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(54) **ABRASIVE GRINDING WHEEL AND RELATED PRODUCTION METHOD**

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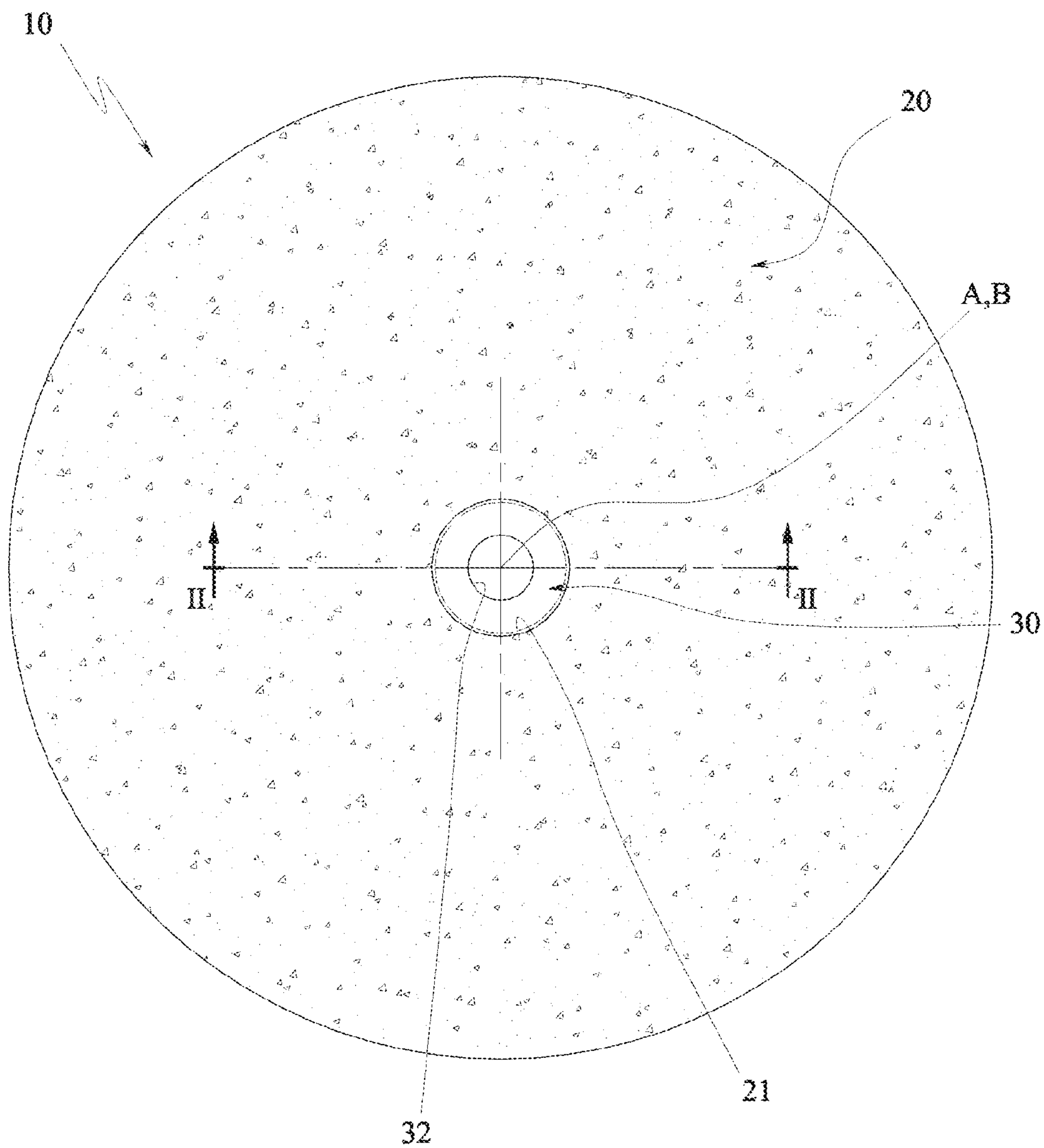
(57) **ABSTRACT**

An abrasive grinding wheel (**10**) that comprises an annular body (**20**) made of abrasive material provided with a central hole (**21**) and a reducing ring (**30**) provided with a central attachment hole (**32**), wherein the reducing ring (**30**) is inserted into the central hole (**21**) so that the attachment hole (**32**) of the reducing ring (**30**) is coaxial with respect to the central hole (**21**) of the annular body (**20**), wherein the reducing ring (**30**) comprises two opposing enlarged axial end stretches (**311** and **312**) configured to axially lock the reducing ring (**30**) to the central hole (**21**) of the annular body (**20**).



