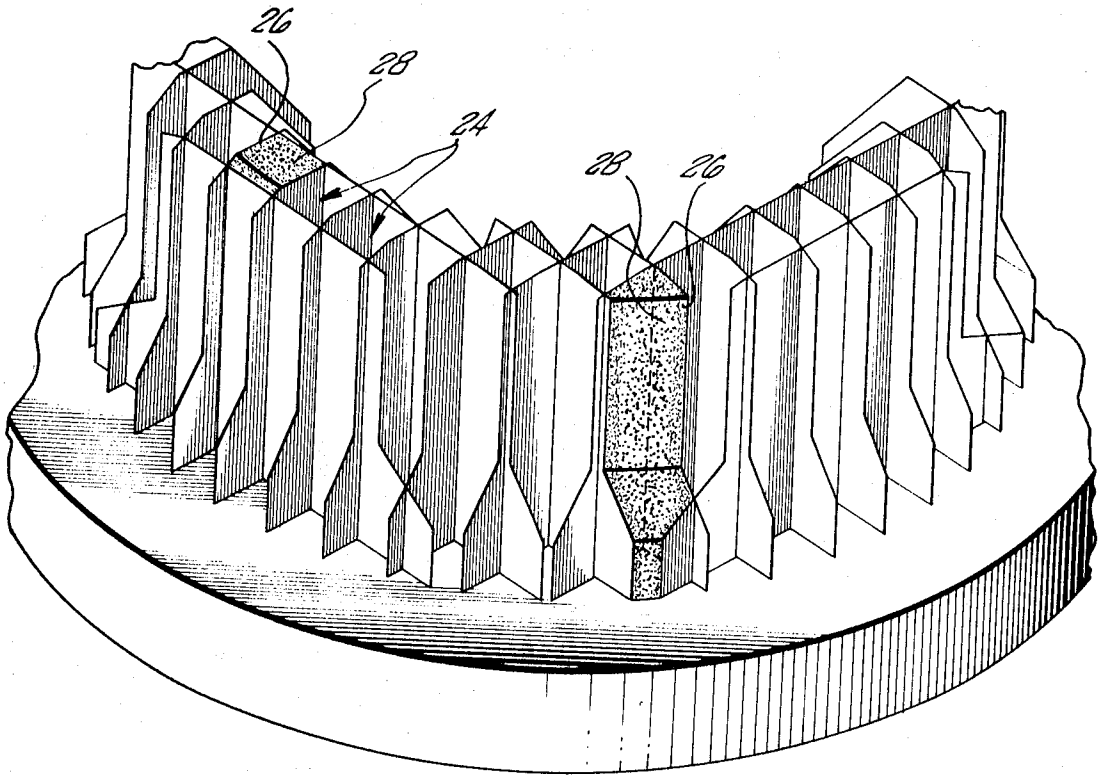


FIG. 4

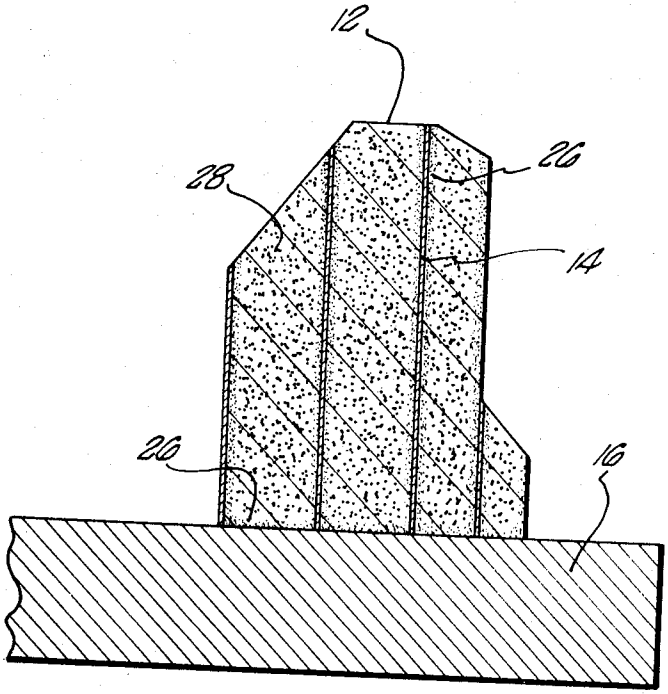


FIG. 3

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United States Patent Office 3,623,276 Patented Nov. 30, 1971