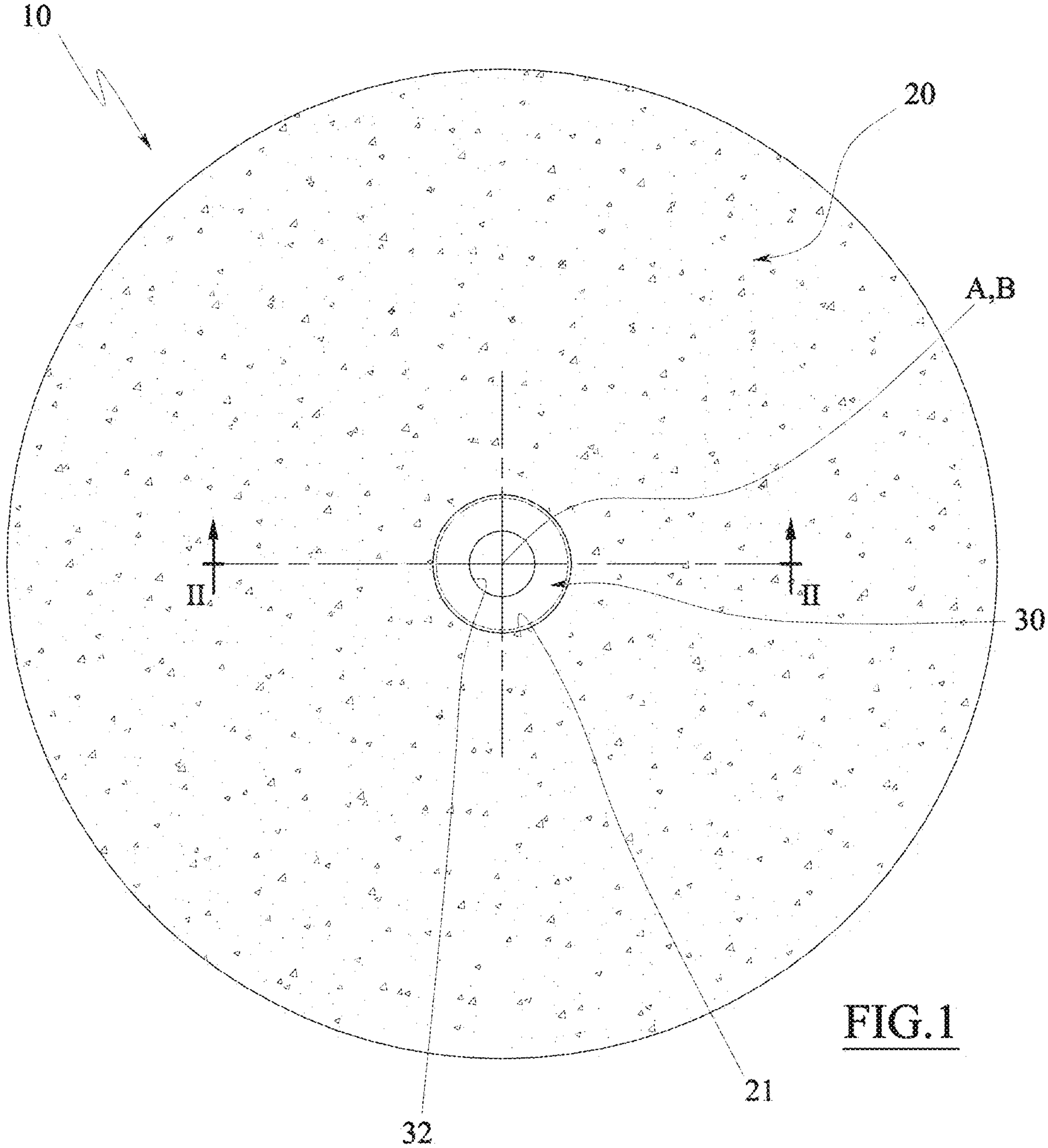


FIG.1

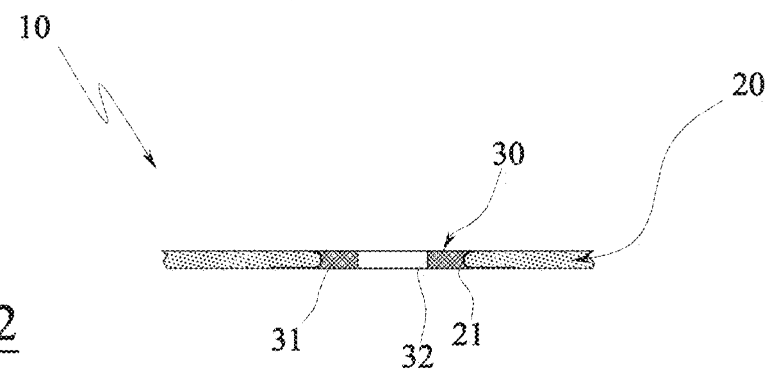


FIG.2

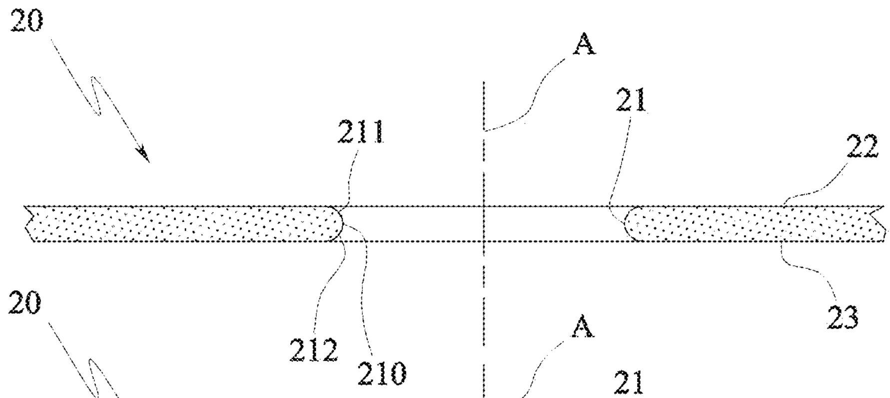


FIG.3

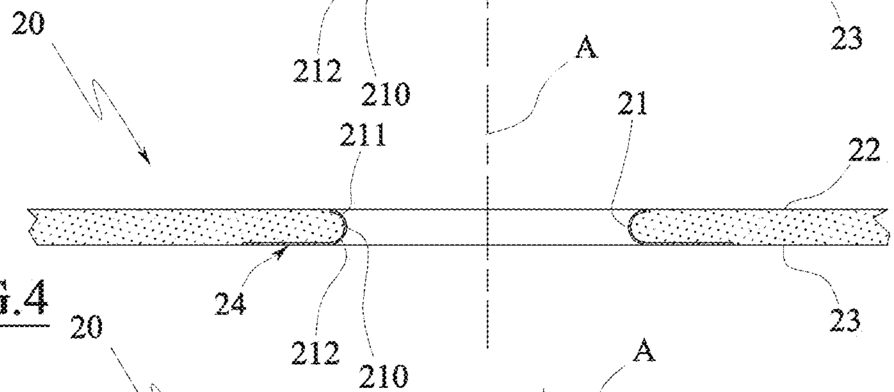


FIG.4

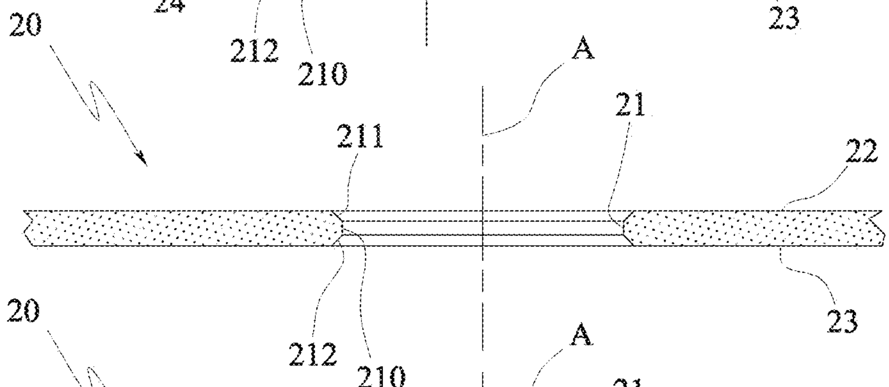


FIG.5

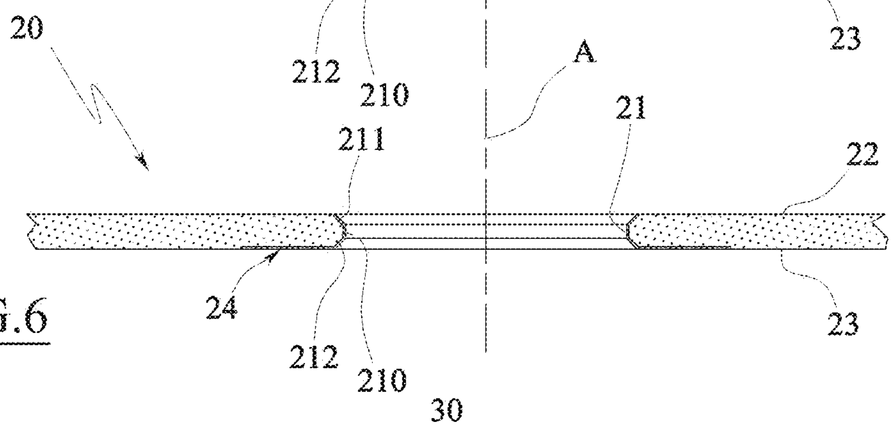


FIG.6

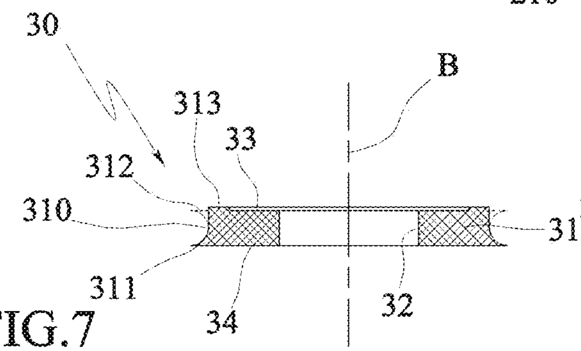


FIG.7

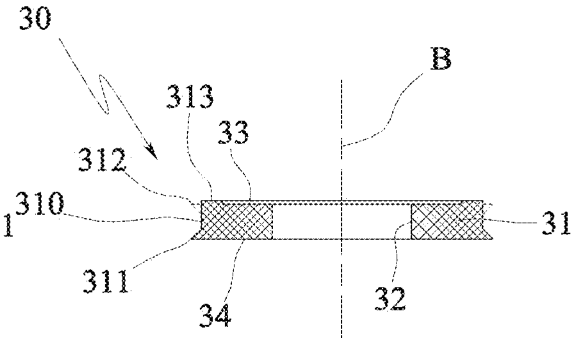


FIG.8

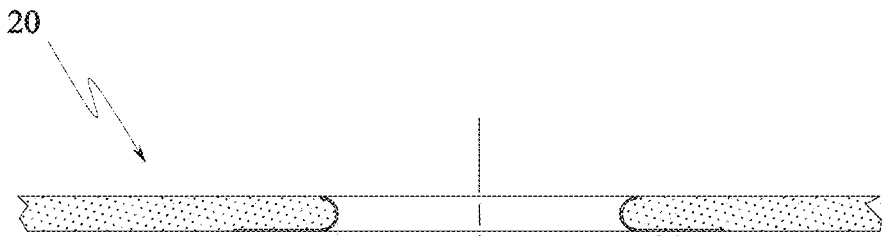


FIG.9a

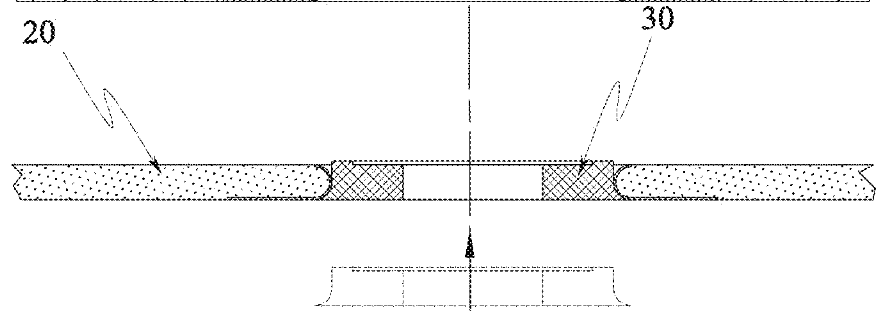


FIG.9b

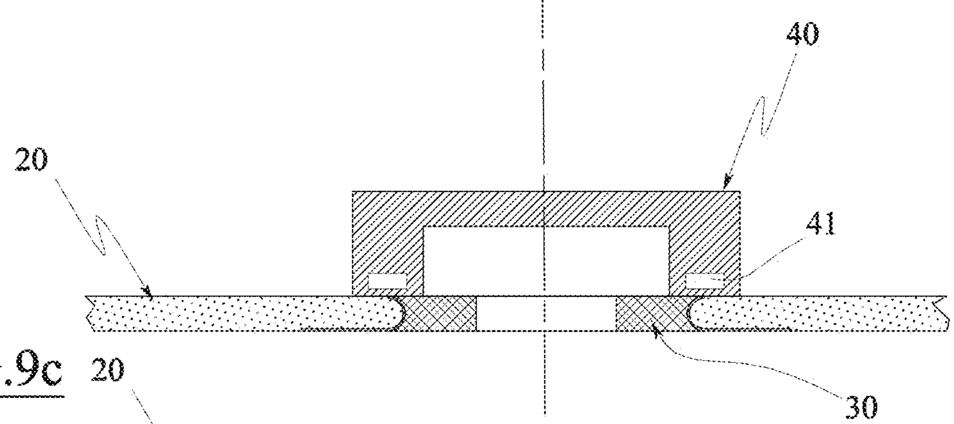


FIG.9c

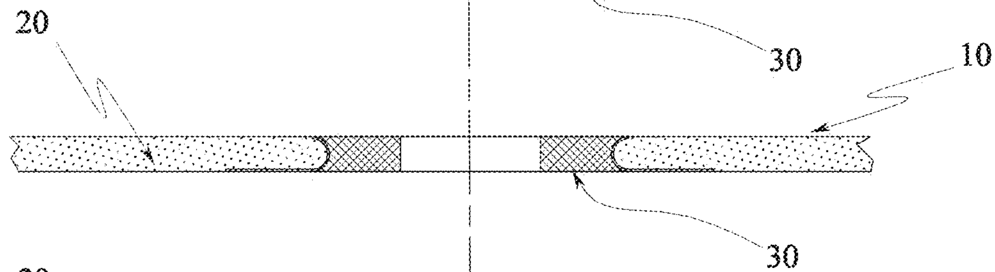


FIG.9d

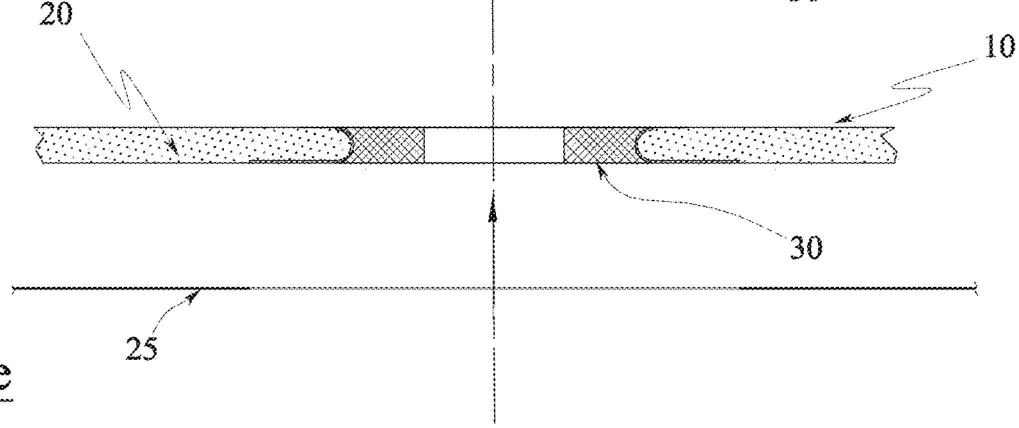


FIG.9e

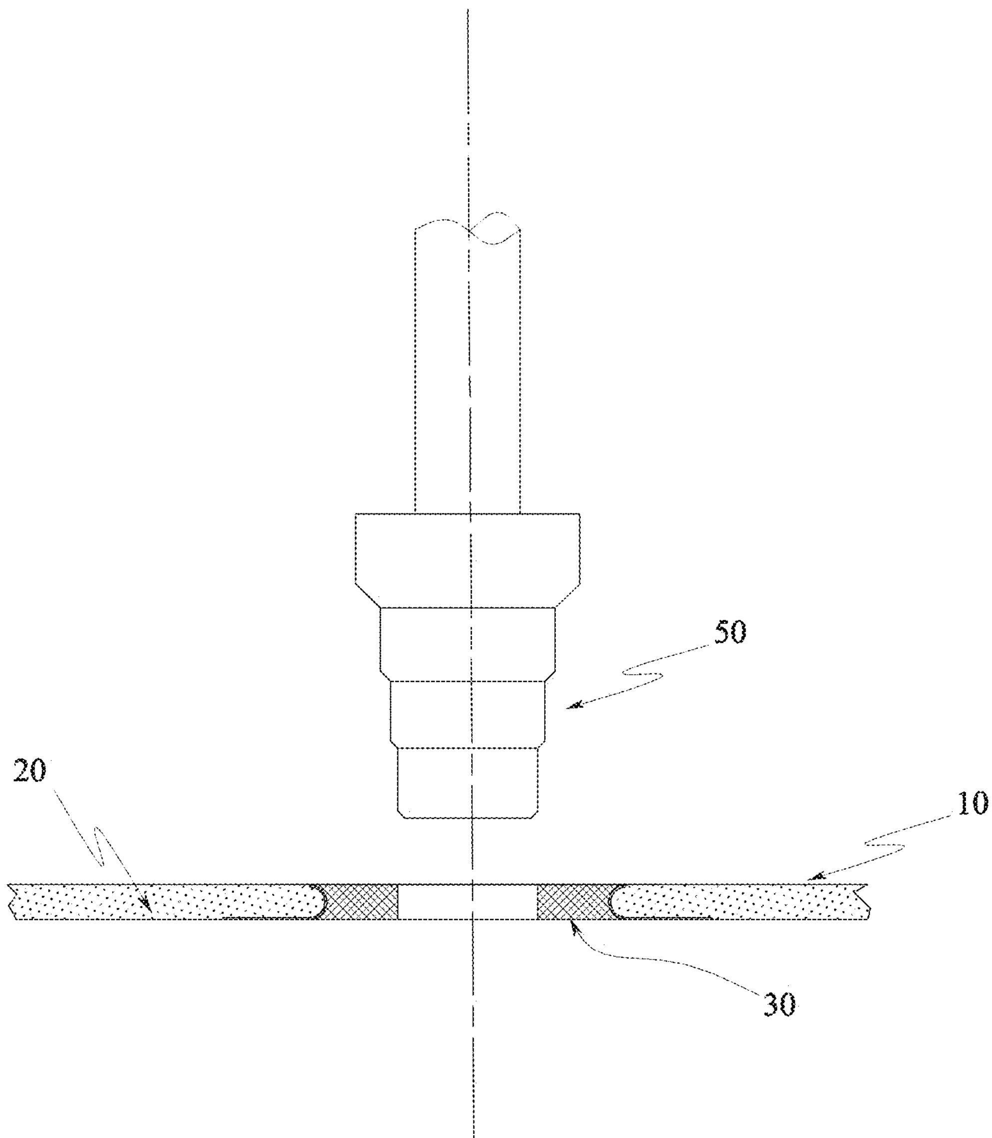


FIG.9f

ABRASIVE GRINDING WHEEL AND RELATED PRODUCTION METHOD

TECHNICAL FIELD

[0001] The present invention relates to an abrasive grinding wheel, e.g. with a depressed or flat centre, or a cutting disc, an emery or cutting grinding wheel, and a method for producing it.

PRIOR ART

[0002] As is known, a grinding wheel is essentially comprised of a disc-shaped body made of an abrasive mixture bound by a resin, reinforced by reinforcements constituted by one or more fabric nets, by one or two metallic annular elements, commonly known as washers or ring nuts, which delimit the hole for attaching the grinding wheel to the shaft of the cutting machine, and by an optional label made of paper or other applied material commonly used, which adheres to one of the two faces of the grinding wheel (usually to the back one).

[0003] In the manufacture and sale of the resinoid bonded abrasive grinding wheels, e.g. of cutting discs, a significant difficulty has always been represented by the remarkable number of attachment holes adopted for the various needs of manufacturers of cutting machines. In particular, it is found that about four or five quality types of grinding wheels can be formed in various formats, e.g. with outer diameters of 300, 350, 400 and 500 mm. Each of such grinding wheels can then be configured so as to have at least seven different attachment hole diameters. Obviously, for the manufacturer and for business, this situation determines at least thirty-five different configuration possibilities of the cutting discs to be produced to fulfil the market needs, in addition to the cost for the manufacturer of having to continuously replace in the forming moulds of such cutting discs, the pins that create the central holes for following order requests sometimes for just a few dozen items.

[0004] Furthermore, this is added to the need for the manufacturer to store reinforcement nets and metal washers with various central holes.

[0005] This is why for a long time grinding wheel manufacturers have tried to remedy this problem by supplying washers for adapting the attachment hole made of plastic materials or aluminium included in various sizes in the packets of discs. However, unfortunately this solution, which is also expensive, has the problem of the poor stability of these adaptation washers once assembled on the grinding wheel. This poor stability often creates problems in the assembly operations of cutting discs on the machines. These solutions are also often totally rejected by the users and the retailers.

[0006] Other known solutions over past times have envisaged valid and stable insertion systems of washers, especially plastic, in the centre of the attachment holes of the cutting discs, for the adherence inside the hole of a crown of plastic material injected hot with special moulds and with injection machinery.

[0007] This is certainly an optimal solution from the mechanical perspective, but is very expensive in terms of the systems (moulds) needed for producing it, and not very versatile according to market requirements as, in order to be implemented, it requires substantial orders in order to be made cost-effective and advantageous for the manufacturer.

[0008] An object of the present invention is to overcome the mentioned drawbacks of the prior art, within the context of a simple and rational solution and at a contained cost.

[0009] Such purposes are accomplished by the characteristics of the invention given in the independent claims. The dependent claims outline preferred and/or particularly advantageous aspects of the invention.

DISCLOSURE OF THE INVENTION

[0010] The invention, particularly, makes available an abrasive grinding wheel that comprises an annular body made of abrasive material provided with a central hole and a reducing ring provided with a central attachment hole, wherein the reducing ring is inserted into the central hole so that the attachment hole of the reducing ring is coaxial with respect to the central hole of the annular body, wherein the reducing ring comprises two opposing enlarged axial end stretches (of which at least one of the two is obtained by plastic deformation for example by riveting) configured to axially lock the reducing ring to the central hole of the annular body. Thanks to such solution, the drawbacks of the prior art are overcome making available an abrasive grinding wheel, i.e. a cutting disc, with a reducing ring firmly fixed to the abrasive annular body of the grinding wheel itself which can initially have a single attachment hole for all the formats (outer diameters) and types (composition of the abrasive mixtures) in which the grinding wheel can be made, which can then be easily and effectively adapted according to the specific customer requirements and requests.