3,623,276

MULTICELLULAR LAPPING HEAD

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Filed Mar. 5, 1970, Ser. No. 16,911
Int. Cl. B24d 5/00, 7/00, 11/00
U.S. Cl. 51—209 12 Claims

ABSTRACT OF THE DISCLOSURE

A grinding or lapping head for providing metal workpieces with specular surface finishes is disclosed. Such a lapping head includes a grinding member having a generally annular shape and a supporting or retaining base plate atop which the grinding member is mounted. The grinding member comprises a honeycomb or cellular core embedded in a rigid foam material which serves as a carrier medium for a particulate abrasive substance.

BACKGROUND OF THE INVENTION

(1) Field of the invention

This invention generally relates to grinding or lapping heads. More specifically, the present invention concerns grinding or lapping heads which may be used to provide solid workpieces with a specular surface finish that satisfies exacting planimetric tolerances of flatness.

(2) Description of the prior art

The rapid advances of present day technology have created a new and significantly more exacting requirement for techniques and devices which may be used to provide metal workpieces with specular surface finishes. As an example, the computer industry is presently employing disc shaped memorys for the magnetic recording of information. Such information may frequently be in the form of "bits."

Generally speaking, the amount of information, or the number of bits, that may be recorded on a memory disc is a function of the size of the disc and/or the allowable bit density. One of the factors controlling the allowable bit density is the planimetric quality or finish given to the surface of a metal disc substrate used in the fabrication of memory discs. The flatter the surface of the disc substrate can be made, the higher the allowable bit density will be for a memory disc. Surface finish tolerances of between 2.8 to 3.6 micro-inches is exemplary of present demands.

Another factor that is critical in the preparation of disc substrates is the amount of slope given to a disc at the edges thereof. It is preferred that this slope, or what is commonly referred to as "roll-off," be minimized as much as possible. Present disc substrate specifications require that this "roll-off" not exceed seventy-five millionths. Demands for amounts of "roll-off" not exceeding thirty-five millionths are expected in the near future.

While the prior art is replete with innumerable types of lapping heads having a variety of different designs, few, if any, of the prior art devices are known to be consistently capable of producing surface finishes meeting present demands.

One such prior art lapping head that has produced inconsistent results, and has been used with limited success to date, includes an annular grinding head of rigid foam material which serves as a carrier medium for an abrasive substance. The lapping head is mounted on a rotating armature and applied to the surface of a workpiece to be finished. The inconsistent results achieved with this prior art lapping head have been found to be derivative of the undesirable and excessive amount of

flexure or sidal deflection of the grinding surface of the lapping head. This flexure tends to produce surface finishes having contours exceeding the necessary planimetric tolerances. An unacceptable amount of "roll-off" is also provided at the edge portions of a surface by such prior art devices.

It is therefore the intention of the present invention to provide a lapping head that is capable of providing a workpiece with a specular surface finish that meets or betters present day planimetric tolerances and which causes substantially reduced amounts of "roll-off."

SUMMARY OF THE INVENTION

Briefly described, the present invention involves a lapping head that may be used to provide metal workpieces with specular surface finishes that meet exacting planimetric tolerances in flatness and which produce substantially reduced amounts of "roll-off."

More particularly, this invention involves a multi-cellular lapping head including a grinding member of rigid foam material which serves as a carrier medium for a particulate abrasive material. A honeycomb or cellular core, generally having the configuration of the grinding member, is embedded in the rigid foam material. The grinding member may be securely mounted atop a base plate of suitable design.

The objects and many attendant advantages of this invention will be more readily appreciated as the same becomes better understood by reference to the following detailed description which is to be considered in connection with the accompanying drawings wherein like reference symbols designate like parts throughout the figures thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic diagram illustrating a top plan view of a lapping head, in accordance with the present invention.

FIG. 2 is a schematic diagram illustrating a side cross-sectional view of a lapping head in accordance with the present invention.