[0011] Advantageously, the central hole of the annular body can comprise two opposing axial end stretches having enlarged sections with respect to a central stretch having a tapered section axially interposed between the two axial end stretches having enlarged sections, the opposing axial end stretches of the reducing ring substantially engaging to measure with the axial end stretches of the central hole of the annular body.

[0012] Again, according to an advantageous aspect of the invention, the reducing ring can be made of a plastic material, e.g. thermosetting.

[0013] A further aspect of the invention makes available a method for producing abrasive grinding wheels that comprises:

- **[0014]** forming, through a pressing of an abrasive mixture comprising abrasive powders and a resinoid binder, an annular body provided with a central hole;
- **[0015]** inserting a reducing ring provided with a central attachment hole inside said central hole of the annular body, so that the attachment hole is coaxial with respect to the central hole; and
- **[0016]** fixing the reducing ring to the annular body by means of riveting the reducing ring.

[0017] Thanks to such solution a quick, economically advantageous (compared to the known methods), safe and repeatable method is made available for producing an abrasive grinding wheel (or a cutting disc) with a reducing ring placed inside it. Advantageously, the fixing of the reducing ring by means of riveting can comprise plastically deforming at least one edge proximal to an axial end of the reducing ring.

[0018] Yet another aspect of the invention can provide for the formation of the annular body comprising the creation of the central hole with an axially variable cross section.

[0019] Within the context of such aspect, the realisation of the central hole can provide for the formation of two opposing end stretches having enlarged sections at two axial ends of the central hole and at least one central stretch having a tapered section axially interposed between the two end stretches.

[0020] Furthermore, the insertion of the reducing ring inside the central hole can provide for the coaxial insertion of the reducing ring in the central hole, so that an enlarged axial end stretch of the reducing ring substantially engages to measure with one of the end stretches of the central hole and, wherein the fixing of the reducing ring to the annular body through riveting of the reducing ring provides for riveting a further axial end stretch of the reducing ring so as to radially enlarge such further axial end stretch of the reducing ring; the further axial end stretch of the reducing ring thus radially enlarged engaging to measure with the other end stretch of the central hole.

[0021] According to a further aspect of the invention, the fixing of the reducing ring to the annular body can be performed through hot riveting of the reducing ring.

[0022] In this way the riveting of the reducing ring is substantially irreversible and the reducing ring is firmly fixed to the inside of the abrasive annular body of the grinding wheel.

[0023] According to an advantageous aspect of the invention, the production method can provide for the step of enlargement through milling of the attachment hole of the reducing ring.

[0024] In this way, the abrasive grinding wheel (or cutting disc), e.g. previously stored by the manufacturer or the retailer in a format that is universal so to speak, wherein the attachment hole has a standard diameter regardless of the outer diameter of the abrasive annular body of the grinding wheel and regardless of the composition of the abrasive mixture, can then be customised according to the customer's specific requirements in a short time and also advantageously for small orders from the customer or small production batches.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] Further characteristics and advantages of the invention will become clear from reading the following description provided as a non-limiting example, with the help of the figures illustrated in the attached tables.

[0026] FIG. **1** is a front view of an abrasive grinding wheel according to the invention.

[0027] FIG. **2** is a sectional view along the trace of section II-II of FIG. **1**.

[0028] FIG. **3** is a central sectional view of a first variant of a first embodiment of an annular body of an abrasive grinding wheel according to the invention.

[0029] FIG. **4** is a central sectional view of a second variant of the first embodiment of an annular body of an abrasive grinding wheel according to the invention.

[0030] FIG. **5** is a central sectional view of a first variant of a second embodiment of an annular body of an abrasive grinding wheel according to the invention.

[0031] FIG. **6** is a central sectional view of a second variant of the second embodiment of an annular body of an abrasive grinding wheel according to the invention.

[0032] FIG. **7** is a central sectional view of a first embodiment of a reducing ring of an abrasive grinding wheel according to the invention.

[0033] FIG. **8** is a central sectional view of a second embodiment of a reducing ring of an abrasive grinding wheel according to the invention.

[0034] FIGS. **9***a*-**9***f* are a schematic sequence of a production method of an abrasive grinding wheel according to the invention.

BEST WAY TO ACTUATE THE INVENTION

[0035] With particular reference to such figures, **10** indicates overall an abrasive grinding wheel, e.g. of the cutting disc type, i.e. a flat abrasive grinding wheel or with a depressed centre.

[0036] The grinding wheel **10** comprises an annular body **20**, provided with a central axis A, which annular body **20** is for example substantially flat (see figures) or with a depressed centre (not shown).

[0037] The annular body **20** is substantially circular and is provided with a central hole **21** that is coaxial with respect to the annular body **20**, passing through in an axial direction from one side to the other of the annular body **20**.

[0038] The annular body **20** has an outer diameter substantially comprised between 250 mm and 500 mm, e.g. equal to 250 mm or 300 mm or 400 mm or 500 mm.

[0039] The annular body **20** comprises two opposing faces **22** and **23**, of which one front face **22** and one rear opposing face **23**, which are, for example parallel to each other overall and orthogonal to the central axis A of the annular body **20**.

[0040] The annular body **20** has a substantially layered structure and has at least one or more layers of abrasive mixture.

[0041] Each layer of abrasive mixture (once pressed and fired) defines a substantially monolithic body.

[0042] For example, each layer of abrasive mixture is made of a mixture of abrasive powders that is compacted and firmly bound to a binding resin.

[0043] In practice, the layer of abrasive mixture is obtained through pressing a mixture of a loose powder of abrasive material, e.g. abrasive material such as natural corundum, sand, recovered artificial corundum or the like, sol-gel abrasives or sintered ceramics, zirconium corundums, or the like, and mixed with an appropriate binder, e.g. based on binding resins, for example phenolic resins, liquid resins and/or powdered resins, and possibly modified with epoxy, phenoxy and/or other resins, modified with organic and/or vegetable or synthetic compounds, and other types of polyimide resin etc., and/or with additives and fillers.

[0044] For example, the quantity of resin is comprised between 15% and 20% by weight with respect to the weight of the abrasive material powder mixture.

[0045] The abrasive material of the layer of abrasive mixture has particle size substantially comprised between 120 and 12 in mesh (however, the use of abrasive mixtures with a larger or smaller particle size than the range, according to requirements, is not excluded).

[0046] The annular body **20** comprises one or more reinforcement nets each substantially incorporated into the layer of abrasive mixture or interposed between them.

[0047] Each reinforcement net is substantially annular and has a hole in the centre with a diameter greater than or equal to the (minimum) diameter of the central hole **21** of the annular body **20**.

[0048] In practice, the layer of abrasive mixture (or the layers of abrasive mixture) surround(s), in particular axially, the entire (lower and upper) surface of the reinforcement net.

[0049] Furthermore, the layer of abrasive mixture can also incorporate more than one reinforcement net.

[0050] The central hole **21** of the annular body **20** preferably has an axially variable cross section, e.g. variable in stretches.

[0051] In particular, the central hole **21** of the annular body **20** comprises a first stretch **210**, for example with a circular cross section (i.e. orthogonal to the central axis A) wherein such first stretch **210** has a first diameter d**1** that is the minimum diameter of the central hole **21**.

[0052] The central hole **21** of the annular body **20** then comprises a second stretch **211**, e.g. with a circular cross section, wherein such second stretch **211** has a larger second diameter d**2** than the first diameter d**1** of the first stretch **210** (e.g. equal to the maximum diameter of the central hole **21**).

[0053] Again, the central hole **21** of the annular body **20** then comprises a third stretch **212**, e.g. with a circular cross section, wherein such third stretch **212** has a larger third diameter d**3** than the first diameter d**1** of the first stretch **210**, preferably but not necessarily equal to the second diameter of the second stretch **211** (e.g. equal to the maximum diameter of the central hole **21**).

[0054] For example, the first diameter d**1** of the first stretch **210** is predefined, i.e. it is a fixed diameter regardless of the outer diameter of the annular body **20** and, preferably, equal for all the annular bodies **20** even with different outer diameters.

[0055] Even more preferably, the first diameter d**1** of the first stretch **210** is greater than the most common inner diameters of the standard attachment holes present on the market for such type of grinding wheels (cutting discs), e.g. it is greater than 35 mm, e.g. it is equal to 40 mm.

[0056] The second diameter d**2** and the third diameter d**3** can be calculated according to the first diameter d**2** and the thickness of the annular body **20** (or the axial length of the central hole **21**), e.g. through the following relationship:

$$d1=d2=d1+k;$$

where k is a whole submultiple of the thickness of the annular body **20** (or the axial length of the central hole **21**), e.g. it is equal to half the length of the annular body **20** or a third of the thickness of the annular body **20**.

[0057] Preferably, the first stretch **210** is (central or) axially interposed between the second stretch **211** and the third stretch **212**.

[0058] In that case, the second stretch **211** and the third stretch **212** are axial end stretches of the central hole **21** and lead directly to a respective face **22** and **23** of the annular body **20**.

[0059] In practice, the second stretch **211** and the third stretch **212** define opposing axial ends with an enlarged section of the central hole **21** with respect to the tapered section axially interposed between them defined by the first stretch **210**.

[0060] In a first embodiment shown in FIGS. **3** and **4**, the central hole **21** has a rounded profile, with a rounding radius R as a function of the thickness of the grinding wheel **10**, or a function of the axial length of the central hole **21**.

[0061] In practice, the first stretch **210** is defined by the minimum section of the central hole **21** placed on the median plane of the grinding wheel **10** (or of the central hole **21**) orthogonal to the central axis A and is connected with two respective substantially truncated cone (rounded) surfaces, that define the second stretch **211** and the third stretch **212**, at the opposite ends of the central hole **21**, with the maximum section.