FIG. 3 is a schematic diagram illustrating an expanded, fragmented, side cross-sectional view of a portion of the present invention.

FIG. 4 is an isometric diagram illustrating an expanded, fragmented, perspective view of a cellular core that may be used to form the present invention wherein a limited number of the multiplicity of cells included in the core are filled with rigid foam material for purposes of discussion.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIGS. 1 and 2, a lapping head, in accordance with the present invention, includes a grinding member **10** having a contact area **12** which is placed in physical contact with a surface of a workpiece to be finished. A honeycomb or cellular core **14** comprising a multiplicity of adjacent, vertically-oriented, elongate cells or pockets is incorporated in the body of the grinding member **10**.

A base plate **16** is employed as a supporting mount for the grinding member **10**. A plurality of anchoring devices **18**, which may be screws, bolts, or the like, are employed to securely retain the grinding member **10** on the base plate **16** by having the heads **20** of the anchoring devices **18** embedding in the body of the grinding member **10**.

The base plate **16** may be disk-shaped to generally conform to the illustrated annular configuration of the grinding member **10**. A center aperture **22** is provided to

enable the lapping head to be securely mounted on, for example, a rotatable armature of a motor which is used to revolve the lapping head in a conventional manner.

It is to be noted that although the grinding member has been illustrated and described as having an annular configuration, that any other configuration may be used.

The body of the grinding member **10** may consist of any rigid foam material which will serve as a carrier medium for a particulate abrasive material that is to be uniformly distributed throughout the rigid foam material.

Any of the presently available rigid foam materials may be employed. It has been found, however, that a pourable, integral skin, rigid foam material having a closed cell polymeric structure and which is capable of being compounded to provide a density which may vary from four to twenty-five pounds per cubic foot, is particularly acceptable. A presently available industrial type of foam material described as being of the polyol-polyisocyanate type is an example of such a particularly acceptable material.

The abrasive material is uniformly distributed or interspersed throughout the body of the grinding member **10** by being encapsulated in the modules formed by each of the closed cells of the foam material. A particulate abrasive in either powder or relatively larger crystalline form may be used, the specific form used being determined by the desired abrasive quality. Any of the readily available abrasive materials, among which are the carbides of silicon and boron, and zircon, may be used.

Although specific materials have been suggested in the above discussion, it is to be understood that these suggestions are considered to be exemplary and not limitations, and that the actual materials used in the construction of a lapping head according to the present invention should be selected after consideration of the degree of resistance offered to cutting oils or like mediums, necessary abrasive qualities, the amount of heat generated by friction upon contact of the grinding area **12** with a workpiece during a grinding or lapping operation, and the centrifugal forces developed by the high-speed revolution of the lapping head in operation.

Referring to FIGS. 3 and 4, the honeycomb or cellular core **14** may be composed of either a metallic or non-metallic material. Preferably, the material used should have the qualities of resistance to cutting oils, non-abrasiveness, and resistance to heat which is developed in the use of the lapping head. The multiplicity of adjacent elongate cells or pockets **24** provided by the cellular case **14** should be vertically oriented or, otherwise stated, orthogonally situated with respect to the plane of the grinding area **12**.

The rigid foam material used to form the body of the grinding member **10** is allowed to completely occupy each of the cells **24** such that the cellular core **14** is in intimate contact with the rigid foam material.

A characteristic of rigid foam materials, suggested for use in the fabrication of the present invention, is that an integral skin of greater hardness than interior or centrally enclosed portions of the foam body is produced when such foam material is allowed to foam or expand in a mold. It is believed that such a skin is developed by reason of the exothermal chemical reaction which takes place in the foaming and/or the crushing of the closed cells forming the polymeric structure and abutting the hard inflexible walls of the mold. The embedding of a honeycomb or cellular core **14** in the fabrication of the grinding member **10** produces a similar result with respect to each of the elongate open-ended cells **24** forming the cellular core **14**. Consequently, the rigid foam material occupying the respective cells **24** comprise a hard integral skin **26**, adjacent the walls of the cellular core **14**, which skin **26** surrounds a relatively softer, lower density, but yet rigid, central portion **28**. The development of integral skins **26** with respect to each cell **24** effectively creates a grinding area **12** having gradients of hardness across the surface thereof. Otherwise considered, each segment of foam material contained by the walls of the cellular core **14** forms a modular grinding surface or area.