[0062] In a second embodiment shown in FIGS. **5** and **6**, the central hole **21** has a substantially cylindrical shaped first central stretch **210**, e.g. with a height substantially equal to half the thickness of the grinding wheel **10**, i.e. equal to half the axial length of the central hole **21**.

[0063] The first stretch **210** is then connected with two respective substantially truncated cone shaped surfaces (substantially inclined by 45° with respect to the central axis A), which define the second stretch **211** and the third stretch **212**, at the opposite ends of the central hole **21**, with the maximum section.

[0064] Finally, the grinding wheel **10**—as shown in FIGS. **4** and **6**—can comprise one or more thinner metal annular elements, commonly known as washers **24** or ring nuts, that delimit the central hole **21** tracing the shape thereof, and act as reinforcement for it (for the contact with the shaft of the cutting machine).

[0065] The washer **24** is fixed to the rear face **23** of the annular body **20** of the grinding wheel **10**, for example for a limited radial stretch of the annular body **20** itself.

[0066] The washer **24** comprises a thin hollow central shank **24** that is substantially inserted to measure in the central hole **21** and that has the same shape (of the axial stretches described above) as the central hole **21**.

[0067] In practice, the hollow central shank **24** radially delimits, without altering the shape thereof described above, the central hole **21**.

[0068] On the rear face **23** of the annular body **20** of the grinding wheel **10**, even after the forming (and firing of the grinding wheel itself, as will be described more clearly below), a label **25** can be placed (visible only in FIG. **9***e*), made of paper or tinfoil or similar applied material, which is substantially annular and can occupy the whole rear face **23** of the annular body **20** of the grinding wheel **10** or a limited radial portion thereof, e.g. an annular crown of the rear face that starts internally from the outer periphery of the washer **24**.

[0069] The grinding wheel **10** then comprises a reducing ring **30**, which is configured to (substantially) reduce the through section of the central hole **21** of the annular body **20**, as will be better described below, until reaching an inner diameter substantially equal to the outer diameter of the rotary shaft of the cutting machine for which the grinding wheel **10** is intended.

[0070] The reducing ring **30** comprises a substantially circular disc-shaped body **31** provided with a central axis B.

[0071] Preferably but not necessarily, the disc-shaped body **31** is provided with a central attachment hole **32**, e.g. coaxial with respect to the disc-shaped body **31**, which passes through in the axial direction from one side to the other side of the disc shaped body **31**.

[0072] The attachment hole **32** is for example cylindrical with a constant section along the entire axial extension thereof.

[0073] Preferably, the diameter D**0** of the attachment hole **32** is smaller than the most common inner diameters of the standard attachment holes present on the market for such type of grinding wheels (cutting discs), e.g. it is equal to 20 mm.

[0074] For example, the diameter D**0** of the attachment hole **32** is predefined, i.e. it is a fixed diameter regardless of the outer diameter of the annular body **20** (and of the inner diameter of the central hole **21**) and, preferably, it is initially the same for all the grinding wheels **10**.

[0075] For example, the diameter D**0** of the attachment hole **32** is substantially comprised between 80% and 25% of the first diameter d**1** of the central hole **21**, preferably comprised between 80% and 50% of the first diameter d**1** of the central hole **21**, in the example, equal to about half of the first diameter d**1** of the central hole **21**.

[0076] The attachment hole **32**, when the reducing ring **30** engages the central hole **21** of the annular body **20**, is coaxial to the annular body **20** (or to the central hole **21** thereof).

[0077] The disc-shaped body **31** comprises two opposing faces **33** and **34**, of which one front face **33** and one rear opposing face **34** which are, for example, parallel to each other overall and orthogonal to the central axis B of the disc-shaped body **31**.

[0078] The thickness (or axial length) of the disc-shaped body **31** is defined by the distance between the faces **33** and **34** thereof, which is preferably equal to (or slightly larger than) the thickness of the grinding wheel **10**, or the axial length of the central hole **21** of the annular body **20** thereof.

[0079] The disc-shaped body **31** has a shaped outer jacket which, once inserted into the central hole **21** of the annular body **20** of the grinding wheel **10**, is substantially complementary to the shape of the central hole **21** of the annular body **20** for which it is intended, so as to define a (substantially perfect) shape connection.

[0080] The outer jacket of the disc-shaped body **31** preferably has an axially variable cross section, e.g. variable in stretches.

[0081] In particular, the outer jacket of the disc-shaped body **31** comprises a first stretch **310** for example with a circular cross section (or orthogonal to the central axis A), in which such first stretch **310** has a first diameter D**1** that is the minimum diameter of the outer jacket of the disc-shaped body **31** and is substantially equal (or slightly smaller) than the first (minimum) diameter d**1** of the first stretch **210** of the central hole **21**.

[0082] The outer jacket of the disc-shaped body **31** then comprises a second stretch **311**, e.g. with a circular cross section, wherein such second stretch **311** has a second diameter D**2** greater than the first diameter D**1** of the first stretch **310**, e.g. equal to the maximum diameter of the outer jacket of the disc-shaped body **31** and is substantially equal to (or slightly smaller than) the second (maximum) diameter d**2** of the second stretch **211** of the central hole **21**.

[0083] Again, the outer jacket of the disc-shaped body **31**—once it has been firmly inserted into the central hole **21** of the annular body **20** of the grinding wheel **10**—comprises a third stretch **312**, e.g. with a circular cross section, wherein such third stretch **312** has a third diameter D**3** greater than the first diameter D**1** of the first stretch **310**, preferably but not necessarily equal to the second diameter D**2** of the second stretch **311**, e.g. equal to the maximum diameter of the outer jacket of the disc-shaped body **31** and is substantially equal to (or slightly smaller than) the second (maximum) diameter d**3** of the third stretch **212** of the central hole **21**.

[0084] Preferably, the first stretch **310** of the outer jacket of the disc-shaped body **31** is axially interposed between the second stretch **311** and the third stretch **312**.

[0085] In that case, the second stretch **311** and the third stretch **312** are axial end stretches of the disc-shaped body **31** and are connected directly to a respective face **33** and **34** of the disc-shaped body **31** (defining at least one end portion thereof).

[0086] In particular, the second stretch **311** defines a first enlarged axial end of the disc-shaped body **31**, i.e. that enlarges in a radial direction (with respect to the central axis B), with respect to the first stretch **310** and the third stretch **312** defines an opposing second enlarged axial end of the disc-shaped body **31**, i.e. that enlarges in a radial direction (with respect to the central axis B), with respect to the first stretch **310**.

[0087] In other words, the second stretch **311** and the third stretch **312** define opposing axial ends with an enlarged section of the disc-shaped body **31** with respect to the tapered section axially interposed between them defined by the first stretch **310**.

[0088] For example, the second stretch **311** is defined by an annular crown that projects radially from the disc-shaped body **31**.

[0089] The annular crown that defines such second stretch **311** has a substantially conical shape whose largest base is substantially coplanar to one of the faces **33** and **34**, in the example the rear face **34**.

[0090] For example, the third stretch **312**, once the grinding wheel **10** is definitively formed, is defined by a further annular crown that projects radially from the disc-shaped body **31**.

[0091] Such further annular crown that defines such third stretch **312** has a substantially conical shape whose largest base is substantially coplanar to the other one of the faces **33** and **34**, in the example the front face **33**.

[0092] Preferably, the annular crown that defines the second stretch **311** is symmetrical to the further annular crown that defines the third stretch **312** with respect to a median plane of the disc-shaped body **31** orthogonal to the central axis B.

[0093] In a first embodiment shown in FIG. **7**, the second stretch **311** and the third stretch **312** have a rounded profile, with a rounding radius R as a function of the thickness of the grinding wheel **10**, or a function of the thickness of the disc-shaped body **31**.

[0094] In practice, the first stretch **310** is defined by the minimum section of the outer jacket of the disc-shaped body **31** placed on the median plane of the disc-shaped body orthogonal to the central axis B and is connected with two respective substantially truncated cone (rounded) surfaces, that define the second stretch **311** and the third stretch **312**, at the opposite ends of the disc-shaped body **31**, with the maximum section.

[0095] Such conformation of the disc-shaped body is intended to be inserted in the first embodiment into the central hole **21** of the annular body **20** shown in FIGS. **3** and **4**.

[0096] In a second embodiment shown in FIG. **8**, the outer jacket of the disc-shaped body **31** has a first central stretch **310** with a substantially cylindrical shape, e.g. with a height substantially equal to half the thickness of the disc-shaped body **31**. The first stretch **310** is then connected with two respective substantially truncated cone shaped surfaces (substantially inclined by 45° with respect to the central axis B), which define the second stretch **311** and the third stretch **312**, at the opposite ends of the disc-shaped body **31**, with the maximum section.

[0097] As will be better described below, the third stretch **312**, or the annular crown that defines it, is obtained through (irreversible) plastic deformation of an edge **313** (see FIGS. **7** and **8**) protruding from the front face **33** of the disc-shaped body **31** in the axial direction.

[0098] For example, the third stretch **312** is obtained through (hot) riveting.

[0099] For example, the edge **313** is movable (by irreversible plastic deformation) from an initial position, in which it projects axially from the front face **33** of the disc-shaped body **31** and is contained within the radial dimensions defined by the first stretch **310**, to a final (definitive) position, in which it projects radially defining said third stretch **312**.

[0100] The edge **313** is for example a circular crown for its whole extension, but could also be defined by a plurality of circular crown shaped stretches separated from each other.

[0101] In practice, when the edge **313** is in its initial position, the disc-shaped body **31** can be axially inserted into the central hole **21** of the annular body **20** (on the side of the front face **33**, or by first inserting the edge **313** and then the first stretch **310**, until the second stretch **311** of the disc-shaped body **31** abuts and is housed in the third stretch **212** of the central hole **21**).

[0102] When instead the edge **313** comes into its final position, it is housed (to measure) in the second stretch **211** of the central hole **21** of the annular body **20**, in practice radially and/or axially contained therein, in fact retaining or being retained axially inside the central hole **21** without the possibility of being axially pulled out from (and rotating with respect to) the annular body **20**.

[0103] For example, the third stretch **312** of the disc-shaped body **31**, or the edge **313** brought into its final position, is adapted to adhere to at least one surface (portion) of the second stretch **211** of the central hole **21** of the annular body **20**, e.g. through an adhesive (preferably, but not necessarily, defined by the binding resin that constitutes the annular body **20** of the grinding wheel **10** or the material—thermally softened and then hardened—that constitutes the edge itself).

[0104] In a preferred embodiment the disc-shaped body **30** is made overall of a plastic material, e.g. a heat deformable plastic material, preferably nylon in some of the numerous appropriate types.

[0105] Preferably, the disc-shaped body **30** is made overall of a plastic material having a higher softening temperature than the softening (or melting) temperature of the binding resin used for realizing the annular body **20** of the grinding wheel **10**.

[0106] Alternatively, it is possible to provide for the disc-shaped body **30** to be made overall of a different material, e.g. metal or another material sufficiently rigid to be able to define an edge **313** adapted to be plastically deformable (due to the shape or size or composition thereof).

[0107] In light of the above description, the method for producing a grinding wheel **10** as described above is as follows.

[0108] The method firstly envisages the step of forming an annular body **20** (see FIG. **9***a*) provided with a central hole **21**, having the shape described above.

[0109] The step of forming the annular body **20** takes place through pressing a mixture of abrasive powders and binding resin (possibly stratified with the interposition of reinforcement meshes), as described above, e.g. through a specific forming mould (as known to a person skilled in the art).

[0110] The central hole **21** is formed with the aforementioned specifications, e.g. covered or not by the aforesaid washer **24**.

[0111] The rear face **23** of the annular body **20** can be covered at least partially by the label **25** during the forming step, or preferably, it can be made to adhere, through relevant adhesives, at a later time according to the requirements.

[0112] The method then envisages arranging at least one reducing ring **30** as described above, e.g. preformed, e.g. through injection moulding or another suitable forming method.

[0113] At the start, the reducing ring **30** is configured so that the edge **313** is in its initial position described above.

[0114] At this point, the method envisages the step of coaxially inserting (see FIG. **9***b*) the reducing ring **30** into the central hole **21** of the annular body **20**, so that the attachment hole **32** of the disc-shaped body **30** is coaxial with respect to the central hole **21** of the annular body **20**.

[0115] Such insertion step can be realized in an automated or semi-automated way by a specific insertion machine.

[0116] Furthermore, such insertion step can be realized by axially inserting the disc-shaped body **31** into the central hole **21** of the annular body **20** on the side of the front face **33**, or by first inserting the edge **313** and then the first stretch **310**, until the second stretch **311** of the disc-shaped body **31** abuts and is housed in the third stretch **212** of the central hole **21**.

[0117] In this position, in which the second stretch **311** of the disc-shaped body **31** abuts and is housed in the third stretch **212** of the central hole **21** the rear face **34** of the reducing ring **30** is substantially coplanar to the rear face **23** of the annular body **20** (or slightly protruding therefrom, e.g. by **1** or **2** tenths of a millimetre).

[0118] Furthermore, in this position, in which the second stretch **311** of the disc-shaped body **31** abuts and is housed in the third stretch **212** of the central hole **21**, the edge **313** in its initial position projects axially beyond the central hole **21** (and beyond the plane defined by the front face **22** of the annular body **20** of the grinding wheel **10**).

[0119] At this point the method envisages the step of fixing (see FIG. **9***c*) the reducing ring **30** to the annular body **20**.

[0120] For example, the fixing step is performed through riveting the second stretch **312** (or the edge **313**) of the reducing ring **30**; in such riveting the edge **313** is plastically deformed so that it is brought irreversibly from its initial position to its final position.

[0121] In such final position the edge **313** prevents the reducing ring **30** being axially pulled out from the annular body **20**.

[0122] For example, the riveting is hot riveting, e.g. it envisages heating, until softening (e.g. to a temperature comprised around 250° C.), the edge **313**, so that it can—once softened—be brought into its final position and, in fact, occupy the annular volume interposed between the reducing ring (with the edge **313** in the initial position) and the second stretch **211** of the central hole **21** of the annular body **20**. Such hot riveting also envisages cooling (or leaving to cool) the edge **313** plastically deformed in the final position, until the hardening thereof, in fact making the plastic deformation undergone by the edge **313** irreversible.

[0123] The hot riveting also allows the adhesion of the third stretch **312** of the reducing ring **30** to the walls of the (second stretch **211**) of the central hole **21** of the annular body **20**.

[0124] Preferably, the riveting **313** is performed through a specific riveting tool **40** depicted in FIG. **9***c*.

[0125] The riveting tool **40** comprises for example a circular crown, e.g. made of metal material, defining a contact surface, adapted to come into contact with the edge **313**, which is for example covered by non-stick materials to promote the detachment of the edge **313** once it has been plastically deformed (through softening). The riveting tool **40** then comprises, as usual, heating elements **41**, such as electric resistors (e.g. provided with thermostats) adapted to heat it, e.g. the contact surface of the riveting tool **40**.

[0126] The riveting tool **40** is then axially movable with respect to the reducing ring **30**, so as to be able to exert a (slight) thrust or axial pressure on the edge **313** that is translated into axial and radial deformation of the edge **313** itself.