Due to the resulting gradients of hardness and/or the individual adjacent modular grinding surface effect, the undesirable sidal deflection or flexure of prior art lapping heads is effectively eliminated. As a consequence, specular surface finishes equaling or bettering present planimetric tolerances of flatness are readily provided by using the lapping head of the present invention. Additionally, substantially decreased amounts of "roll-off" have been realized by using the present invention. Exemplary of the much improved results able to be accomplished with the present invention, are measured surface finishes having tolerances of between 2.2 to 2.4 micro-inches and measured reductions in "roll-off" or sloping, to between 10 to 15 millionths at the edges of a surface.

The cellular core **14**, which is substantially co-extensive with the rigid foam material forming the grinding member **10**, may be of either a metallic or non-metallic material. Where a metallic material is used, it is preferred that such material be a soft metal, for example, aluminum, to avoid scoring of a workpiece. The respective cells **24** may be of any desired size, the main requirement being that the foam material be able to flow or expand upwards through each of the cells **24**.

From the foregoing description, it is now clear that the use of the lapping head of the present invention enables the realization of specular surface finishes that are significantly smoother than finishes able to be produced using prior art devices.

While a preferred embodiment of the present invention has been described hereinabove, it is intended that all matter contained in the above description and shown in the accompanying drawings be interpreted as illustrative and not in a limiting sense and that all modifications, constructions and arrangements which fall within the scope and spirit of the present invention may be made.

What is claimed is:

1. A lapping head for providing workpieces with specular surface finishes, said lapping head comprising:

a grinding member formed with a rigid foam material which is configured to provide a planar grinding surface, said rigid foam material serving as a carrier medium throughout which a particulate abrasive material is distributed; and

a cellular core embedded in said rigid foam material, said cellular core including walls forming a multiplicity of adjacently positioned open-ended cells each having a longitudinal axis that is parallel to the axis of all other cells and orthogonal with respect to said planar grinding surface.

2. The apparatus defined by claim **1** wherein said rigid foam material fully occupies each of said multiplicity of adjacently positioned open-ended cells.

3. The apparatus defined by claim **2** wherein said rigid foam material, occupying each of said multiplicity of adjacently positioned open-ended cells, includes an integrally formed skin portion abutting said walls of said cellular core and a central portion encompassed by said skin portion, said central portion having a structural consistency that is softer and less dense than the structural consistency of said skin portion.

4. The apparatus defined by claim **1** further including a flat base plate for securely supporting said grinding member, said base plate being adapted to be revolved about an axis extending through a center point thereof and in a direction orthogonal to a plane defined by the major dimensions of said base plate.

5. The apparatus defined by claim **1** wherein said rigid foam material is of a type having a closed cell polymeric structure and which will provide an integral skin having a hardness and density that is greater than internally situated portions.

6. The apparatus defined by claim 1 wherein said grinding member is shaped to have an annular configuration, said planar grinding surface being situated in a radial plane.

7. The apparatus defined by claim 1 wherein said planar grinding surface includes a multiplicity of adjacent modular grinding areas, each said grinding area having a peripheral section and a central section enclosed by said peripheral section, said central section having a hardness and density that is lesser than the hardness and density of said peripheral section.

8. The apparatus defined by claim 7 wherein said rigid foam material fully occupies each of said multiplicity of adjacently positioned open-ended cells.

9. The apparatus defined by claim 8 wherein said rigid foam material, occupying each of said multiplicity of adjacently positioned open-ended cells, includes an integrally formed skin portion abutting said walls of said cellular core and a central portion encompassed by said skin portion, said central portion having a structural consistency that is softer and less dense than the structural consistency of said skin portion.

10. The apparatus defined by claim 9 wherein said grinding member is shaped to have an annular configuration, said planar grinding surface being situated in a radial plane.

11. The apparatus defined by claim 1 wherein said cellular core is a metallic material.

12. The apparatus defined by claim 1 wherein said cellular core is a non-metallic material.

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OTHELL M. SIMPSON, Primary Examiner

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