[0127] The riveting step can even last a few seconds.

[0128] At the end of such step, the edge **313** has been brought into the final position and has provided the aforesaid third stretch **312** of the disc-shaped body **31** of the reducing ring **30**, as illustrated in FIG. **9***d*.

[0129] In this final position, in which the third stretch **312** of the disc-shaped body **31** abuts and is housed (to measure) in the second stretch **211** of the central hole **21** the front face **33** of the reducing ring **30** is substantially coplanar to the rear face **22** of the annular body **20** (or slightly protruding therefrom, e.g. by **1** or **2** tenths of a millimetre at the most).

[0130] The method also envisages the step of firing the grinding wheel **10**, or the annular body **20** thereof.

[0131] Such firing step can take place prior to the step of inserting the reducing ring **30** in the central hole **21** of the annular body **20** or following the fixing step (by riveting) of the reducing ring **30** to the annular body **20**.

[0132] Such firing step envisages subjecting the annular body **20** (or the entire grinding wheel **10**) to a thermal firing treatment, e.g. in specific polymerization ovens, in which the polymerization of the binding resin is completed as it stably solidifies and retains the abrasive mixture that constitutes the annular body **20** of the grinding wheel **10**.

[0133] In practice, the annular body **20** is subjected to a thermal cycle that envisages the insertion thereof in an oven at a temperature substantially comprised between 80° and 200° C. for a time substantially comprised between 1 and 50 hours, or may be fired in situ in the same pressing mould, where the latter is provided with heating means.

[0134] Such firing step, where performed following the fixing step (by riveting) of the reducing ring **30** to the annular body **20** is such as not to deform the reducing ring **30**.

[0135] The grinding wheel **10** thus finished or to be finished therefore has an annular body **20** provided with a central hole **21** inside which a reducing ring **30** is firmly fixed, in turn with an attachment hole **32**, wherein the attachment hole **32** has the aforesaid diameter D**0** (a lot smaller than the minimum diameter of the central hole **21**).

[0136] The method for producing the grinding wheel **10** can, further, envisage the step of applying (see FIG. **9***e*) a label **25** (self-adhesive or glued) to the rear face of the annular body **20**, unless it has been previously applied during the formation of the annular body **20**.

[0137] In this way the label **25**, as well as the information related to the grinding wheel **10**, can bear customized information related to the retailer and/or the manufacturer or other required information. In practice, such solution allows the affixing of customized labels (customer brand) and the specification thereon of the instructions and characteristics of use of the grinding wheel **10**.

[0138] The method finally envisages the step of enlarging the attachment hole **32** of the reducing ring **30**.

[0139] For example, it is possible to enlarge the attachment hole **32** according to customer requests according to requirements, or to bring it to compatible dimensions with the diameter of the rotary shaft of the cutting machine in which the grinding wheel **10** is to be assembled.

[0140] Preferably, the step of enlarging the attachment hole **32** can be performed through milling (see FIG. **9***f*).

[0141] Such milling operation can be performed through a relevant milling tool **50**, which has, for example, a milling cutter with increasing diameters, in stretches.

[0142] The first diameter at the free end of the milling cutter can be equal to the diameter D**0** of the attachment hole **32** of the reducing ring **30**, in that way the coaxial insertion of the milling cutter in the attachment hole **32** of the reducing ring **30** is guided by the cylindrical coupling between the first diameter and the attachment hole **32** of the reducing ring **30**.

[0143] By axially sinking the milling cutter into the reducing ring as far as the desired axial position corresponding to the diameter of the attachment hole **32**, the attachment hole **32** will be enlarged to the desired dimension, e.g. 22 mm, 25 mm or 32 mm or other customizable sizes.

[0144] For example, the maximum diameter to which it is possible to enlarge the attachment hole **32** is for example less than or equal to 80% of the first diameter d**1** of the central hole **21** of the annular body **20**.

[0145] This solution therefore allows the grinding wheel **10** manufacturer to prepare and store grinding wheels **10** provided with a reducing ring **30** having a smaller common attachment hole **32** for a certain type of grinding wheels **10** (e.g. for cutting discs); such attachment hole **32** could have a diameter equal to 20 mm.

[0146] Such reducing ring **30** provided with the attachment hole **32** common to all would be assembled on all the annular bodies **20** in the quality type variants (e.g. 5-6 different abrasive mixtures), in fact constituting a stock of grinding wheels **10** to be finished, whose finalization can envisage only the preparation (enlargement) of the attachment hole **32**, also of a few dozen pieces at a time, quickly and cheaply when an order from the distributor/customer is finalized.

[0147] What has been described above could be performed, being equipped with simple equipment even for use by distributors (if different from the manufacturer), avoiding useless and expensive storage of too many different types of grinding wheels in which the only variant is the attachment hole.

[0148] The invention thus conceived can undergo numerous modifications and variants all of which are covered by the inventive concept.

[0149] Moreover, all of the details can be replaced by other technically equivalent elements.

[0150] In practice, the materials used, as well as the contingent shapes and sizes, can be whatever according to the requirements without for this reason departing from the scope of protection of the following claims.

1. A method for producing abrasive grinding wheels that comprises:

forming, through a pressing of an abrasive mixture comprising abrasive powders and a resinoid binder; an annular body provided with a central hole;

inserting a reducing ring provided with a central attachment hole inside said central hole of the annular body, so that the attachment hole is coaxial with respect to the central hole; and

fixing the reducing ring to the annular body by means of riveting the reducing ring.

2. The method according to claim **1**, wherein the fixing of the reducing ring by means of riveting comprises plastically deforming at least one edge proximal to an axial end of the reducing ring.

3. The method according to claim **1**, wherein the formation of the annular body comprises the creation of the central hole with an axially variable cross section.

4. The method according to claim **3** wherein the creation of the central hole provides for the formation of two opposing end stretches having enlarged sections at two axial ends of the central hole and at least one central stretch having a tapered section interposed axially between the two end stretches.

5. The method according to claim **4**, wherein the insertion of the reducing ring inside the central hole provides for the coaxial insertion of the reducing ring in the central hole, so that an enlarged axial end stretch of the reducing ring substantially engages to measure with one of the end stretches of the central hole and wherein the fixing of the reducing ring to the annular body through riveting of the reducing ring provides for riveting a further axial end stretch of the reducing ring so as to radially enlarge such further axial end stretch of the reducing ring; the further axial end stretch of the reducing ring thus radially enlarged engaging to measure with the other end stretch of the central hole.

6. The method according to claim **1**, wherein the fixing of the reducing ring to the annular body is performed through hot riveting of the reducing ring.

7. The method according to claim **1**, which comprises the step of enlargement through milling of the attachment hole of the reducing ring.

8. An abrasive grinding wheel that comprises:

an annular body made of abrasive material, obtained by pressing of an abrasive mixture comprising abrasive powders and a resinoid binder, wherein the annular body is provided with a central hole; and

a reducing ring provided with a central attachment hole, wherein the reducing ring is inserted into the central hole so that the attachment hole of the reducing ring is coaxial with respect to the central hole of the annular body, and wherein the reducing ring comprises two opposing enlarged axial end stretches configured to axially lock the reducing ring to the central hole of the annular body.

9. The abrasive grinding wheel according to claim **8**, wherein the central hole of the annular body comprises two opposing axial end stretches having enlarged sections with respect to a central stretch having a tapered section axially interposed between the two axial end stretches having enlarged sections, the opposing axial end stretches of the reducing ring substantially engaging to measure with the axial end stretches of the central hole of the annular body.

10. The abrasive grinding wheel according to claim **8**, wherein the reducing ring is made of a plastic material.

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